|  |  |
| --- | --- |
| **Radiocommunication Study Groups** |  |
|  |  |
|  |  |
| Source: Document 5A/TEMP/190 | **Annex 16 to****Document 5A/421-E** |
| **2 December 2013** |
| **English only** |
| Annex 16 to Working Party 5A Chairman’s Report |
| Working document toward a preliminary draft new Report ITU-R M.[PPDR]  |
| “Public protection and disaster relief communications”Editor’s Note: Align the title to the content at a later stage |

INDEX

[1. Scope 3](#_Toc372813379)

[2. Introduction 3](#_Toc372813380)

[3. References 3](#_Toc372813381)

[4. Abbreviations and acronyms 6](#_Toc372813382)

[5. Terminology 7](#_Toc372813383)

[Part 1 - Objectives and requirements](#_Toc372813384) 10

[6. Generic radiocommunication objectives and requirements for
PPDR services and applications 10](#_Toc372813385)

[6.1 Objectives 10](#_Toc372813386)

[6.1.1 General objectives 10](#_Toc372813387)

[6.1.2 Technical objectives 11](#_Toc372813388)

[6.1.3 Operational objectives 12](#_Toc372813389)

[6.2 Technical requirements 13](#_Toc372813390)

[6.2.1 General requirements 13](#_Toc372813391)

[6.2.2 User requirements 20](#_Toc372813392)

[6.2.3 Operating environments 20](#_Toc372813393)

[6.3 Examples of PPDR network deployment scenarios and
technical implementation 22](#_Toc372813394)

[6.4 General aspects of frequency bands for PPDR 26](#_Toc372813395)

[6.5 Interoperability 26](#_Toc372813396)

[Part 2 – Broadband PPDR](#_Toc372813397) 28

[7. Broadband PPDR communications 28](#_Toc372813398)

[7.1 Considerations on further developments of B-PPDR services and applications 28](#_Toc372813399)

[7.1.1 Demands and requirements on broadband PPDR systems 28](#_Toc372813400)

[8. The evolution of broadband PPDR through advances in technology 32](#_Toc372813401)

[8.1 Current standardized solutions 32](#_Toc372813402)

[8.2 Table of broadband PPDR requirements 36](#_Toc372813403)

[8.3 Spectrum requirements for broadband PPDR [place TBD] 37](#_Toc372813404)

[8.3.1 Harmonisation of spectrum and the establishment of harmonized
conditions for PPDR 37](#_Toc372813405)

[8.4 Planned evolutions of the standards 38](#_Toc372813406)

[8.4.1 Advantages of globally harmonized IMT technology for BB PPDR 38](#_Toc372813407)

[8.4.2 Advantages of PPDR using frequency bands harmonized for IMT 39](#_Toc372813408)

[8.5 Technology development 40](#_Toc372813414)

[Part 3 – Narrow / Wideband PPDR communications](#_Toc372813415) 40

[Part 4 – Needs of developing countries](#_Toc372813421) 41

[9. The needs of developing countries 41](#_Toc372813422)

[9.1 Technology requirement 41](#_Toc372813423)

[9.2 Cost requirement 41](#_Toc372813424)

[9.3 Deployment requirement 41](#_Toc372813425)

[Annex 1 42](#_Toc373310832)

[Annex 2 - Throughput requirements of broadband PPDR scenarios 49](#_Toc373310833)

[Annex 3 - Methodology to calculate [broadband] spectrum requirements 53](#_Toc373310834)

[Annex 4 - Scenario of lte based technology for PPDR broadband
provided by China 68](#_Toc373310835)

[Annex 5 - Methodology for the calculation of broadband PPDR
spectrum requirements within CEPT 69](#_Toc373310837)

[Annex 6 - Definitions 70](#_Toc373310839)

[Annex 7 - Table of technical requirements for mission critical PPDR
broadband communications 73](#_Toc373310841)

[Annex 8 - Information from International Standardisation Organisation
on activities with regards to public protection and disaster relief (PPDR) 81](#_Toc373310843)

# 1 Scope

This report addresses:

* the generic technical and operational requirements relating to public protection and disaster relief (PPDR);
* the mobile broadband PPDR services and applications including further developments and the evolution of PPDR through advances in technology;
* the current use of narrow and wide-band PPDR;
* the needs of developing countries in accordance with Resolution **648**,

whilst also aiming to depict the current and future use of narrow-, wide- and broadband networks or technologies for PPDR services and applications.

Editor’s Note: What the scope addresses in the bullets above may be a bit too wide.

This Report should be reviewed during each ITU-R study period to ensure that it is up-to-date and meets user requirements and technology advances.

# 2 Introduction

In recent decades, demand for global development and enhancement of PPDR applications for public protection requirements has shown a significant increase, in order to enable more efficient and more effective responses to PPDR events including natural and man-made disasters, in addition to responding to routine daily events. At the same time, mobile broadband technologies have advanced rapidly with peak data rates up to 1 Gbit/s in the downlink and 500 Mbit/s [Editor’s Note: To check for the numbers in the WP 5D Report] in the uplink. On the other hand narrow and wideband technologies for PPDR services and applications are still in widely use in all the Regions.

WRC-12 resolved to review the requirements of broadband PPDR technologies and applications, including the need for mobile video and other applications demanding high bit rates by PPDR organizations, and adopted WRC-15 agenda item 1.3 “to review and revise [Resolution **646** **(Rev.WRC-12)**](http://www.itu.int/oth/R0A0600001A/en) for broadband public protection and disaster relief (PPDR) , in accordance with Resolution **648 (WRC-12)**”

Resolution **648 (WRC-12)** invites ITU‑R to study technical and operational issues relating to broadband PPDR and its further development and to develop recommendations, as required, on:

– technical requirements for PPDR services and applications;

– the evolution of broadband PPDR through advances in technology;

– the needs of developing countries.

# 3 References

ITU-R Recommendations and Reports

Editor's note: Most of the References below were taken from current Report ITU-R M.2033 and need to be reviewed.

Resolution ITU-R [53](http://www.itu.int/pub/R-RES-R.53) - The use of radiocommunications in disaster response and relief.

Resolution ITU-R [55](http://www.itu.int/pub/R-RES-R.55) - ITU studies of disaster prediction, detection, mitigation and relief.

Resolution ITU-R **646 (Rev.WRC-12)** - Public protection and disaster relief.

Resolution ITU-R **644 (Rev.WRC-12)** - the ITU-R was asked to study those aspects of Radiocommunication resources for early warning, disaster mitigation and relief operations.

Resolution ITU-R **647 (Rev.WRC-12)** - Spectrum management guidelines for emergency and disaster relief operations.

Report ITU-R [M.2085](http://www.itu.int/pub/R-REP-M.2085/en) - Role of the amateur and amateur-satellite services in support of disaster mitigation and relief.

Report ITU-R [M.2014](http://www.itu.int/pub/R-REP-M.2014) - Digital land mobile systems for dispatch traffic.

Report ITU-R [M.[IMT.BROAD.PPDR]](http://www.itu.int/md/R12-SG05-C-0064/en) - The use of International Mobile Telecommunications (IMT) for broadband public protection and disaster relief (PPDR) applications.

Recommendation ITU-R [M.1042](http://www.itu.int/rec/R-REC-M/recommendation.asp?lang=en&parent=R-REC-M.1042) - Disaster communications in the amateur and amateur-satellite services.

Recommendation ITU-R [M.1637](http://www.itu.int/rec/R-REC-M.1637/en) - Global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations.

Recommendation ITU-R [M.2015](http://www.itu.int/rec/R-REC-M.2015/en) - Frequency arrangements for public protection and disaster relief radiocommunication systems in UHF bands in accordance with Resolution **646 (Rev.WRC-12)**.

Recommendation ITU-R [M.2009](http://www.itu.int/rec/R-REC-M.2009/en) - Radio interface standards for use by public protection and disaster relief operations in some parts of the UHF band in accordance with Resolution **646 (WRC‑03)**.

Recommendation ITU-R [M.1826](http://www.itu.int/rec/R-REC-M.1826/en) - Harmonized frequency channel plan for broadband public protection and disaster relief operations at 4 940-4 990 MHz in Regions 2 and 3.

Recommendation ITU-R [M.1746](http://www.itu.int/rec/R-REC-M.1746/en) - Harmonized frequency channel plans for the protection of property using data communication.

Recommendations and Reports of other organisations

APT, Report 38 on technical requirements for mission critical broadband PPDR communications.

<http://www.apt.int/sites/default/files/Upload-files/AWG/APT-AWG-REP-38-APT_Report_on_PPDR.docx>

CEPT, ECC Report 199 – User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks).

<http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP199.PDF>

Editor’s Note: A relevant separate ECC Deliverable will at a later stage be provided to depict the decision of CEPT on possible frequency bands/ranges and spectrum needs and requirements.

Editor’s Note: CITEL Recommendation missing here.

[Public Safety 700 MHz Broadband Statement of Requirements, v0.6, by the National Public Safety Telecommunications Council (NPSTC), USA, 8th November 2007.

Public Safety Statement of Requirements (PS SoR) for Communications and Interoperability (C&I), Volume 1, v1.2, by the Department of Homeland Security’s Office for Interoperability and Compatibility, October 2006.

Public Safety Statement of Requirements (PS SoR) for Communications and Interoperability (C&I), Volume 2, v1.0, by the Department of Homeland Security’s Office for Interoperability and Compatibility, August 2006.]

"FCC Takes Action to Advance Nationwide Broadband Communications for America’s First Responders" <http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-304244A1.doc>

FCC "Third Report and Order and Fourth Further Notice of Proposed Rulemaking" pertaining to Docket Numbers: WT Docket No. 06-150, PS Docket No. 06-229 and WP Docket No. 07-100. The Report and Order was adopted on January 25, 2011 and released on January 26, 2011. <http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-6A1.pdf>.

National Public Safety Telecommunications Council, “700 MHz Statement of Requirements for Public Safety (SoR)” <http://www.npstc.org/statementOfRequirements.jsp>.

U. S. Department of Homeland Security, “Technology Solutions and Standards Statement of Requirements” <http://www.safecomprogram.gov/library/lists/library/DispForm.aspx?ID=302>.

National Public Safety Telecommunications Council, “Recommended Minimum Technical Requirements to Ensure Nationwide Interoperability for the Nationwide Public Safety Broadband Network, Final Report”, NPSTC BBWG, 22 May 2012.

National Public Safety Telecommunications Council, “Mission Critical Voice Communications Requirements for Public Safety”, NPSTC BBWG, 30 August 2011

National Public Safety Telecommunications Council, “Public Safety Broadband High‑Level Statement of Requirements for FirstNet Consideration”, NPSTC Report Rev B, 13 June 2012

Editor's note: The US to check the validity of the above references for Broadband use.

FCC "Third Report and Order and Fourth Further Notice of Proposed Rulemaking" pertaining to Docket Numbers: WT Docket No. 06-150, PS Docket No. 06-229 and WP Docket No. 07-100. The Report and Order was adopted on January 25, 2011 and released on 26 January 2011. <http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-6A1.pdf>.

National Public Safety Telecommunications Council, 700 MHz Statement of Requirements for Public Safety (SoR) <http://www.npstc.org/statementOfRequirements.jsp>.

U. S. Department of Homeland Security Technology Solutions and Standards Statement of Requirements <http://www.safecomprogram.gov/library/lists/library/DispForm.aspx?ID=302>.

CEPT ECC WG FM PT 49 Radio Spectrum for Public Protection and Disaster Relief (PPDR), Report from FM Project Team 49 (2nd and 3rd meetings) <http://www.cept.org/ecc/groups/ecc/wg-fm/fm-49>.

Recommended Minimum Technical Requirements to Ensure Nationwide Interoperability for the Nationwide Public Safety Broadband Network, Final Report, NPSTC BBWG, 22 May 2012.

Mission Critical Voice Communications Requirements for Public Safety, NPSTC BBWG, 30 August 2011.

Public Safety Broadband High-Level Statement of Requirements for FirstNet Consideration, NPSTC Report Rev B, 13 June 2012.

Editor’s Note: Standardisation activities and related references are moved in to Annex 8.

# 4 Abbreviations and acronyms

Editor’s Note: to be cross-checked with 5.2.1 on Terminology and Annex [5] on Definitions, only one appropriate place for each term should remain.

Editor’s Note: Missing terms to be provided.

|  |  |
| --- | --- |
| A(V)LS  | [No explanation given in the text] |
| AGA | Air-ground-air (communication) |
| ANPR | [No explanation given in the text] |
| B-PPDR | Broadband PPDR |
| CCC | Command and control centre |
| D2D | Device to device (communications) |
| DMO | Direct mode operation |
| CHOGM | Commonwealth Heads of Government Meeting  |
| GIS | Geo information system |
| GMPCS-MoU | Global Mobile Personal Communications by Satellite Memorandum of Understanding  |
| GoS | Grade of Service  |
| IMT | International Mobile Telecommunication  |
| LTE | Long Term Evolution (3GPP 4G technology) |
| NB | Narrow band(widths) |
| OAM | Operation administration and maintenance |
| PDA | [No explanation given in the text] |
| PIM | [No explanation given in the text] |
| PPDR | Public Protection and Disaster Relief |
| PTT | Push to talk |
| RAN | Radio access network  |
| SDR | Software defined radio |
| UE | User equipment |
| VPN | Virtual Private Network  |
| WAN | Wide Area Network |
| WB | Wide band(widths) |
| BB | Broad band(widths) |

# 5 Terminology

Editor’s Note: This section will have to be reconciled with Annex 5.

Public protection and disaster relief (PPDR)

There are terminology differences between administrations and regions in the scope and specific meaning of PPDR. The following terms are appropriate for the purpose of discussing this issue:

– Public protection (PP) radiocommunication: Radiocommunications used by agencies and organizations responsible for dealing with maintenance of law and order, protection of life and property, and emergency situations.

– Disaster relief (DR) radiocommunication: Radiocommunications used by agencies and organizations dealing with a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as a result of complex, long-term processes.

Editor’s Note: To be aligned with the result of related considerations on the definitions above.

Narrowband, wideband, broadband

Communications supporting PPDR operations cover a range of radiocommunication services such as fixed, mobile, amateur and satellite. Typically, narrowband systems are used for PPDR communications within the terrestrial mobile service, while wideband and broadband systems are used for PPDR applications within all radiocommunication services.

There are some differences between administrations and regions in the scope and specific meaning of narrowband, wideband and broadband. However, the ITU-R considers the following terms appropriate for the purpose of discussing this issue.

Narrowband (NB)

To provide PPDR narrowband applications, the trend is to implement wide area networks including digital trunked radio networks providing digital voice and low speed data applications (e.g. pre‑defined status messages, data transmissions of forms and messages, access to databases). ITU Report ITU-R M.2014 lists a number of systems, with typical channel bandwidths up to 25 kHz that are currently used to deliver narrowband PPDR applications. Some countries do not mandate specific technology standards, but promote the use of spectrum-efficient technologies.

Wideband (WB)

Wideband systems carry raw data rates of several hundred kilobits per second (e.g. in the range of 384-500 kbit/s). In the future, it is anticipated that networks may be required higher to support data rates, as a whole new class of applications including wireless transmission of large blocks of data, video and Internet protocol-based connections in mobile PPDR, may be introduced.

The use of relatively high-speed data in commercial activities has therefore spurred the development of specialized mobile data applications. Short message and e-mail are seen as a fundamental part of any communications control and command system and may play an integral part of any PPDR capability.

A wideband wireless system may be able to reduce response times of accessing the Internet and other information databases directly from the scene of an incident or emergency. This has initiated the development of a range of secure applications for PPDR agencies.

Systems for wideband applications to support PPDR are under development in various standards organizations. Many of these developments are referenced in Report ITU-R M.2014 and in Recommendations ITU-R M.1073, ITU-R M.1457, ITU-R M.1801 and ITU-R M.2012, and with channel bandwidths dependent on the use of spectrally efficient technologies.

Broadband (BB)

Broadband applications enable an entirely new level of functionality with additional capacity to support higher speed data and higher resolution images. It should be noted that the demand for multimedia capabilities (several simultaneous wideband and/or broadband applications running in parallel) puts a huge demand with very high bit rates on a wireless system.

Broadband applications provide voice, high-speed data, high quality digital real time video and multimedia (indicative data rates in range of 1-100 Mbit/s) with channel bandwidths dependent on the use of spectrally efficient technologies. Examples of possible applications include:

– high-resolution video communications from wireless clip-on cameras to a vehicle-mounted laptop computer, used during traffic stops or responses to other incidents and video surveillance of security entry points such as airports with automatic detection based on reference images, hazardous material or other relevant parameters;

– remote monitoring of patients and remote real time video view of the single patient demanding high bit rates. The demand for capacity can easily be envisioned during the rescue operation following a major disaster.

Editor’s Note: Definitions to be updated, consideration to given to deleting any mention of data rates.

Categories of operations

Public protection radiocommunications (PP) are to be used by responsible agencies and organisations dealing with maintenance of law and order, protection of life, property and other emergency situations under the following operations:

* day-to-day operations – planned (category “PP1”);
* large emergency and/or public events – planned and/or unplanned (category “PP2”);
* disasters – unplanned (category “DR”).

Editor’s Note: Section 6.2.3 – Operation environments - might be moved to this section.

Consideration of advantages with state-of-the-art technologies

While voice communications will remain a critical component of PPDR operations, new data and video services will play a key role. For instance, PPDR agencies today use applications such as video for surveillance of crime scenes and of highways, to monitor and conduct damage assessment of wild fire scenes from airborne platforms to provide real-time video back to emergency command centres. Also, there is a growing need for full motion video for other uses such as robotic devices in emergency situations. These types of future advanced solutions will be capable of providing local voice, video and data networks, thereby serving the needs of emergency personnel responding to an incident.

If these applications were implemented globally with state-of-the art technologies, it could increase the availability, and reduce the cost of both, user and infrastructure equipment, increase the potential of interoperability, may provide for a wider range of capabilities and reduce network infrastructure rollout time.

PPDR agencies and organizations may also be enabled to keep up with increasing demands and facilitate the implemention of advanced voice, text, video and other intensive data applications and services designed to enhance service delivery. In this regard, it should be noted that any development or planning for the use of state-of-the art technologies may require that consideration be given to spectrum aspects for PPDR applications.

Editor’s Note: Relevant parts of Report ITU-R M.[IMT.BROAD.PPDR] could be inserted in this section.

Editor’s Note: Part of the cost related consideration (in 6.2.1) might be moved to here in order to replace the above.

Part 1

Objectives and requirements

Editor’s Note: Considerations within the preparatory process in ITU-R WP 5A prior WRC-15 on agenda item 1.3 with regards to the invites of **Resolution 648 (WRC-12)** revealed obvious similarities and commonalities of objectives and requirements for PPDR services and applications for all bandwidths to be used. This text originates from Annex 20 of Document [5A/306](http://www.itu.int/md/R12-WP5A-C-0306/en).

The following section describes objectives and requirements for PPDR services and applications in a generic way, autonomously from intended bandwidths or frequency ranges.

# 6 Generic technical and operational objectives and requirements for PPDR services and applications

## 6.1 Objectives

### 6.1.1 General objectives

Editor’s Note: Revision to Report ITU-R M.2033 to be highlighted.

PPDR radiocommunication systems aim to achieve the following general objectives:

a) to provide radiocommunications that are vital to the achievement of:

– the maintenance of law and order;

– response to emergency situations and protection of life and property;

– response to disaster relief situations;

b) to provide the services as identified above in item a) over a wide range of geographic coverage areas, including urban, suburban, rural and remote environments;

c) to aid the provision of future advanced solutions requiring high data rates, video and multimedia used by PPDR agencies and organizations especially in day-to-day operations and in large emergencies and public events;

d) to support interoperability and interworking between networks, both nationally and for cross-border operation, in emergency and disaster relief situations;

e) to allow international operation and roaming of mobile and portable units;

f) to make efficient and economical use of the radio spectrum, consistent with providing services at an acceptable cost;

g) to accommodate a variety of mobile terminals from those which are small enough to be carried on ones person to those which are mounted on vehicles;

h) to encourage the cooperation between countries for the provision of effective and appropriate humanitarian assistance during disaster relief situations;

i) to make available PPDR radiocommunications at reasonable costs in all markets;

j) to support the needs of developing countries, including the provision for low-cost solutions for PPDR agencies and organisations.

### 6.1.2 Technical objectives

Editor’s Note: Revision to Report ITU-R M.2033 to be highlighted.

Systems for PPDR aim to achieve the following technical objectives:

a) to support the integration of voice, data, video and image communication;

Editor’s Note: Streamlining on “voice data graphics video” in the whole draft necessary.

Editor’s Note: Maybe we could consider introducing a term such as “multi-media delivery (both real-time and non-real time)” this term is actually used subsequently.. so perhaps a good idea to mention it here upfront...

b) to provide additional level(s) of priority, availability and security associated with the type of information carried over the communication channels associated with the various PPDR applications and operations;

[c) to provide each PPDR organization with user authentication (e.g., public key cryptography) among PPDR organizations and for their devices prior granting access to their applications or network resources;]

d) to support equipment that operates in extreme and diverse operational conditions (rough road, dust, extreme temperature, etc.);

e) to accommodate the use of repeaters for covering long distances between terminals and base stations in rural and remote areas and also for intensive on-scene localized areas;

f) to provide fast call set-up, one touch broadcasting (PTT to group) and group call features;

g) to provide for emergency calls, one touch emergency alert, emergency voice PTTs, and emergency data PTTs (e.g. sending images, real-time video) during PPDR events.h) to support information pull, push and subscription with prioritisation;

i) to provide for strong multi-national/multi-agency technical interoperability over multi‑network and device technologies in a seamless fashion;

j) to provide DMO communication;

k) to provide for the ability to interface with existing communication systems, e.g. for capacity off load;

Editor’s Note: Clarification needed what is meant by “existing communication system” – PPDR or non-PPDR? – another bullet might be required.

l) to be scalable in order to suit small and large agencies, without sacrificing the ability to interoperate;

m) to provide for quick deployment of temporary infrastructure and services as well as recovery from failure;

[n) to provide continuous support for on-going services in case of backhaul-link failure to a minimal set of PPDR services;]

Editor’s Note: m) + n) might be combined.

Editor’s Note: The following section on “Applicability of…” might be deleted.

Applicability of voice, data, images and video to global/regional PPDR

As PPDR operations become more reliant on electronic databases and data processing, access to accurate and detailed information by staff in the field such as police, fire fighters and medical emergency personnel is critical to improving the effectiveness of the staff in resolving emergency situations. This information is typically held in office based database systems and includes images, maps, architectural plans of buildings, and locations of hazardous materials systems.

In the other direction, the flow of information back from units in the field to operational control centres and specialist knowledge centres is equally important. Examples to note are the remote monitoring of patients and remote real-time video monitoring of civil emergency situations including the use of remote control robotic devices. Moreover, in disaster and emergency situations, critical decisions to be made by controlling authorities are often impacted by the quality and timeliness of the information received from the field.

These applications in general require higher bit rate data communications than can be provided by narrowband PPDR systems. The availability of future advanced applications is expected to be beneficial to PPDR operations.

Editorial Note: The section above is taken from Report ITU-R M.2033 and may need to be reviewed to bring up to date.

### 6.1.3 Operational objectives

Systems for PPDR aim to achieve operational objectives, including the following:

a) to provide security including end-to-end encryption possibility, and secure terminal/network authentication;

b) to enable communications management to be controlled by PPDR agencies and organizations through such functions as instant/dynamic reconfiguration change, set-up talk groups, guaranteed access including priority and pre-emption calls, groups or general calls, spectrum resource availability for multiple PPDR agencies and organizations, coordination and rerouting;

[Editors’s note: The added text to b) was taken from Report ITU-R M.2033.]

c) to provide communications through the system/network and/or independent of the network such as direct mode operation (DMO), simplex radio and push-to-talk;

d) to provide customized and reliable coverage especially for indoor areas such as under‑ground and inaccessible areas. To also allow for the extension of cell size or capacity in rural and remote areas or under severe conditions during emergency and disaster situations;

e) to provide full service continuity through measures such as redundancy for emergency operations, and the possibility to rapidly provide temporary coverage and capacity, e.g. at partial loss of infrastructure;

f) to provide high quality of service including instant call set-up and instant push-to-talk, resilience under extreme load, very high call set-up success rate, etc.;

g) to take account of various PPDR applications;

h) to provide for multi-national/multi-agency interoperability at various levels of chain of command as well as other collaborating organisations and/or entities;

i) user handsets/devices to be easily useable and configurable with little need for technical expertise.

## 6.2 Technical requirements

### 6.2.1 General requirements

a) Applications associated with the routine day-to-day and emergency operations for public protection applications as outlined in Table 6-1 could be offered.

b) Applications associated with disaster relief operations as outlined in Table 6-1 could be offered.

c) Regional and/or international harmonization of spectrum for the provision of PPDR applications could be considered if a requirement is determined for this need.

d) Applications for PPDR could be developed to support a variety of user terminals including handheld and vehicle-mounted.

e) The description of operating environments for PPDR is provided in section 6.2.3 below.

Editor’s note: If the text in e) “operating environments” is moved then this text will need to be updated.

Application availability requirements

The eventual availability of applications for PPDR may depend on various factors. These include the cost, the regulatory and the national legislative climate, the nature of the PPDR mandates, and the need of the area to be served. The exact applications and particular features to be provided by the various PPDR organizations are to be decided by such organizations.

Editor’s Note: Need to consider an alternative term for accessibility.

Envisioned applications

Table 6-1 lists the envisioned applications with particular features and specific PPDR examples. The applications are grouped under the narrowband, wideband or broadband headings to indicate which technologies are most likely to be required to supply the particular application and their features. However, Broadband technologies are expected to be able to supply all of the applications shown in table 6-1 below. Broadband applications enable an entirely new level of functionality with additional capacity to support higher speed data and higher solution images. The exact applications and particular features to be provided by the various PPDR organizations are to be decided by such organizations. Furthermore, for each example, the importance (high, medium or low) of that particular application and feature to PPDR is indicated.

Editor’s note: There is a need to check for appropriate grouping, deletion of duplication and reconsideration on importance for both Tables 6-1 and 6-2.

TABLE 6-1

PPDR Applications and Examples

Editor’ Note: May be reconciled with the Table 9-4.

| Application | Feature | PPDR Example | Importance(1) |
| --- | --- | --- | --- |
| PP (1) | PP (2) | DR |
| 1.*Narrowband* |  |  |  |  |  |
| Voice | Person-to-person | Selective calling and addressing |  |  |  |
| One-to-many | Dispatch and group communication |  |  |  |
| Talk-around/directmode operation | Groups of portable to portable (mobile-mobile) in close proximity without infrastructure |  |  |  |
| Push-to-talk | Push-to-talk |  |  |  |
| Instantaneous access to voice path | Push-to-talk and selective priority access |  |  |  |
| Security | Voiceencryption/scrambling |  |  |  |
| Facsimile | Person-to-person | Status, short message |  |  |  |
| One-to-many (broadcasting) | Initial dispatch alert (e.g. address, incident status) |  |  |  |
| Messages | Person-to-person | Status, short message, short e-mail |  |  |  |
| One-to-many (broadcasting) | Initial dispatch alert (e.g. address, incident status) |  |  |  |
| Security | Priority/instantaneous access | Man down alarm button |  |  |  |
| Telemetry | Location status | GPS latitude and longitude information |  |  |  |
| Sensory data | Vehicle telemetry/status |  |  |  |
| EKG (electrocardiograph) in field |  |  |  |
| Environmental information including sensory data on air quality, temperature, contamination, radiation levels etc. |  |  |  |
| Database interaction (minimal record size) | Forms based records query | Accessing vehicle license records |  |  |  |
| Accessing criminal records/missing person |  |  |  |
| Forms based incident report | Filing field report |  |  |  |
| 2. *Wideband* |  |  |  |  |  |
| Messages | E-mail possibly with attachments | Routine e-mail message |  |  |  |
| Data Talk‑around/direct mode operation | Direct unit to unit communication without additional infrastructure | Direct handset to handset, on-scene localized communications |  |  |  |
| Database interaction (medium record size) | Forms and records query | Accessing medical records |  |  |  |
| Lists of identified person/missing person  |  |  |  |
| GIS (geographical information systems) |  |  |  |
| Text file transfer | Data transfer | Filing report from scene of incident |  |  |  |
| Records management system information on offenders |  |  |  |
| Downloading legislative information |  |  |  |
| Image transfer | Download/upload of compressed still images | Biometrics (finger prints, facial recognition) |  |  |  |
| ID picture (car number plate recognition) |  |  |  |
| Building layout maps |  |  |  |
| Telemetry | Location status and sensory data | Vehicle status |  |  |  |
| Security  | Priority access | Critical care |  |  |  |
| Video | Download/upload compressed video | Video clips |  |  |  |
| Patient monitoring (may require dedicated link) |  |  |  |
| Video feed of in-progress incident |  |  |  |
| Interactive | Location determination | 2-way system  |  |  |  |
| Interactive location data |  |  |  |
| 3. *Broadband* |  |  |  |  |  |
| Direct mode operation of video and data | Direct unit to unit video and data communication without infrastructure | Direct handset to handset, on-scene localized command and control |  |  |  |
| Database access | Intranet/Internet access | Accessing architectural plans of buildings, location of hazardous materials |  |  |  |
| Web browsing | Browsing directory of PPDR organization for phone number |  |  |  |
| Robotics control | Remote control of robotic devices | Bomb retrieval robots, imaging/video robots |  |  |  |
| Video | Video streaming, live video feed, Download/upload of video clips, Video Conferencing  | Video communications from wireless clip-on cameras used by in building fire rescue |  |  |  |
| Image or video to assist remote medical support |  |  |  |
| Surveillance of incident scene by fixed or remote controlled robotic devices |  |  |  |
| Assessment of fire/flood scenes from airborne platforms |  |  |  |
| Multi-scene video dispatch |  |  |  |
| Multicast of Multimedia from a BS to multiple users in a given area (e.g. Pt to MPt/Broadcast) |  |  |  |
| video conferencing 1 to 1, 1 to many, etc  |  |  |  |
| Encrypted video streaming |  |  |  |
| Real-time multimedia intelligence | Real time optimisation of video or other multimedia content | Optimise the use of allocated bandwidth to support multiple video streams |  |  |  |
| Imagery | Download/upload High resolution imagery | Downloading Earth exploration-satellite images |  |  |  |
| Real-time medical imaging |  |  |  |
| (1) The importance of that particular application and feature to PPDR is indicated as high (H), medium (M), or low (L). This importance factor is listed for the three radio operating environments: “Day-to-day operations”, “Large emergency and/or public events”, and “Disasters”, represented by PP (1), PP (2) and DR, respectively. |

The Table below lists examples of the envisioned applications based on current operational experience and the vision of future working practices of PPDR organisations.

Editor’s Note: Table 6-2 needs to be aligned with Table 6-1 and/or checked to see if it should be in Broadband section of the report.

TABLE 6-2

Overview on envisaged PPDR applications

| Type of application | Service |
| --- | --- |
| Location data | A(V)LS data to CCC (persons + vehicles positions) |
| A(V)LS data return |
| Multi media | Video from/to CCC for following + intervention |
| Low quality additional feeds |
| Video for fixed observation |
|  |
| Video on location (disaster or event area) to and from control room – high quality |
| Video on location (disaster or event area) to and from control room – low quality |
| Video on location (disaster or event area) for local use |
| Video conferencing operations |
| Non real time recorded video transmission |
| Photo broadcast |
| Photo to selected group (e.g. based on location) |
| **Office applications** | PDA PIMsync |
| Mobile workspace + (incl. public internet) |
| **Download operational information** | Incident information download (text + images) from CCC to field units + Netcentric working |
| ANPR update hit list |
| Download maps with included information to field units |
| Command & control information incl. task management + briefings |
| **Upload operational information** | Incident information upload (text + images) to CCC + Netcentric working |
| Status information + location |
| ANPR / speed control automatic upload to data base incl. pictures (temporally ‘fixed’ camera’s + from vehicles) |
| Forward scanned documents |
| Reporting incl. pictures etc. |
| Upload maps + schemes with included information |
| Patient monitoring (ECC) snapshot to hospital |
| Patient monitoring (ECC) real time monitoring to hospital |
| Monitoring status of security worker (drop detection, stress level, carbon monoxide etc) |
| **Online data base enquiry** | Operational data base search (own + external) |
| Remote medical database services |
| ANPR checking number plate live |
| Biometric (e.g. fingerprint) check |
| Cargo data |
| Crash Recovery System (asking information on the spot) |
| Crash Recovery System (update to vehicles from data base) |
| **Miscellaneous** | Software update online |
| GIS maps updates |
| Automatic telemetries inclusive remote controlled devices + information from (static) sensors |
| Hotspot on disaster or event area (e.g. in mobile communication centre) |
| Front office – back office applications |
| Alarming / paging |
| Traffic management system: information on road situations to units |
| Connectivity of abroad assigned force to local ccc / Mutual aid operations |

Editors Note: The para below needs to be reviewed to see if it would be more suitable in the Interoperability section 6.5, The term Technical Compatibility may need to be defined or needs to aligned with ITU-R Definitions. Two separate ideas are trying to be addressed here compatibility/interopibility between PPDR networks and the other between PPDR and Commercial networks.

[Interoperability (Technical compatibility to address technology evolution)

PPDR networks should be compatible with existing networks used for PPDR communications. Compatibility requirements may include diversity of supply, use of open international standards, backward compatibility, and a smooth upgrade and evolution path. The currently on-going evolution of systems and technology providing PPDR might alleviate most of the compatibility requirements (see section 9.3.2 - Interoperability and Roaming).

PPDR networks must provide compatibility with existing network types such as current PPDR trunked networks, although the mechanism of achieving this may differ between countries. Compatibility requirements may also include diversity of supply, use of open international standards, backward compatibility, and having a smooth upgrade and evolution path.]

Spectrum usage and management

Depending on national circumstances and regulatory options, PPDR users may need to share spectrum resources with other terrestrial mobile users. The detailed arrangements regarding sharing of the spectrum vary from country to country. Furthermore, there may be several different types of systems supporting PPDR operating in the same geographical area.

Therefore systems and applications providing for PPDR need appropriate/sufficient protection in order to meet the required QoS. Depending on the national regulations, systems supporting PPDR may be required to use specific channel spacing between mobile and base station transmit frequencies.

Editor’s Note: CEPT to explain what the term appropriate/ sufficient protection means.

And/Or

Therefore, interference to systems supporting PPDR from non-PPDR users should be minimized as much as possible. This is generally achieved through appropriate spectrum planning and frequency coordination at the national level.

Each administration has the discretion to determine suitable spectrum for PPDR.

Regulatory compliance

Systems supporting PPDR should comply with the relevant national regulations. In border areas (near the boundary between countries), suitable coordination of frequencies should be arranged, as appropriate.

Editorial Note: Concern expressed that the text below may need to be reviewed to explain the situation of where extended coverage may be necessary across borders more clearly.

The capability of systems supporting PPDR to support or provide where necessary extended coverage into the neighbouring country(ies) should also comply with regulatory agreements between the neighbours.

Planning

Planning and pre-coordination by PPDR agencies and organisations are essential to providing reliable PPDR communications. This includes ensuring that sufficient equipment and backhaul is available (or can be rapidly called upon) to provide communications during unpredictable events and disasters, and ensuring that channels/resources, user groups and encryption keys are pre-allocated for seamless deployment. It would be beneficial to maintain accurate and detailed information so that PPDR users can access this information at the scene.

Administrations have, or may also find it beneficial to have, provisions supporting national, state/provincial and local (e.g. municipal) systems.

Cost related requirements

Cost effective solutions and applications are extremely important to PPDR users. These can be facilitated by open standards, a competitive marketplace, and economies of scale. Furthermore, cost effective solutions that are widely used can reduce the deployment costs of network infrastructure as well as user devices and other equipment.

Although the importance of the given demands and requirements is recognised, PPDR equipment should be manufactured at a reasonable cost, while incorporating various aspects specific to each country/organization. Administrations should consider the cost implications of interoperable equipment since this requirement should not be so expensive as to preclude implementation within an operational context.

Considering for example PPDR applications using IMT systems, it may be possible to use commercial IMT networks in regions where it is not cost-effective to deploy a dedicated network. IMT is intended for deployment in a wide range of environments, from rural to the densest urban areas. Commercial networks that are being deployed using IMT systems may not meet all of the identified needs for PPDR. However, the use of these systems should be considered, particularly in terms of the potential associated cost savings and advanced features that they offer.

Broadband PPDR services will be realized through any type of network (commercial, hybrid or dedicated), which will be deployed in frequency bands identified for IMT. The possibility to use available commercial equipment, or equipment based on commercial radio modules or chipsets may significantly reduce the costs for network infrastructure (e.g. base stations) and user devices (e.g. terminals).

Editor’s note: The above two paragraphs are more relevant for BB technologies. We need to consider if this text should be moved to section 5 or section 7.1.1 of this report.)

ITU-R also notes that PP networks may cost more than DR networks due to more stringent requirements of PP systems[[1]](#footnote-1). However, most of these costs are related to network design (power supply, redundant transmission etc).

Cost effective solutions and applications will continue to be extremely important to PPDR agencies, especially if they are responsible for ongoing operational expenses. Therefore, the use of open standards, maintenance of a competitive marketplace, and explicit support for broader economies of scale, will be important issues for consideration by national administrations.

Electromagnetic compatibility (EMC) requirements

Systems supporting PPDR should be in accordance with appropriate EMC regulations. Adherence to national EMC regulations may be required between networks, radiocommunications standards and co located radio equipment.

### 6.2.2 User requirements

Editor’s Note: Report ITU-R M.2033 also had a section on “System requirements.” The text from this section of Report ITU-R M.2033 is currently found in section 7.1.1 of this report. Should it be handled here as another heading and deleted from section 7.1.1?

This section includes the requirements from the perspective of the PPDR end users. General technologies, as well as functional and operational requirements are described. Although some of the requirements do not relate specifically to the radiocommunication network or system used by PPDR, they do affect the design, implementation and use of radiocommunications. Network related PPDR requirements are the requirements from the perspective of PPDR users who are supposed to utilise the communications network in order to fulfil their duties. Network related requirements describe the communications network’s capabilities that are observable to the users.

The categories of network related PPDR requirements have been identified: functional requirements, performance requirements, security requirements, interoperability requirements, adaptability requirements, compatibility requirements, reliability requirements and expandability requirements.

However, the detailed choice of PPDR applications and features to be provided in any given area by PPDR is a national or operator specific matter. However, the capabilities of the service are affected by these requirements.

The listed above requirements are seen as integral part of a day-to-day usage of a PPDR network, Nevertheless First Responders and other forces, e.g. in disaster relief may have more specialized demand to PPDR systems and networks, not covered by this generic overview.

### 6.2.3 Operating environments

Editor’s Note: This section may be moved to section 5 after “categories of operation.” We also need to look at rationalising the text in this section and possibly the text in section 5.

Editor’s Note: The paragraphs below down to the section entitled “day to day operations” should be moved below the section entitled “Disaster Relief” (i.e. directly above section 6.3)

Systems support PPDR should be able to operate in a variety of radio operating environments explained in this section. [The purpose of further explaining distinct radio operating environments is to define scenarios that, from the radio perspective, may impose different requirements on the use of PPDR applications and their importance.

The identified PPDR scenarios could serve as the basis for identifying PPDR requirements and may complement the estimate for spectrum.]

Editor’s Note: CEPT to provide reasoning for wanting to delete text above in square brackets at next meeting.

PPDR systems and equipment capable of being deployed and set-up rapidly for large emergencies, public events and disasters (e.g. severe floods, large fires, the Olympics, peacekeeping) is extremely beneficial as is the ability to reallocate both, upload and download rates – to manage radiocommunication resources more efficiently.

The scenarios include average day-to-day operations, large emergencies or public events and disasters. These have been identified since they are distinct in terms of the characteristics and may impose different requirements for PPDR communications. These may include a variety of cross-border operational activities (e.g. medical emergency, cross-border pursuit, Air-Ground-Air and Direct Mode Operations).

Editors Note: Text below from APT contribution previously in section 6.1.3.

The overall safety of PPDR personnel can be significantly improved via more functional, more reliable, and more extensive wireless communications systems. Systems supporting PPDR should be able to operate in the various radio operating environments, which are defined as average day-to-day operations, large emergencies or public events, and disasters. These operational distinctions are identified since they have subtly distinct characteristics and may impose different requirements for PPDR communications.

PPDR radiocommunications equipment should be able to support at least one of these operating PPDR environments; however, it is preferable that PPDR radiocommunications equipment support all of these radio operating environments. For any of these environments, information may be required to flow to and from units in the field to the operational control centre and specialist knowledge centres.

Although the type of operator for systems supporting PPDR is usually a regulatory and national matter, systems supporting PPDR may be satisfied by public or private operators, or a combination of the two.

Day-to-day operations

Day-to-day operations encompass the routine operations that PP agencies and organisations conduct within their jurisdiction. Typically, these operations are within national or where appropriate, regional borders. Generally, most PP spectrum and infrastructure requirements are determined using this scenario with extra capacity to cover unspecified emergency events. Day-to-day operations can be either mission critical or non-mission critical. For the most part day-to-day operations are minimal for DR. In Tables 6-1 and 6-2, day-to-day operations are referred to as PP(1).

Large emergency and/or public events

Large emergencies and/or public events are those that PP and potentially DR agencies respond to in a particular area of their jurisdiction; however they are still required to perform their routine operations elsewhere within their jurisdiction. The size and nature of the event may require additional PPDR resources from adjacent jurisdictions, cross-border agencies, or international organizations. In most cases, there are either plans in place or there is some time to plan and coordinate the requirements.

A large fire encompassing 3-4 blocks in a large city (e.g. New York, New Delhi) or a large forest fire are examples of a large emergency under this scenario. Likewise, a large public event (national or international) could include the Commonwealth Heads of Government Meeting (CHOGM), G8 Summit, the Olympics, etc.

Generally, additional radiocommunications equipment for large events is brought to the area as required. This equipment may or may not be linked into the existing PP network infrastructure. In Tables 6-1 and 6-2, large emergencies or public events are referred to as PP (2).

Disaster relief

Disasters can be those caused by either natural or human activity. For example, natural disasters include an earthquake, major tropical storm, a major ice storm, floods, etc. Examples of disasters caused by human activity include large-scale criminal incidences or situations of armed conflict. Generally, both the existing PP communications systems and special on-scene communications equipment brought by DR organizations are employed.

[In DR operations, public protection agencies will use the whole variety of communications provided by the public protection networks to meet their operation requirements. Even in areas where suitable terrestrial services exist, satellite systems will play a significant role in disaster situation. The existing terrestrial infrastructure may have been damaged by the disaster itselft, or may be unable to cope with the increased traffic demands resulting from a disaster situation. In these situations, satellite services can offer a reliable solution. The frequency bands used by Mobile Satellite Service (MSS) systems are generally harmonised at a global level. However, the cross border circulation of terminals in disaster situations is a critical issue, as recognised in the Tampere Convention. It is imperative that neighbouring countries that may hold satellite terminals as part of their contingency planning are able to offer the initial essential communications required with minimum delay. To this end, advanced bilateral and multilateral agreements are desirable and may be accomplished through, for example the Global Mobile Personal Communications by Satellite Memorandum of Understanding (GMPCS-MoU).

Some PPDR agencies/organizations and amateur radio groups use High Frequency (HF) narrowband systems including the use of data modes of operation as well as voice. Other capabilities such as digital voice, high-speed data and video have been implemented either using terrestrial or satellite network services. In Tables 6-1 and 6-2, disasters are referred to as DR.]

Editors Note: The text in the two paragraphs above in square brackets will need to be reviewed to bring up to date.

## 6.3 Examples of PPDR network deployment scenarios and technical implementation

When considering these sections, it is important to note that public protection organisations currently use various arrangements of mobile systems or a combination thereof, as described below in Table 6-3.[[2]](#footnote-2)2

TABLE 6-3

Arrangements of mobile systems used by public protection

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Network ownership | Operator | User(s) | Spectrum assignment |
| a | PP organization | PP organization | PP exclusive | PP |
| b | PP organization | Commercial | PP exclusive | PP |
| c | Commercial | Commercial | PP exclusive | PP or commercial |
| d | Commercial | Commercial | Shared with PP priority | PP or commercial |
| e | Commercial and PP organization | Commercial and PP organization | Shared with PP (e.g. Virtual Private Network (VPN) or PPDR as a preferential subscriber with suitable assigned priority) | Commercial |
| f) | Commercial  | Commercial  | Shared with PP treated as ordinary customer | Commercial |

Item a) Dedicated PP systems owned and operated by PP agencies

PP agencies have traditionally relied on their own specific, purpose-built networks in dedicated spectrum, to meet their unique operational requirements. Under such a scheme, PP organizations would have their own infrastructure and would control their system’s full capabilities during times of emergencies. PP organizations will be able to dynamically change the performance of the service as the situation demands so that PP decision-makers can make the appropriate decisions based on the best available information. Besides dynamic control of the system, PP organizations determine the level of security, reliability, robustness, and survivability of the system.

Editor’s Note: The paragraphs below down to the section for item c) seem to describe and correspond with the item b) from table 6-3 above rather than item a). This should be reviewed and checked for the next meeting.

In some countries, PP agencies have expressed concerns with the concept of operational reliance on commercial networks, and with the motivation or willingness of commercial network operators to meet the functional and performance requirements specified by the PP sector.

These concerns are focused on:

– assurances in regard to communications security and priority access over other users;

– the level of network ‘hardening’, compared to their traditional networks, including susceptibility to failure, intrusion and sabotage;

– requirements for a range of more ruggedized user devices (e.g. for motorcycles, marine craft, aircraft and handheld applications), that contain chipsets that may differ in robustness from those provided to commercial consumers;

– commercial networks not extending into non-populated areas (while noting that investment constraints on PPDR networks often result in the same coverage shortcoming); and

– relying on commercial operators for commitment to maintain mission-critical services, especially during ‘major’ incidents.

However, where these concerns have been addressed, successful arrangements of mobile systems as described in item b) of Table 6-3 result.

Item c) Dedicated PPDR systems owned and operated by commercial

Under these arrangements, the PPDR network is owned and operated by a commercial entity. Reasons for this approach include flexibility for funding the build-out and maintenance of the network.

These networks enjoy the same benefits as the dedicated networks and are used in some countries today. In some cases, such networks are not favoured due to privacy and security concerns.

Item d) PPDR agencies using commercial networks as a special subscriber

As an alternative (or complementary) approach to deployment of a dedicated PPDR network, a further option that might be considered by PPDR agencies is the use of commercial services as a ‘special’ subscriber group. To satisfy PPDR operational needs, such an arrangement may involve negotiating special commercial terms for such features as:

– priority access privileges – especially in relation to emergencies and disaster events;

– extended coverage arrangements, that may go beyond areas ordinarily considered viable for commercial services;

– enhanced minimum network Grade of Service (GoS), reliability and robustness, in the context of potential equipment failure, power failure and natural disaster scenarios;

– dynamically reconfigurable push-to-talk ‘group calling’ functions, to facilitate efficient and effective multi-agency co-ordination and response to events; and

– special encryption and authentication/security features, to ensure an appropriate level of network traffic integrity to protect PPDR operational communications.

At a domestic level this option would provide a degree of natural harmonization of spectrum resources and technology compatibility between PPDR agencies and, depending on the agreements made between agencies and commercial operators, could result in seamless interoperability across agencies and jurisdictions. This, however, would not necessarily translate to international interoperability. In this case, harmonisation between administrations would be subject to sovereign decisions by each country and associated agreements to adopt a common spectrum and technology approach.

In some cases, the cost to PPDR agencies of paying for such generic features as listed above may be less than the cost of deploying a dedicated PPDR network (since a large proportion of the underlying network and its functionality will be almost entirely subsidised by the larger ‘base-load’ of commercial users). However, this is dependent on a full cost analysis between the commercial and dedicated network options.

For example, many of the additional costs, such as for extended coverage, may provide indirect yet tangible benefits for the broader customer base. Therefore, PPDR agencies may not bear the full amount of associated additional capital or operational costs. Consequently, this option may present a significantly lower capital and operational cost burden for national/local governments in comparison to deploying a dedicated network. Relevant savings could instead by directed toward further extending coverage and increasing functionality to a much greater degree than would otherwise be possible under a dedicated network approach. Furthermore, this option could negate the need for dedicated spectrum for PPDR, which could result in license cost savings for PPDR agencies.

In regard to special PPDR requirements of user terminal devices, including issues of robustness, air and marine certification, and special mounting arrangements, sourcing arrangements may either be via the commercial network operator (who retains User Equipment (UE) authentication responsibility) or directly managed by the relevant PPDR agencies. In the latter case, there may also be need for special arrangements to address UE authentication setup procedures.

On the assumption that the priority access, coverage, functionality and security concerns are met, there may yet be lingering concern over the degree of control that PPDR agencies can exert over their access, usage and functional configuration of network resources.

This network sharing approach could provide the following benefits:

– access to new capabilities when required by both commercial and PPDR users;

– improved access to more radiocommunication resources for other uses;

– provision of better services and applications to the consumers by the commercial operators;

– access to the large ecosystem of terminals integrated seamlessly in existing and future devices providing hand-over between the various IMT systems as well as between different frequency bands, while providing backward compatibility and international roaming.

Editor’s Note: The text in Item e) below needs to be review and checked to see how it compares to the highlighted rows for e) and f) in table 6-3 above. There will also need to be a separate section added to describe and correspond with the new f) added to Table 6-3 above.

Item e) Sharing the public operator’s infrastructure (e.g. as a Shared RAN)

Under this model, PPDR organizations would share the common radio access network (RAN) infrastructure with a commercial operator as outlined above, but would instead own and be responsible for operation of its own switching nodes, authentication nodes, gateways, and user management facilities. Such arrangements are specifically aimed at reducing expenditure on duplication of the radio network portion of commercial systems – and for shared use of the scarce radio spectrum resource.

With this option, PPDR agencies have greater operational management control over their ‘network’ and its users, as they would share ownership of the system, or enter into a contractual agreement so that they have the necessary level of control over the system in times of crisis. This would require that the system infrastructure be built to accommodate the required functions and features that PPDR organizations demand and need to execute their various missions.

It is expected that there will still be a need for negotiated commercial arrangements to cover additional requirements including: priority access in times of crisis, extended coverage, network reliability/robustness, and security. This option may provide improved coverage, capacity and the expanded functionality found in modern all-Internet Protocol (IP) public networks.

Coexistence of established dedicated PPDR radiocommunication networks alongside commercial mobile broadband networks would need to continue into the foreseeable future. If a VPN-type model is to be adopted, detailed functional and coverage requirements would need to be agreed between PPDR agencies and commercial network operators, and the contractual arrangements and tariff plans would need to be negotiated to fit within financial budget constraints. Agreements in regard to response times to service outages, regular maintenance, technology upgrades, capacity expansions, and even arbitration, change of ownership or commercial circumstance terms will need to be determined.

Such an integrated approach could reduce capital and operational costs, harness the power of
the larger commercial ecosystem and provide seamless multimedia services to PPDR agencies and teams. There may also be cost savings for PPDR agencies if no licence fees are required for spectrum.

It should be noted that systems described in Report ITU-R M.2014 may still be used.

As the traffic on a PPDR network is likely to be higher at times of emergency such as natural disasters and major public disorder than at ‘normal times’, the network deployment scenarios described in Items d) and e) may enable PPDR networks to gain access to extra commercial channels or capacity during emergencies that cannot be made available on a permanent basis.

In some countries, network deployment scenarios described in items b), c), d) and f) of Table 6-3 are currently used by PP organizations to supplement their own systems or in some cases to provide all their communications requirements, but not necessarily for all the features and requirements specified in Tables 2 and 3. It is likely that this trend will continue into the future, particularly with the introduction of advanced wireless solutions, such as IMT.

Editors Note: Table references highlighted in the paragraph above need to be clarified.

Some of the applications listed in Tables 6-1 and 6-2 may depend significantly on commercial systems, while other applications for the same PP organizations may be totally independent of commercial systems.

## 6.4 [General aspects of frequency bands for PPDR

Based on input contributions and discussions during the study cycle, the following comments should be noted:

a) there is some uniformity in regard to frequency bands used/identified for PPDR in different countries, especially for B-PPDR usage;

b) while in most countries the bands used for public protection are the same as those used for disaster relief, [but bands may differ between ITU Regions;

c) many administrations have designated or will designate one or more frequency bands for broadband PPDR operations. It should be noted that only particular sub-bands of the frequency ranges or parts thereof listed below are utilised or planned to be utilised in an exclusive manner for PPDR radiocommunications in so called dedicated networks, additionally sub-bands could be used on shared basis with commercial operators.

Editor’s Note: The below are placeholders for the information of the Administrations on the frequency bands used. The whole section should be considered either as bases for the necessary depiction in Resolution 646 or for deletion.

Some administrations in Region 1 are using or plan to use or have identified parts of the frequency bands …

Some administrations in Region 2 are using or plan to use or have identified parts of the frequency bands …

Some administrations in Region 3 are using or plan to use or have identified parts of the frequency bands …

Noting the above, the current preferred reference technology chosen is the latest LTE Release number.]

## 6.5 Interoperability

Interoperability is an important requirement for PPDR operations. PPDR interoperability is the ability of PPDR personnel from one agency/organisation to communicate by radio with personnel from another agency/organisation, on demand (planned and unplanned) and in real time. This includes the interoperability of equipment internationally and nationally for those agencies that require domestic and international cross-border cooperation with other PPDR agencies and organizations.

Several options are available to facilitate communications interoperability between multiple agencies and networks.

These include, but are not limited to:

a) adoption of a common technology and/or standards, [such as TETRA, APCO P25, IMT (e.g. LTE, as in the US);]

b) the use of common frequencies and standardised equipment;

c) equipment and infrastructure supporting common frequency bands;

 Editors Note: Bullets b) and c) above need to be reviewed to show the difference between them more clearly.

d) utilising local, on-scene command vehicles/equipment/procedures;

e) communicating via dispatch centres/patches; or

f) utilising technologies such as audio switches or software defined radios. Typically multiple agencies use a combination of options; or

g) interconnection with (via standard interface and open system infrastructure:

• narrow-/wide- and broadband PPDR systems;

• commercial communication networks (fixed and mobile);

• satellite communication network;

• other information systems.

How these options are used to achieve interoperability depends on how the PPDR organizations want to communicate with each other and at what level in the organization. Usually, coordination of tactical communications between the on-scene or incident commanders of multiple public protection and disaster relief agencies is required.

Regarding the technology element, there are a variety of solutions implemented either through pre-planning activities or by using particular technologies, which could support and facilitate interoperability.

Editors Note: The paragraph below does not seem to fit into this section we should either delete this or move to another section of the document.

A variety of these new technologies with future enhancements including developments in digital processing techniques could be applied to increase the data throughput of systems supporting PPDR. These technologies could also support and may enable dissimilar radios to be interoperable across different frequency bands and with different waveforms. Current advanced solutions could also satisfy some PPDR requirements by assisting the migration to new technology solutions. The evolution of these technologies and solutions will be exemplified in the following sections on either narrow- and wideband or broadband PPDR.

Editor’s Note: The content of the text in the Sections and annexes below have not been agreed in WP 5A, The content only been looked at editorially to ensure that all of the relevant input contributions were contained in the Document.

Part 2

Broadband PPDR

The following section is dedicated to mobile broadband PPDR communication only and is intended to provided basis for consideration on methods to satisfy WRC-15 agenda item 1.3 in accordance with **Resolution 648 (WRC-12)**.

Editor’ Note: Text from Annex 21 to Document 5A/306.

# 7 Broadband PPDR communications

## 7.1 Considerations on further developments of B-PPDR services and applications

In addition to the generic requirements collected in section 6.2 of this report, the ITU-R considers the following demands and requirements as a basis for the further evolution and development of PPDR services and applications. These assumptions are commonly based on the following:

- Broadband PPDR technologies aiming at wide area coverage constitute an evolution from Narrow Band technology currently applied for mission critical PPDR voice communications in all ITU-R Regions.

- Broadband PPDR applications for PPDR such as transmission of high resolution images and video require much higher basic bit-rates than current PPDR technology can deliver.

- Broadband systems may have inherent noise and interference trade-offs with data rates and associated coverage. Depending on the technology and the deployed configuration, a single broadband network base station may have different coverage areas in the range of a few hundred metres up to hundred kilometres, offering a wide range in spectrum reuse capability.

### 7.1.1 Demands and requirements on broadband PPDR systems

Editor’s Note: Section to be reviewed with regards to generic systems requirements section in Part 1.

It should be noted that the new demands for several simultaneous multimedia capabilities (several simultaneous applications running in parallel) over a mobile system presents a huge demand on throughput and high speed data capabilities while the system at the same time should provide very high peak data rates.

Such demand is particularly challenging when deployed in a localized areas with intensive scene-of-incident requirements where PPDR responders are operating under often very difficult conditions.

Collectively, the high peak data rates, extended coverage and data speeds plus localized coverage area open up numerous new possibilities for broadband PPDR applications including tailored area networks as described.

In addition IPv6 (with efficient backward compatibility with IPv4) should be considered as the protocol underpinning the system architecture, design and development of Broadband PPDR networks.

PPDR multimedia applications

Broadband PPDR applications, such as transmission of high resolution images and video, requires much higher basic bit-rates than current narrowband PPDR technology can deliver.

New demand for several simultaneous multimedia capabilities (several simultaneous applications running in parallel) over a mobile system can only be met by a significant increase in throughput and high speed data capabilities, and simultaneous need for very high peak data rates. Such demand is particularly challenging when deployed in localized areas with intensive scene-of-incident requirements where PPDR responders are often operating under very difficult conditions.

Broadband systems may have inherent noise and interference trade-offs with data rates and associated coverage. Depending on the technology and the deployed configuration, a single broadband network base station may have different coverage areas in the range of a few hundred meters up to tens of kilometers, offering wide variations in scope for spectrum reuse. PPDR agencies of different administrations will have different operational and environmental requirements, which will determine the technologies, topologies, coverage areas, applications or broadband PPDR systems, as well as the business models for their deployment.

Collectively, the high peak data rates, extended coverage and data speeds, plus localized coverage area, open up numerous new possibilities for broadband PPDR applications including tailored area networks as described.

Editor’s Note: The majority of the material for the remainder of section 7.1.1 as well as Annex 7 of this report was taken from the Annex 3 of Report ITU-R M.2033 under the section “systems requirements”. Should parts of section 7.1.1 and Annex 7 be handled as a separate sub-section in section 6.2 of this report?]

Support of multiple applications

System serving PPDR should be able to support a broad variety of applications.

Simultaneous use of multiple applications

Systems serving PPDR should be able to support the simultaneous use of several different applications with various bit rate requirements.

Some PPDR users may require the integration of multiples applications (e.g. voice and low/medium speed data) over the complete network or on a high speed network to service localized areas with intensive on-scene activity.

Priority access

Systems serving PPDR should have the ability to manage high priority traffic and possibly manage low priority traffic load shedding during high traffic situations. PPDR may require either the exclusive use of frequencies or equivalent high priority access to other systems or a combination thereof. This could also mean priority access is given to certain public safety personnel or agencies when they connect to a given network either permanently or at predefined times. This is especially important in the scenario where the network supports a mixture of public safety communications and ordinary commercial communications as served by MNOs. This may also involve some sort of pre-emption (i.e. disconnecting commercial users from a fully loaded BS to allow public safety users to make a connection).

Grade of service (GoS) requirements

Suitable grade of service should be provided for PPDR applications.

PPDR users may also require reduced response times for accessing the network and information directly at the scene of incidence, including fast subscriber/network authentication.

Coverage and capacity

The PPDR system is typically required to provide complete geographic coverage (for “normal” traffic within the relevant jurisdiction and/or area of operation (national, provincial/state or at the local level). This coverage is required 24 h/day, 365 days/year. Usually, systems supporting PPDR organizations are designed for peak loads, high data throughput and wide fluctuations in use, e.g. from demands for several simultaneous applications running in parallel.

Additional resources, enhancing either coverage, system capacity or both may be added during a PP emergency or DR event by techniques such as reconfiguration of networks with intensive use of DMO and vehicular repeaters, which may be required for coverage of localized areas.

Systems supporting PPDR are also usually required to provide reliable indoor and outdoor coverage, coverage of remote areas, and coverage of underground or inaccessible areas (e.g. tunnels, building basements). Further, appropriate levels of redundancy to ensure minimal loss of operational coverage in the event of equipment/infrastructure failure is also likely to be considered extremely beneficial. In addition, such networks should be designed to maximize spectral efficiency, for example by maximizing frequency reuse.

PPDR systems are not generally installed inside buildings. PPDR entities do not have a continuous revenue stream to support installation and maintenance of an intensive variable density infrastructure. Urban PPDR systems are designed for highly reliable coverage of subscribers outdoors, and indoors by direct propagation through the building walls. Sub-systems may be installed in specific buildings or structures, such as tunnels, if penetration through the walls is insufficient. Traditionally and in current practice, narrowband PPDR systems have tended to use larger radius cells. Trade-offs between coverage, capacity and spectrum reuse against infrastructure cost will likely be a decision for each Administration to consider within their own particular context, noting that some administration may favour a larger cell model for PPDR networks.

In modern mobile broadband technologies, such as LTE, the user equipment (UE) are pre-specified to be able to reduce their maximum transmit power and transmission bandwidth configuration in order to meet additional (tighter) unwanted emissions requirements. During emergency situations, ability to access to the full UL transmission bandwidth configuration, all resource blocks at maximum power are required by PPDR user(s) to upload mission critical information to their command and control centers with minimum delay. This function may not be required in all scenarios. This should be achieved without the need to activate the NS\_0X/A-MPR function which will require the UE to reduce its maximum output power.

Reliability

PPDR applications should be provided on a stable and resilient working platform. Reliability requirements should include a stable and easy to operate management system, offer resilient service delivery and a high level of availability (commonly achieved using redundancy and backup, fall‑back and auto-recovery, self-organization). In the event of the network failure or loss of network coverage, Direct Mode Operation between PPDR users is required as an immediate solution for re-establishing communications. Methods of achieving direct mode between users are also needed either through deliberate user action or as a result of devices leaving the network coverage. This may be referred to as DMO (Direct Mode Operation), off-network communication or D2D communication (Device-2-Device).

Capabilities

PPDR users require control (full or in part) of their communications, including centralized dispatch (command and control centre), and management of access control, dispatch group (talk group) configuration, priority levels, and pre-emption (override other users).

Rapid dynamic reconfiguration of the system serving PPDR may be required. This includes robust operation administration and maintenance (OAM) offering status and dynamic reconfiguration. System capability of over-the-air programmability of field units is extremely beneficial.

Robust equipment (e.g. hardware, software, operational and maintenance aspects) are required for systems serving PPDR. Equipment that functions while the user is in motion is also required. Equipment may also require high audio output (to cope with high noise environment), unique accessories, such as special microphones(e.g. lapel, in-ear), operation while wearing gloves, operation in adverse environments (heat, cold, dust, rain, water, shock, vibration, explosive and extreme electromagnetic environments, etc.) and long battery life.

PPDR users require the system to have capability for fast call set-up and dialing, including instant push-to-talk operations (internally or to different technologies) or a one-touch broadcasting/group call and Direct mode (also known as talk-around or simplex) operations., PPDR users also require communications with aircraft and marine vessels, control of robotic devices, vehicular coverage extenders (deployable base stations, to extend network coverage to remote locations).

PPDR systems and equipment capable of being deployed and set-up rapidly for large emergencies, public events and disasters (e.g. severe floods, large fires, the Olympics, peacekeeping) is extremely beneficial as is the ability to reallocate both, upload and download rates.

PPDR systems should include capability for rapid deployment, and for self-management.

PPDR systems should include a capability for rapid deployment coverage extension, and for a high degree of systems self-management. Further, as the trend continues to move towards IP based solutions, all PPDR systems may be required to be either fully IP compatible or at least able to interface with other IP based systems.

Appropriate levels of interconnection to the public telecommunications network may also be required3. The decision regarding the level of interconnection (i.e. all mobile terminals vs. a percentage of terminals) may be based on the particular PPDR operational requirements. Furthermore, the specific access to the public telecommunications network (i.e. directly from mobile or through the PPDR dispatch) may also be based on the particular PPDR operational requirements.

There may be additional requirements for simulcast (quasi-synchronous broadcast), receiver operating (in-bound path diversity) that have not been covered in the section above.

Security related requirements

PPDR networks must provide a secure operational environment. Security requirements should include encryption technology, support for domestic encryption algorithms, authentication for users, terminals and networks , user identification and location, air interface encryption and integrity protection ability, end to end encryption, support for third-party key management centre, system authorization management and over-the-air key updating. In addition to these system-level requirements, suitable operational procedures should be developed to accomplish required levels of security for information being passed across the network. Efficient and reliable PPDR communications within a PPDR organization and between various PPDR organizations, which are capable of secure operation, may be required.

Notwithstanding, there may be occasions where administrations or organisations, which need secure communications, bring equipment to meet their own security requirements.

Performance

PPDR networks must be able to support the following performance requirements: high quality audio quality and intelligibility, secure communications (e.g. encryption), real time interactive text, mobile form filling, images and video, real-time video.

To support these functions the following will be needed, fast dialling and setup of calls, high throughput with adequate guarantees of quality of service, and robustness. These may be accomplished through; reallocation of both uplink and downlink rates (depending on the RAN technology), increasing spectrum efficiency, ergonomic design of terminals, very good signal coverage, high terminal performance, and mobility.

The Broadband PPDR system will support various medias such as a flexible combination between broad band video, data and narrow band voice. A Broadband PPDR Communication System is required to inherit the necessary standardised key characteristics of Narrowband System (such as the group call setup time).

This section includes the requirements of broadband PPDR applications and services in terms of functional requirements, performance requirements, security requirements, interoperability requirements, adaptability requirements, compatibility requirements, reliability requirements and expansibility requirements.

# 8 The evolution of broadband PPDR through advances in technology

## 8.1 Current standardized solutions

Suitable standards for broadband PPDR are included in Recommendation ITU-R M.2009 “Radio interface standards for use by Public Protection and Disaster Relief operations in some parts of the UHF band in accordance with Resolution **646** **(Rev.WRC-12)**”.

Editor’s Note: Extracted M.[IMT.BROAD.PPDR].

Report ITU-R [M.[IMT.BROAD.PPDR]](http://www.itu.int/md/R12-SG05-C-0064/en) considered how the use of IMT, and LTE in particular, can support current and possible future PPDR applications. The broadband PPDR communication applications are detailed in various ITU-R Resolutions, Recommendations and Reports; and this Report has assessed the LTE system capabilities to support these applications. This Report has also considered the benefits that can be realized when common radio interfaces technical features, and functional capabilities, are employed to address communications needs of public safety agencies.

The report describes the features and benefits that make LTE particularly suitable for PPDR applications as compared to traditional PPDR systems. These features and benefits include:

– greater economies of scale;

– enhanced interoperability;

– better performance;

– simplified IP-based architecture;

– low latency;

– enhanced security;

– enhanced network sharing;

– enhanced Quality of service and prioritization;

– bandwidth flexibility;

– simultaneous use of multiple applications; and

– enhanced spectrum efficiency.

In addition, case studies have been provided in Annexes 2 to 5 of that Report that offer real-world examples of ways in which administrations are employing IMT to support broadband PPDR applications.

Editor’s Note: Consideration needed on Annexes of the Report from WP 5D.

Table 9-4 below shows selected PPDR applications and related examples based on Table 6-2 connected to relevant supporting technologies.

Editor’s Note: The last columns of Table 9-4 will be used to file the responses on related LS to external organisations.

Editor’s Note: Table 6-1 should be used as basis for Table 9-4!

Table 9-4

PPDR Applications and Examples currently supported by various technologies

[Editor’s Note: Canada’s proposed table format in Document 5A/369 is to be considered if this table is not deleted or the table from the WP 5D Report is copied into this report.]

| **Application** | **Feature** | **PPDR Example** | **Technology based system capability** |
| --- | --- | --- | --- |
| **3GPP** **(See Note A, B, C)** | **CCSA** | **other technologies** |
| 1. Narrowband |   |   |  |  |  |
| Voice | Person-to-person | Selective calling and addressing | Supported | Supported |  |
| One-to-many | Dispatch and group communication | Proposals being considered in 3GPP for this capability in LTE**(See Note A, B, C)** | Supported |  |
| Talk-around/direct mode | Groups of portable to portable (mobile-mobile) in close proximity without infrastructure | Proposals being considered in 3GPP for this capability in LTE | Being considered in CCSA for this capability |  |
| Push-to-talk | Push-to-talk | Proposals being considered in 3GPP for this capability in LTE | Supported |  |
| Instantaneous access to voice path | Push-to-talk and selective priority access | Proposals being considered in 3GPP for this capability in LTE | Supported |  |
| Security | Voice encryption/scrambling | Supported | Supported |  |
| Facsimile | Person-to-person | Status, short message | Supported | Supported |  |
| One-to-many (broadcasting) | Initial dispatch alert (e.g. address, incident status) | Supported | Supported |  |
| Messages | Person-to-person | Status, short message, short e-mail | Supported | Supported |  |
| One-to-many (broadcasting) | Initial dispatch alert (e.g. address, incident status) | Supported | Supported |  |
| Security | Priority/instantaneous access | Man down alarm button | Supported | Supported |  |
| Telemetry | Location status | GPS latitude and longitude information | Supported | Supported |  |
| Sensory data | Vehicle telemetry/status | Supported | Supported |  |
| EKG (electrocardiograph) in field | Supported | Supported |  |
| Database interaction (minimal record size) | Forms based records query | Accessing vehicle license records | Supported | Supported |  |
| Accessing criminal records/missing person | Supported | Supported |  |
| Forms based incident report | Filing field report | Supported | Supported |  |
| 2. Wideband |   |   |  |  |  |
| Messages | E-mail possibly with attachments | Routine e-mail message | Supported | Supported |  |
| Data Talk‑around/direct mode operation | Direct unit to unit communication without additional infrastructure | Direct handset to handset, on-scene localized communications | Proposals being considered in 3GPP for this capability in LTE | Being considered in CCSA for this capability |  |
| Database interaction (medium record size)  | Forms and records query | Accessing medical records | Supported | Supported |  |
| Lists of identified person/missing person  | Supported | Supported |  |
| GIS (geographical information systems) | Supported | Supported |  |
| Text file transfer   | Data transfer   | Filing report from scene of incident | Supported | Supported |  |
| Records management system information on offenders | Supported | Supported |  |
| Downloading legislative information | Supported | Supported |  |
| Image transfer | Download/upload of compressed still images | Biometrics (finger prints) | Supported | Supported |  |
| ID picture | Supported | Supported |  |
| Building layout maps | Supported | Supported |  |
| Telemetry | Location status and sensory data | Vehicle status | Supported | Supported |  |
| Security  | Priority access | Critical care | Supported | Supported |  |
| Video   | Download/upload compressed video   | Video clips | Supported | Supported |  |
| Patient monitoring (may require dedicated link) | Supported | Supported |  |
| Video feed of in-progress incident | Supported | Supported |  |
| Interactive  | Location determination  | 2-way system  | Supported | Supported |  |
| Interactive location data | Supported | Supported |  |
| 3. Broadband |   |   |  |  |  |
| Database access | Intranet/Internet access | Accessing architectural plans of buildings, location of hazardous materials | Supported | Supported |  |
| Web browsing | Browsing directory of PPDR organization for phone number | Supported | Supported |  |
| Robotics control | Remote control of robotic devices | Bomb retrieval robots, imaging/video robots | Supported | Supported |  |
| Video | Video streaming, live video feed | Video communications from wireless clip-on cameras used by in building fire rescue | Supported | Supported |  |
| Image or video to assist remote medical support | Supported | Supported |  |
| Surveillance of incident scene by fixed or remote controlled robotic devices | Supported | Supported |  |
| Assessment of fire/flood scenes from airborne platforms | Supported | Supported |  |
| Assessment of fire/flood scenes from airborne platforms | Supported | Supported |  |
| Imagery | High resolution imagery | Downloading Earth exploration-satellite images | Supported | Supported |  |
| Real-time medical imaging | Supported | Supported |  |
| **Note A:** The term “supported” as utilized in the new column in the table (Technology Based System Capability) includes not only the inherent capabilities of the radio technology and related 3GPP system but also the ability to support a varied range of “applications” that could provide the indicated service/capability. Some new capabilities may be under consideration for development in 3GPP and others may be the subject of work to improve or enhance the capability and/or performance.**Note B:** This was based strictly on a review of Report ITU-R M.2033 and does not address any specific performance requirements or operational thresholds that might be announced by relevant PPDR entities. **Note C:** A “blank” indicates that further study would be needed in order to respond. |

Editor’s Note: The document has been reviewed up-to-here with regards to completeness of contributions.

## 8.2 Table of broadband PPDR requirements

Annex 6 contains an example table of requirements indicating the degree of importance attaching to particular requirements under the three radio operating environments: “Day-to-day operations”, “Large emergency and/or public events”, and “Disasters”. The degree of importance attributed to each requirement may be different between administrations. It is up to the administrations to make a choice regarding the relative importance of these requirements. This table may require future review and updating as mobile broadband technologies evolve.

## 8.3 Spectrum requirements for broadband PPDR [place TBD]

In considering spectrum requirements for B-PPDR the following need to be assessed:

Editor’s note: Bullet points need to be added to reflect the things that need to be assessed when considering spectrum requirements.

Examples of assessments of Broadband PPDR Spectrum Requirements have been done in a number of studies reflecting various environments based on the above elements and considering their unique environments. A short introduction of these examples which are shown in Annex 1 to 4 of this Report can be seen in the bullets below:

- Annex 1 – Gives an example provided by Israel which looks at a particular PPDR incident scenario using LTE as the representative technology to estimate Broadband PPDR spectrum needs. Appendix 1 of Annex 1 is an example of the unique applications used by the Israeli PPDR agencies that are needed for their Broadband PPDR systems. Some of these applications have been used in incident scenario shown in Annex 1.

- Annex 2 – Gives an example provided by Motorola that uses a spectrum calculator which allows a user to model up to two incident scenes of small, medium, large or very large emergencies. Appendix 1 of Annex 2 presents some PPDR scenarios using this calculator to estimate the throughput and the bandwidth requirements for these Broadband PPDR scenarios.

- Annex 3 – Gives an example provided by China (People’s Republic of) that looks at the providing spectrum estimates based on the PPDR service traffic (including use of voice, data, image and video services) of Wuhan city (capital of Hubei province) in China. The methodology and calculations are presented in Annex 3. The intent is that it will assist administrations in planning for PPDR services that support a wide range of video applications.

- Annex 4 – Gives an example provided by CEPT of the methodology used in ECC Report 199 for the calculation of Broadband PPDR spectrum requirements within CEPT.

### 8.3.1 Harmonisation of spectrum and the establishment of harmonized conditions for PPDR

The ITU recognized the benefits of spectrum harmonization, such as a greater potential for interoperability, a broader industrial base and a larger volume of material resulting from economies of scale and greater availability of equipment; improved spectrum management and planning and greater cross-border coordination and circulation of equipment and that there are Administrations in all Regions, which are considering implementation of PPDR broadband applications based on IMT systems, either in dedicated spectrum or shared spectrum with commercial networks.

Harmonisation of spectrum for broadband PPDR applications is in a transition phase where related studies and identification of possible tuning-ranges and sub-bands have been started, such as in ITU-R Region 1 (CEPT), aiming to accommodate future operational needs of broadband applications, while significant amounts of spectrum bands are already in use in various countries for narrowband PPDR applications.

Experience has shown that harmonisation of use has benefits including economic benefits, the development of compatible networks and effective services and the promotion of interoperability of equipment internationally and nationally for those agencies that require national and cross-border cooperation with other PPDR agencies and organizations. Specifically, some potential benefits are as follows:

– economies of scale in the manufacturing of equipment;

– competitive market for equipment procurement;

– increased spectrum efficiency, and easy cross-border coordination;

– increased effective response to disaster relief.

Harmonized conditions can be established for PPDR if:

1. a tuning-range can be identified;
2. a technology standard can be harmonized, such as IMT (LTE).

Harmonized conditions will offer full flexibility for nations/regulators to decide their national dedicated PPDR spectrum chosen from within the tuning-range in accordance with local demands. The LTE technology will then provide full roaming and open for interoperability even if the PPDR spectrum band is not strictly harmonized across borders.

An entire Region can enjoy the benefit of harmonized conditions for BB PPDR if for instance the WRC-15 under AI 1.3 decides to add for Region 1 a 700 MHz tuning range as applicable.

## 8.4 Planned evolutions of the standards

### 8.4.1 Advantages of globally harmonized IMT technology for BB PPDR

Whilst mission critical voice communications will remain a key component of PPDR operations for the next decade or more, new advanced data and video services has become an immediate requirement. For instance, PPDR agencies today use applications such as video for surveillance of crime scenes and of highways, to monitor and conduct operations. Also, there is a growing need for full motion video for other uses such as robotic devices in emergency situations. These types of advanced solutions will be capable of providing local voice, video and data networks, thereby serving the needs of emergency field personnel responding to an incident.

Should harmonized IMT technologies for BB PPDR be implemented initially on a regional basis and with a global vision in the expansion phase, it would drastically reduce the cost of equipment, increase availability of equipment, increase potential for interoperability, provide for a wider range of end-to-end solutions and reduce network infrastructure rollout time.

Some countries are in the process of developing their technical requirements and analysis using example technologies (e.g. IMT standard LTE)

Furthermore introduction of these technologies may enable PPDR agencies and organizations to keep up with increasing demands but also may enable them to implement advanced voice, text, video and other intensive data applications and services designed to enhance service delivery

In this regard, it should be noted that any development or planning for the use of a future IMT technologies would require that consideration be given to spectrum aspects for broadband PPDR applications.

### 8.4.2 Advantages of PPDR using frequency bands harmonized for IMT

Basic assumptions

• Broadband PPDR could be realised through dedicated PPDR networks, the use of commercial networks, or with a hybrid network (combination of dedicated and commercial networks). When comparing the different alternatives, each solution has both advantages and disadvantages. Eventually the choice is a national matter likely to involve a political decision. However, future regulation and harmonisation for there is a common broadband PPDR needs to enable and support all these three solutions.

• With a strong identification of dedicated PPDR (not harmonised for commercial IMT) a majority of the commercial products (e.g. terminals and chipsets) will most likely not support these dedicated frequencies.

Flexibility

Future harmonisation of broadband PPDR needs to be flexible enough to consider different needs such as the amount of available spectrum and the possible use of commercial networks. Dedicated spectrum for PPDR limits this flexibility and may lead to unused spectrum in counties using a PPDR solution based on commercial networks.

Interoperability and Roaming

With dedicated PPDR spectrum, roaming between a commercial and dedicated/hybrid solution would only be achieved with the prerequisite that every user device supports both the commercial frequency band as well as the dedicated frequency band. In countries that choose a commercial solution it is likely that the users (due to economic reasons and possibly also availability) want to use commercial LTE-products that do not support the dedicated PPDR-frequencies. These terminals will not be able to roam into a country with a different PPDR solution which is using the dedicated PPDR frequencies.

Gradual introduction of broadband PPDR

The PPDR user community clearly state that the need for PPDR broadband services exist already today. The regulation process for a harmonisation of PPDR broadband is a lengthy process. Given this, it is inevitable that the introduction of PPDR broadband services will go through commercial networks, no matter the final national choice of solution (dedicated, commercial or hybrid network). Dedicated frequencies for PPDR may make this migration problematic since the commercial user devices used in the temporary commercial solution cannot be used in the dedicated or hybrid network that replaces the commercial solution.

Economies of scale

Economic considerations will be a key factor for the (most likely political) decisions to be made on national level regarding for example choice of PPDR solution, network design and realisation time frame. The broadband PPDR market is large, but still be a niche market compared to the commercial LTE-market.

Assuming that a major part of the commercial equipment will not support a frequency band which is dedicated exclusively for PPDR, the user equipment used in dedicated PPDR networks (or hybrid solutions) may form a niche market, separate from the commercial LTE-market. For a niche market, products may be considerably more expensive.

## 8.5 Technology development

With a dedicated PPDR-spectrum not supported by commercial equipment, PPDR equipment may use different radio modules or chipsets. The lower production volumes (compared to the commercial market) for these products may result in longer product cycles where the availability and introduction of the latest commercial technology may be delayed for the PPDR market.

Part 3

Narrow / Wideband PPDR communications

Editor’s Note: The following section is to be developed by the CG. Based on Report ITU-R M.2033 and taking into account other contributions (including Document 5A/399).

Part 4

Needs of developing countries

# 9 The needs of developing countries

Editor’s Note: WP 5A did not receive yet any contribution on this part. Interested parties should be invited to provide content.

Considering the cost, technology gap and the existing deployment status of developing countries, the long-term coexistence of narrowband and broadband has to be highlighted. Developing countries may choose to install more broadband or narrowband sites of network based on their available budget. An integrated narrowband and broadband network system within the same Core Network might be suggested. The needs of developing countries are particular in the following aspects.

## 9.1 Technology requirement

Developing countries may need new communication technology system to realize broadband multimedia services, wider coverage, larger uplink channel capacity, more dispatching functions, simpler network element and protocol than existing technologies.

## 9.2 Cost requirement

Developing countries may need less expense on equipment acquisition, telephone bill and operation such as maintaining.

## 9.3 Deployment requirement

Developing countries may build nationwide broadband PPDR network to support broadband multimedia dispatch as well as traditional voice dispatch, In order to reach the goal, the deployment network process can be divided into the following phases:

Phase 1: BB to cover critical areas and service complementary of NB.

Phase 2: BB to cover larger areas and service integrated with NB.

Phase 3: BB to cover the whole nationwide areas.

Editor’s Note: The needs of BB PPDR network in developing countries may be various from each other, and maybe different from that in developed countries. We give some tentative suggestions about requirements of developing countries. It is open for discussion. We hope it the needs of developing countries to be well emphasized.

ANNEX 1

Representative scenario- deploying LTE for PPDR

Use of IMT-LTE for Broadband PPDR system refers to 15 time line events and a typical response sequence based on the number of responders, as well as the broadband resources throughout the incident. The data traffic supporting this response is assumed to be served by a wide area, mobile broadband network. The PPDR agencies also use Project-25 system for voice only. Project-25 system had not been analysed during this event.

Incident scenario

The scenario includes an accident in which a chemical material truck crashes in the city; the truck hits several cars and the truck tank is damaged. The chemical material starts to leak, and the PPDR agencies start to evacuate the area. Two cars are on fire, the fire is spreading fast, people are injured and some are trapped inside the cars, a nearby building must be evacuated as soon as possible.

The following table shows the time line scenario step by step.

The table includes:

1. Event description.
2. Time line from 0 to 6 hours.
3. Link type: Project 25 system for Voice and LTE for data.
4. Required actions uplink.
5. Required actions downlink.
6. Total number of users that arrive each time line.

The following PPDR agencies take part during the event:

1. Police.
2. Ambulances.
3. Fire brigade.
4. Hazardous materials response team.
5. City control forces.

Event description

Call received at police operation centre, and the operation centre dispatch immediately broadcasts to all forces to go there as soon as possible. 12 police cars confirm that they on the way to scene. The operation centre dispatch sends location information to vehicles’ computers and the police cars also request more information about the area and more GIS information. The dispatch sends them the GIS information and high resolution video of the event from a security camera close to the truck. After 7 minutes, the police cars arrive at the scene and send real time low resolution video from the area. The policemen are getting real time high resolution video from a high resolution security camera via the LTE system on a nearby building in which people are trapped because of the fire. They are also getting GIS information and building information. After 12 minutes, additional police vehicles with 2 chief officers arrive at the scene. They also send real time low resolution video from the area and they receive real time high resolution video from a police helicopter via the LTE system. After 13 minutes, a city control vehicle with 2 officers arrives at the scene. They send real time low resolution video from the area to the city control room and they receive real time high resolution video from a city traffic control camera via the LTE system. After 14 minutes, four ambulances arrive. They request GIS information and send real time high resolution video to their Command Centre. They are receiving real time high resolution video from a security camera via the LTE system about the injuries and getting medical information and GIS information. After 15 minutes the fire-brigade arrives, requests GIS information, sends real time medium resolution video from the vehicle’s camera, receives real time medium resolution video from the scene and gets GIS information and building scheme. After 16 minutes, hazardous materials response team arrive and request GIS information, send high resolution pictures in order to verify the chemical liquid with the help of their experts, receive real time medium resolution video from the scene and get GIS information. After 20 minutes, Front Command and Control deployed in the scene area are connecting to the police database. They operate voice conference calls and video conferences; receive real time low resolution video from the helicopter and real time high resolution video from forces inside the building. At this point the Front Command and Control are fully connected to the police database and can use any police information such as cars and people information, real time video, and pictures that can be shared with anyone that needs the information. The information is now fully displayed in the main command and control room of the police and other forces. Commanders can share the information and get full control of the event.

Table A1-1

Incident scenario time line

|  |
| --- |
| Scenario time line |
| No of users | Used systems | Required action Downlink | Required action Uplink | Link type | Time+ | Part number and event description |
|  |  |  |  |  | 0 | 1. Accident occurs
 |
|  |  |  |  |  | 1 minute | 1. Call received at police Operation Centre
 |
| 12 | Project 25 | Call to the closest police vehicles and send location information to vehicles' computer |  | Voice | 2 minutes | 1. Operation Centre dispatch sent
 |
| 12 | Project 25 & LTE | Getting GIS information and each policeman (total of 12 ) getting real time high resolution video of the event from security camera close to the truck  | Request for information from Vehicle’s computer+GIS information | Voice+Data | 3 minutes | 1. Police vehicles on the way to scene
 |
| 12 | Project 25 & LTE | Getting real time high resolution video from security camera close to the truck and getting GIS information | Sending real time low resolution video from the area | Voice+Data | 7 minutes | 1. Policemen arrive at scene
 |
| 2 | Project 25 & LTE | Getting real time high resolution video from police helicopter | Sending real time low resolution video from the area | Voice+Data | 12 minutes | 1. Additional police vehicle with 2 chief officers arrives
 |
| 2 | Project 25 & LTE | Getting real time high resolution video from traffic control camera | Sending real time low resolution video from the area | Voice+Data | 13 minutes | 1. City control vehicle with 2 officers arrives at scene
 |
| 12 | Project 25 & LTE | Getting real time high resolution video from security camera about the injuries and getting GIS information | Request for GIS information and sending real time high resolution video to command centre | Voice+Data | 14 minutes | 1. Four ambulances arrival
 |
| 3 | Project 25 & LTE |  Getting real time medium resolution video from scene and get GIS information | Request for GIS information and sending real time medium resolution video from vehicle camera  | Voice+Data | 15 minutes | 1. Fire forces arrival
 |
| 1 | Project 25 & LTE | Getting real time medium resolution video from scene and getting GIS information  | Request for GIS information and sending high resolution pictures  | Voice+Data | 16 minutes | 1. Hazardous materials response team arrival
 |
| 4 | Project 25 & LTE | Video conference , getting real time low resolution video from helicopter and real time high resolution video from scene | Connecting to police database and video conference | Voice+Data | 20 minutes | 1. Front Command and Control deployment
 |
|  | Project 25 & LTE | Total of 36 users who operate 72 applications simultaneously | Total of 36 users who operate 36 applications simultaneously | Voice+Data | 20 minutes | 1. All forces arrived and operational
 |
|  | Project 25 & LTE |  |  | Voice+ Data | 40 minutes | 1. The ambulances leave the area on the way to hospital
 |
|  | Project 25 & LTE |  |  | Voice+ Data | 100 minutes | 1. The forces succeeded to isolate the truck and to close the leak
 |
|  |  |  |  | Voice+ Data | 125 minutes | 1. Chemical material removing to replacement tanks
 |
|  |  |  |  | Voice+ Data | 200 minutes | 1. Replacements tanks are removed from area
 |
|  |  |  |  | Voice+ Data | 250 minutes | 1. The area is clean and checked
 |
|  |  |  |  | Voice+ Data | 360 minutes | 1. End of the event
 |

The following table summarizes the data rate (kbps) for each application during the event:

Table A1-2

Application data rate

|  |  |  |  |
| --- | --- | --- | --- |
| UL (kbps) | Downlink (kbps) | Description | Application |
| N/A (Project 25) | N/A (Project 25) | Voice call | Voice |
| N/A (Project 25) | N/A | Information from the command centre | Request for Information from Vehicle computer |
| 100 | 2000 | Map of the area of the event | GIS Information |
| 2000 | 2000 | Real time video | High resolution video |
| 1000 | 1000 | Real time video | Medium resolution video |
| 500 | 500 | Real time video | Low resolution video |
| 384 | 384 | Video conference application | Video conference |
| 300 | 300 | Image | High resolution picture |

The event occurs within 1.6 km radius area. The area has been closed by the police, and one 45 m antenna mast LTE site gives service to this area.

Analysis

In order to analyse the required spectrum 'Monte Carlo' simulation has been used. The urban clutter loss has been defined to 10 dB. The LTE data (see Report ITU-R M.2241 Table 2.2.1-1 for most of the site and equipment parameters):

1. 3 sector site.
2. Dual-transmitter and dual-receiver configuration per sector (MIMO).
3. 40 W on each diversity antenna[[3]](#footnote-3).
4. 45 m antenna height above ground level.
5. Antenna parameters:
	1. 17 dBi antenna gain.
6. 65 deg Horizontal pattern (aperture in the horizontal plane at 3 dB (in deg.).
7. 15 deg Vertical pattern (aperture in the vertical plane at 3 dB (in deg.).
8. 3 dB losses (cable losses + connector losses feeder losses).
9. 60 dBm eirp, including cable losses.
10. 2 degree down tilt.
11. Modulation parameters: QPSK , 16-QAM and 64 QAM.
12. Duplex mode – FDD.
13. Duty cycle(downlink applications activity factor): 0.5.

The LTE UE data (see Report ITU-R M.2241 Table 2.2.1-1 for most of the parameters):

1. 1.5 m antenna height above ground level.
2. Omni antenna.
3. 0 dBi antenna gain.
4. Maximum Transmitter e.i.r.p. (dBm): 21 to 23.
5. Average Transmitter e.i.r.p. (dBm): -9.
6. Modulation parameters: QPSK , 16-QAM and 64 QAM.
7. Duplex mode – FDD.
8. Duty cycle (uplink applications activity factor): 0.5.

The analysis has been run to analyse part 12 (all the forces arrived to the area). A total of 36 users get information from a few LTE applications (Table 2). Six bandwidths have been checked to get the required spectrum for event part 12 (the maximum required spectrum):

1. 10 MHz.
2. 15 MHz.
3. 18 MHz (Not a LTE BW based on spec. Has been used just for calculation).
4. 18.8 MHz (Not a LTE BW based on spec. Has been used just for calculation).
5. 20 MHz.

The results from each simulation are:

 Reliability. The reliability in % that the system will be able to give the required data rate and for the required spectrum for all users during the event. The goal is to achieve 95% reliability for the whole area and 90% reliability for a particular application. The reliability results are for each application and composite reliability.

Results

The reliability tables results for each bandwidth are shown below:

Table A1-4

10 MHz reliability results (%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| High resolution image | Video conference | Low resolution video | Medium resolution video | High resolution video | GIS Information | Whole area | Time line |
| N/A | 81.9 | 76.19 | 58.1 | 35.8 | 36.6 | 47.7 | Downlink |
| 98.9 | 98.8 | 98.6 | 97.9 | 78.9 | N/A | 97.5 | Uplink |

Table A1-5

15 MHz reliability results (%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| High resolution image | Video conference | Low resolution video | Medium resolution video | High resolution video | GIS Information | Whole area | Time line |
| N/A | 98.3 | 94 | 79.1 | 65.8 | 66.4 | 72.9 | Downlink |
| 98.9 | 98.9 | 98.8 | 98.2 | 96.2 | N/A | 98.5 | Uplink |

Table A1-6

18 MHz reliability results (%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| High resolution image | Video conference | Low resolution video | Medium resolution video | High resolution video | GIS Information | Whole area | Time line |
| N/A | 99 | 98.9 | 93.7 | 86.8 | 88.5 | 94.3 | Downlink |
| 98.9 | 98.9 | 98.8 | 98.2 | 96.5 | N/A | 98.6 | Uplink |

Table A1-7

18.8 MHz reliability results (%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| High resolution image | Video conference | Low resolution video | Medium resolution video | High resolution video | GIS Information | Whole area | Time line |
| N/A | 99 | 99 | 96.2 | 93.6 | 94.3 | 97 | Downlink |
| 98.9 | 98.9 | 98.8 | 98.3 | 96.6 | N/A | 98.7 | Uplink |

Table A1-8

20 MHz reliability results (%)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| High resolution image | Video conference | Low resolution video | Medium resolution video | High resolution video | GIS Information | Whole area | Time line |
| N/A | 99 | 99 | 98.4 | 97.7 | 98 | 98.7 | Downlink |
| 98.9 | 98.9 | 98.9 | 98.3 | 96.8 | N/A | 98.6 | Uplink |

Conclusions of the representative scenario

The reliability results show that the required spectrum for this event is 18.8 MHz for the downlink and 15 MHz for the uplink. The heavy loaded application is the high resolution video at the downlink and uplink paths. The limitation path is the Downlink, since more capacity is required; but if additional users would be using additional high resolution video than the uplink path could be the limitation of the spectrum. The growing demand for broadband mobile LTE PPDR requires a dedicated RF spectrum. Since the present IMT FDD channel arrangements provide equal RF for downlink and uplink, and 18.8 MHz is not part of the LTE specification, 20MHz X 2 is the required spectrum for this example.

Appendix 1 of Annex 1

Example for wireless applications needed for Broadband PPDR system

|  |
| --- |
| Wireless Applications |
| Video |
| real time video from helicopter |
| real time video from [drone/UAS] |
| real time video from other cameras |
| video transmission from scene |
| Data |
| First responders information database connectivity  |
| First responders tactical systems connectivity  |
| First responders cars computers connectivity  |
| First responders citizens information database connectivity  |
| First responders GIS information database connectivity  |
| First responders LPR information database connectivity  |
| First responders vehicle information database connectivity  |
| First responders technical information database connectivity  |
| First responders internal mail connectivity  |
| First responders internal application connectivity  |
| TMS/SMS and MMS capability |
| Location and GIS |
| Sending location information |
| Maps and GIS information |
| First responders tactical GIS system connectivity  |
| Communications  |
| VOICE call |
| Conference call |
| PTT call to P25  |
| PTT group call |
| Emergency call |
| Talk around between to handsets capability |
| video call |
| Broadband communications  |
| Voice over IP connectivity  |
| Mobile base station connectivity  |
| front command and control connectivity  |

Annex 2

Throughput requirements of broadband PPDR scenarios

Mobile Broad Band technology aiming at wide area coverage constitute an evolution from Narrow Band technology currently applied for mission critical PPDR voice communications in all ITU-R Regions.

A Mobile Broad Band application for the PPDR such as transmission of high resolution images and video requires much higher basic bit-rates than current PPDR technology can deliver.

It should be noted that the new demands for several simultaneous multimedia capabilities (several simultaneous applications running in parallel) over a mobile system presents a huge demand on throughput and high speed data capabilities while the system at the same time shall provide very high peak data rates.

Such demand is particularly challenging when deployed in a localized areas with intensive scene-of-incident requirements where PPDR responders are operating under often very difficult conditions.

For example a 700 MHz LTE PPDR base station deployed to support Broad Band applications in urban environments could typically be tailored to servicing a localized area in the order of 1 km2 or even less offering access to voice, high-speed data, high quality digital real time video and multimedia services, at indicative continuous data rates in the downlink direction in the range of 1 ‑ 10 - 100 - 150 Mbit/s per sector, with a total capacity of 300-450 Mbit/s over the area of 1 km2, with channel bandwidths determined by the particular deployment of the system. Examples of possible applications include:

– high-resolution video communications from portable terminals such as during traffic stops;

– video surveillance of security entry points such as airports with automatic detection based on reference images, hazardous material or other relevant parameters;

– remote monitoring of patients and remote real time video view of the single patient demanding the order of up to 1 Mbit/s. The demand for capacity can easily be envisioned during the rescue operation following a major disaster. This may equate to a net hot spot capacity of over 100 Mbit/s close to a broadband PPDR base station.

Mobile Broad Band systems may have inherent noise and interference trade-offs with data rates and associated coverage. Depending on the technology and the deployed configuration, a single broadband network base station may have different coverage areas in the range of a few hundred metres up to hundred kilometres, offering a wide range in spectrum reuse capability.

Collectively, the high peak data rates, extended coverage and data speeds plus localized coverage area open up numerous new possibilities for BB PPDR applications including tailored area networks as described.

A spectrum throughput and bandwidth calculator has been developed based on the requirements of some Public Safety agencies. This calculator is based on a set of PPDR applications which is based on their current operational experience and their vision of future working practices. The Calculator allows the user to model up to two incident scenes of small, medium, large or very large emergencies. The first incident scene is assumed to take place near the cell edge, and the second incident scene is assumed to be uniformly distributed somewhere in the cell (at a median location/area). The calculator utilizes a blended spectral efficiency model (with a total of 9 spectral efficiency values dependent on the deployment scenario), where background data traffic is modelled with average spectral efficiencies, and the incident scenes are modelled with different spectral efficiencies depending on their location (based on simulations, which are ongoing).

In this calculator, the user may change any boxes highlighted in blue to study different effects (e.g., incident scene size, placement, system deployment topology, bldg. coverage, actual application usage for each incident size/type). While the calculator allows the study of various effects through simulations of various scenarios, it may be noted that there is significant increase in spectral requirements at a cell edge and for large incidents; this requirement becomes overwhelming, likely resulting in the need to offload PS traffic to commercial networks, or deploy an incident scene microcell (CoW). One can also see from the spreadsheet that a medium sized incident near the cell edge and a large incident at a median location require approximately 10+10 MHz of spectrum which is in-line with some other published studies.



Appendix 1 of this Annex provides some of the PPDR scenarios using this calculator to show the throughput and the bandwidth requirements of these Broadband PPDR scenarios. These scenarios include level 1 being a Tanker Spill, Level 2, a Clandestine (Drug) Lab, and Level 3, a Petrochemical Refinery incident. Figure 1 below summarizes the expected public safety equipment and personnel response needed to manage such an incident in a local Chicago (Illinois, USA) suburb.

Appendix 1 of Annex 2

Given the unique mission critical requirements of public safety, it is essential that first responders have unilateral control over sufficient broadband capacity to serve current and future needs. To this end, Motorola Solutions developed a model to evaluate public safety’s broadband wireless requirements by drawing upon existing policies and recent incident feedback. For purposes of this research, Level 1 through Level 3 Hazardous Materials Incidents were considered: Level 1 being a Tanker Spill, Level 2, a Clandestine (Drug) Lab, and Level 3, a Petrochemical Refinery incident. Figure 1 below summarizes the expected public safety equipment and personnel response needed to manage such an incident in a local Chicago (Illinois, USA) suburb.[[4]](#footnote-4)

Figure A2-1

Typical Response Scope for Level 1-3 Hazardous Materials Incidents



As is clearly evident in Figure A2-1, even the lowest level incident, Level 1, will elicit considerable response from a variety of public safety agencies that will all arrive on the scene needing broadband services.

The incident scene broadband demands are classified as follows based on usage:

**1 Individual (Person/Vehicle) CAD overhead functions**: The classification includes incident data, GPS information, biosensors and other status, messaging, and queries. Each station individually consumes relatively low down/uplink bandwidth but in aggregate usage can be significant across many users.

**2 Incident Scene database lookups/downloads and information searches**: The classification includes the download of manuals, incident scene images, maps and topography information, building plans, etc. This use case has the unique requirement that, in general, the information is needed quickly as incident commanders initially assess the scene and develop a strategy. The model assumes that all expected initial data is downloaded and available with the first 10 minutes of the incident. The demands are scaled with the incident size and complexity.

**3 Video**: This classification of usage is comprised of personal video cameras for workers operating in the hot-zone, incident scene (car) video positioned around the perimeter, and cameras deployed within the scene. The video is uplinked via the network and a subset of the streams (switchable on command) is down-linked to the on-scene command centre. Rates of 400kbps (QVGA 320x240 @ 30fps) and 1.2 Mbps (1280x960 @ 30fps) are used and the number of each type of video stream is scaled with the size and complexity of the incident.

Figure 2 below summarizes the results of the analysis where the bandwidth demands for both uplink and downlink are compared with the expected *average* capacity of a single LTE serving sector (*cell edge* performance, especially on the uplink, would be considerably less and obviously under optimistic conditions peak data rates can be much higher). A “background” load of 20% is added to the total demand assuming this would be a minimum “base load” for other non-incident related, nominal activities across the sector coverage area.

Figure A2-2

Broadband Wireless Capacity Implications



LTE spectrum requirement observations

The results shown in Figure A2-2 clearly show that for the environment applying in the United States of America, 10 MHz (5+5) of capacity is insufficient to service the uplink demands for even a Level 1 incident. On the other hand, although 10+10 is still deficient for the ideal Level 3 workload, it services the Level 1 and Level 2 incident demands and comes much closer to providing reasonable capability for the Level 3 case.

It is estimated that in the U.S., a Level 2 incident occurs once a week in a large metropolitan city with a population in the millions, such as Chicago, once a month in a large suburb with a population upwards of 100,000, and two times a year in a small suburb with a population in the tens of thousands.

ANNEX 3

Methodology to calculate [broadband] spectrum requirements

Table A3-1

Methodology

|  |  |
| --- | --- |
| **IMT-2000 methodology (Recommendation ITU-R M.1390)** | **Methodology** |
| **A Geography** |  |
| **A1** Operational Environment Combination of user mobility and user mobility. Usually only analyse most significant contributors. | **A1** PPDR user density is much lower and more uniform. PPDR users roam from one environment to another as they respond to emergencies. PPDR systems are usually designed to cover all environments (i.e., wide area network provides in-building coverage). Instead of analyzing by physical environment, assume that there will likely be multiple overlapping systems each providing different services (narrowband, wideband, and broadband). Each service environment will probably operate in a different frequency band with different network architectures. Analyse three overlapping urban “service environments”: narrowband, wideband, broadband. |
|  |
|  |
| **A2** Direction of calculation | **A2** Usually separate calculations for uplink and downlink due to asymmetry in some services |
| **A3** Representative cell area and geometry for each environment type | **A3**Average cell radius of radius to vertex for hexagonal cells |
| **A4** Calculate area of typical cell | **A4** Omni cells  i *R*2 Hexagonal cells  2.6 · *R*2 3-sector hex  2.6/3 · *R*2 |
|
|
| **B** Market & traffic |  |
| **B1** Services offered | **B1** Net user bit rate (kbit/s) for each of the four PPDR service environments: narrowband voice, narrowband data, wideband image, broadband video.  |
| **B2** Population density Persons per unit of area within each environment. Population density varies with mobility | **B2** Total PPDR user population within the total area under consideration. Divide PPDR population by total area to get PPDR population density.  PPDR users are usually separated into well-defined categories by mission. Example: *Category Population* Regular Police 25848 Special Police Functions 5169 Police Civilian Support 12924 Fire Suppression 7755 General Government Service 130 Other PPDR users 5039  **Total PPDR population 58157** Area under consideration. Area within well-defined geographic or political boundaries.  Example: City of Wuhan 1550 km2 PPDR population density  PPDR population/area Example: Wuhan 37.5 PPDR/km2 |
| **B3** Penetration ratePercentage of persons subscribing to a service within an environment. Person may subscribe to more than one service | **B3** Similar table.Rows are services, such as voice, data, video Columns are “service environments”, such as narrowband, wideband, and broadband. May collect penetration rate into each “service environment” separately for each PPDR category and then calculate composite PPDR penetration rate.Example: *Category Population* *Penetration* (NB Voice) Regular Police 25848 100% Special Police Function 5169 20% Police Civilian Support 12924 10% Fire Suppression 77557 0% Emergency Medical service 1292 50%General Government Service 130 40%Other PPDR users 5039 40%**Total PPDR Population 58157** **Narrowband Voice PPDR Population 36807.9** PPDR penetration rate for narrowband “service environment” and voice “service”:  Sum(Pop  Pen)/sum(Pop)  63.2% |
| **B4** Users/cellNumber of people subscribing to service within cell in environment | **B4** Users/cell Pop density  Pen Rate  Cell area |
| **B5** Traffic parameters Busy hour call attempts: average number of calls/sessions attempted to/from average user during a busy hourEffective call duration  Average call/session duration during busy hourActivity factor Percentage of time that resource is actually used during a call/session. Example: bursty packet data may not use channel during entire session. If voice vocoder does not transmit data during voice pauses  | **B5** Calls/busy hourSources: current PPDR data and prediction datas/call0-100% |
| **B6** Traffic/userAverage traffic generated by each user during busy hour | **B6** Call-seconds/userBusy hour attempts  Call duration  Activity factor |
| **B7** Offered traffic/cell Averagetraffic generated by all users within a cell during the busy hour (3 600 s) | **B7** Erlangs Traffic/user  User/cell/3 600 |
| **B8** Quality of service functionOffered traffic/cell is multiplied by typical frequency reuse cell grouping size and quality of Service factors (blocking function) to estimate offered traffic/cellat a given quality level | One carrier is applied in TD-LTE system. Group size is 1. |
| Group size |  |
| Traffic per group | =Traffic/cell (E) |
| Service channels per group | Use 1% blocking. Erlang B factor probably close to 1.5. Need to consider extra reliability for PPDR systems, excess capacity for peak emergencies, and number of channels likely to be deployed at each PPDR antenna site. Technology modularity may affect number of channels that can be deployed at a site |
| **C** Technical and system considerations |  |
| **C1** Service channels per cell to carry offered load | **C1** Service channels per cell  Service channels per group/Group size |
| **C2** Service channel bit rate (kbit/s) | **C2** Service channel bit rate  Net userbit rate Overhead factor  Coding factor |
| Equals net user bit rate plus additional increase in loading due to coding and/or overhead signalling, if not already included | If vocoder output  4.8 kbit/s, FEC  2.4 kbit/s, and Overhead  2.4 kbit/s, then Channel bit rate  9.6 kbit/s |
| **C3** Calculate traffic (Mbit/s)Total traffic transmitted within area under study, including all factors | **C3** Total traffic Service channels per cell x service channel bit rate |
| **C4** Net system capability Measure of system capacity for a specific technology. Related to spectral efficiency | **C4** Calculate for typical narrowband voice, narrowband data, wideband image and broadband video, spectrum efficiency based on simulation results. |
| **D** Spectrum results |  |
| **D1-D4** Calculate individual components (each cell in service vs environment matrix | **D1-D4** Calculate for each cell in service vs. “service environment” matrix |
| **D5** Weighting factor (alpha) for busy hour of each environment relative to busy hour of other environments, may vary from 0 to 1 | **D5** If all environments have coincident busy hours, then alpha  1Freqes Freq  alpha requirements in D1‑D4 |
| **D6** Adjustment factor (beta) for outside effects – multiple operators/networks, guard bands, band sharing, technology modularity | **D6**Freq(total)  beta  sum(alpha  Freqes) |

Application of the methodology to the calculation of spectrum requirements for Wuhan city in China

According to above modified method, the frequency band based on TD-LTE system is predicted, considering voice (including point-to-point downlink and uplink and point-to-multipoint downlink and uplink), narrow band data, image and video. Packet data is carried in TD-LTE system, the quality of the voice service focus on time delay, corresponding spectrum efficiency is a litter bit low, shown in Table 1. The spectrum efficiency of Point-to-point uplink and downlink is 0.2 Mbit/s/cell/MHz; In order to guarantee the quality of cell edge, corresponding spectrum efficiency of point-to-multipoint downlink is a little bit lower, that is 0.1 Mbit/s/cell/MHz.

To narrow band data and image, it needs to be differentiated the average spectrum efficiency and edge spectrum efficiency. According to simulation results, average spectrum efficiency uplink is 1.2 Mbit/s/cell/MHz, however, the edge of spectrum efficiency uplink is only 0.1 Mbit/s/cell/MHz; Average spectrum efficiency downlink is 1.6 Mbit/s/cell/MHz, however, the edge of spectrum efficiency uplink is only 0.1 Mbit/s/cell/MHz. Average spectrum efficiency is applied to uplink and downlink in this report.

To wide band video service, spectrum efficiency is calculated by factoring average spectrum efficiency and edge spectrum efficiency, shown in Table A3-3.

Table A3-2

Spectrum efficiency of TD-LTE voice

|  |  |  |
| --- | --- | --- |
| Parameters of voice | Value | Unit |
| Band（MHz) | 20 |  |
| Frequency Reuse factor | 1 |  |
| Point-to-point uplink spectrum efficiency | 0.2 | Mbit/s/cell/MHz |
| Point-to-point downlink spectrum efficiency | 0.2 | Mbit/s/cell/MHz |
| Point-to-multipoint downlink spectrum efficiency | 0.1 | Mbit/s/cell/MHz |

Table A3-3

Spectrum efficiency of TD-LTE narrow band data and image

|  |  |  |
| --- | --- | --- |
| Parameters of voice | Value | Unit |
| Band（MHz) | 20 |  |
| Frequency Reuse factor | 1 |  |
| Uplink average spectrum efficiency | 1.2 | Mbit/s/cell/MHz |
| Uplink edge spectrum efficiency | 0.1 | Mbit/s/cell/MHz |
| Downlink average spectrum efficiency | 1.6 | Mbit/s/cell/MHz |
| Downlink edge spectrum efficiency | 0.1 | Mbit/s/cell/MHz |

Table A3-4

Spectrum efficiency of TD-LTE video

|  |  |  |
| --- | --- | --- |
| Parameters of voice | Value | Unit |
| Band（MHz) | 20 |  |
| Frequency Reuse factor | 1 |  |
| Spectrum efficiency adjustment factor/ Edge proportion | 0.7 |  |
| Uplink spectrum efficiency | 0.437 | Mbit/s/cell/MHz |
| Downlink spectrum efficiency | 0.536 | Mbit/s/cell/MHz |

Wuhan city is capital of Hubei province and centre of politics, economy and culture, which located in the centre of China. It’s urban and main suburb cover 1550 km2. It is predicted that population of 2020 will be about 20 million.

The PPDR is categorized as 4 classes that are police, other police, police civilian support, and fire. The respective probable number is shown as following .

Table A3-5

PPDR population of Wuhan city in 2020

|  |  |
| --- | --- |
| PPDR category | PPDR population |
| Police | 25848 |
| Special police function | 5169 |
| Police civilian support | 12924 |
| Fire | 7755 |
| Emergency medical service | 1292 |
| General government service | 130 |
| Other PPDR users | 5039 |

Service model of voice and data are from Report ITU-R M.2033.

Table A3-6

Spectrum requirement of TD-LTE Voice

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | Geographic considerations | 　 | 　 | 　 | 　 |
| A1 | Select operational environment typeEach environment type basically forms a column in calculation spread sheet. Do not have to consider all environments, only the most significant contributors to spectrum requirements. Environments may geographically overlap.No user should occupy any two operational environments at one time | 　 | Urban pedestrian and mobile | Urban pedestrian and mobile | 　 |
| A2 | Select direction of calculation, uplink vs. downlink or combined | 　 | Uplink | Downlink | 　 |
| A3 | Representative cell area and geometry for each operational environment type，(radius of vertex for sectored hexagonal cells km） | 　 | 1.5 | 　 |
| A4 | Calculate representative cell area hexagonal = 2.6 • r\*r | 　 | 5.85 | 　 |
|  |  |  |  |  |  |
| B | Market and traffic considerations | 　 | 　 | 　 | 　 |
| B1 | Telecommunication services offered(kbit/s) | 　 | 　 | 　 | 　 |
| B2　 | Total population  | 　 | 58157 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| 　 | 　 | Police | 25848 | 1 | 　 |
| 　 | 　 | Special police function | 5169 | 0.2 | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.1 | 　 |
| 　 | 　 | Fire | 7755 | 0.7 | 　 |
|  |  | Emergency Medical service | 1292 | 0.5 |  |
|  |  | General Government Service | 130 | 0.4 |  |
|  |  | Other PPDR users | 5039 | 0.4 |  |
| 　 | 　 | 　 | 36807.9 | 　 | 　 |
| 　 | Area under consideration | 　 | 1550 | km2 | 　 |
| 　 | Number of persons per unit of area within the environment under consideration. Population density may vary with mobility Potential user per km2 | 　 | 37.5 | POP/km2 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| B3 | Penetration rate | Police | 25848 | 0.481  | 　 |
| 　 | 　 | Special police function | 5169 | 0.024  | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.025  | 　 |
| 　 | 　 | Fire | 7755 | 0.106  | 　 |
|  |  | Emergency medical service | 1292 | 0.011 |  |
|  |  | General government service | 130 | 0.001 |  |
|  |  | Other PPDR users | 5039 | 0.034 |  |
| 　 | 　 | 　 | 0.34  | using voice | 　 |
| B4 | The number of cell | 　 | 265 | 　 | 　 |
| Users/cell | 　 | 139.58  | 　 | 　 |
| B5 | Traffic parameters | 　 | Uplink | Downlink |
| 　 | 　 | 　 | 　 | Point-to-Point | Point-to-Multipoint |
| 　 | Busy hour call attempts (BCHA) (Calls/busy hour) | From PSWAC | 0.0073284E/ busy hour | 0.0463105E/ busy hour | 　 |
| 　 | 　 | 　 | 　 | 0.007718417 | 0.038592083 |
| 　 | Average number of calls/sessions attempted to/from average user during busy hour | 　 | 3.54  | 1.05  | 5.24  |
| 　 | Average call/session duration during busy hours Seconds/call | 　 | 7.88  | 26.53  | 26.53  |
| 　 | Activity factor | 　 | 1.00  | 1.00  | 1.00  |
| B6 | Average traffic in call-seconds generated by each user during busy hour  | 　 | 27.86  | 27.79  | 138.93  |
| B7 | Average traffic generated by all userswithin a cell during the busy hour (3 600 s) Erlangs | 　 | 1.08  | 1.08  | 5.39  |
| B8 | Establish quality of service (QOS) function parameters | 　 | 1.5 | 1.5 | 1.5 |
| 　 | frequency reuse factor | 　 | 1 | 1 | 1 |
| 　 | Traffic per cell | 　 | 1.08  | 1.08  | 5.39  |
| 　 | Total Traffic per cell | 　 | 1.62  | 1.62  | 8.08  |
|  |  |  |  |  |  |
| C | Technical and system considerations | 　 | 　 | 　 | 　 |
| C1 | Total Traffic per cell | 　 | 1.62  | 1.62  | 8.08  |
| C2 | Bitrate（kbit/s)(12.2k AMR，about 16k) | 　 | 16.00  | 16.00  | 16.00  |
| C3 | Calculate traffic（Mbit/s) | 　 | 0.026  | 0.026  | 0.129  |
| C4 | Frequency Efficiency | 　 | 0.200  | 0.200  | 0.1 |
|  |  |  |  |  |  |
| D | Spectrum results | 　 | 　 | 　 | 　 |
| D1 | 　 | 　 | 0.13  | 0.13  | 1.29  |
| D2 | Weighting factor for each environment （α） | 　 | 1.00  | 1.00  | 1 |
| D3 | Adjustment factor（β） | 　 | 1.00  | 1.00  | 1 |
| D4 | Calculate total spectrum(MHz) | 　 | 1.55  |

Table A3-7

Spectrum requirement of TD-LTE narrow band data

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | Geographic considerations | 　 | 　 | 　 | 　 |
| A1 | Select operational environment typeEach environment type basically forms a column in calculation spreadsheet. Do not have to consider all environments, only the most significant contributors to spectrum requirements. Environments may geographically overlap.No user should occupy any two operational environments at one time | 　 | Urban pedestrian and mobile | Urban pedestrian and mobile | 　 |
| A2 | Select direction of calculation, uplink vs downlink or combined | 　 | Uplink | Downlink | 　 |
| A3 | Representative cell area and geometry for each operational environment type，(radius of vertex for sectored hexagonal cells km） | 　 | 1.5 | 　 |
| A4 | Calculate representative cell area hexagonal = 2.6 • r\*r | 　 | 5.85 | 　 |
|  |  |  |  |  |  |
| B | Market and traffic considerations | 　 | 　 | 　 | 　 |
| B1 | Telecommunication services offered(kbit/s) | 　 | 　 | 　 | 　 |
| B2 | Total population  | 　 | 58157 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| 　 | 　 | Police | 25848 | 0.5 | 　 |
| 　 | 　 | Special police function | 5169 | 0.05 | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.05 | 　 |
| 　 | 　 | Fire | 7755 | 0.35 | 　 |
|  |  | Emergency medical service | 1292 | 0.2 |  |
|  |  | General government service | 130 | 0.2 |  |
|  |  | Other PPDR users | 5039 | 0.21 |  |
| 　 | 　 | 　 | 18162.8 | 　 | 　 |
| 　 | Area under consideration | 　 | 1550 | km2 | 　 |
| 　 | Number of persons per unit of area within the environment under consideration. Population density may vary with mobility Potential user per km2 | 　 | 37.5 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| B3 | Penetration rate | Police | 25848 | 0.240  | 　 |
| 　 | 　 | Special police function | 5169 | 0.006  | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.012  | 　 |
| 　 | 　 | Fire | 7755 | 0.053  | 　 |
|  |  | Emergency medical service | 1292 | 0.05 |  |
|  |  | General government service | 130 | 0 |  |
|  |  | Other PPDR users | 5039 | 0.02 |  |
| 　 | 　 | 　 | 0.39 | 　 | 　 |
| B4 | The number of cell | 　 | 265 | 　 | 　 |
| Users/cell | 　 | 68.46  | 　 | 　 |
| B5 | Traffic parameters | 　 | Uplink | Downlink | 　 |
| 　 | Busy hour call attempts (BCHA) (Calls/busy hour) | 　 | 30.00  | 30.00  | 　 |
| 　 | kbit/date | 　 | 80.00  | 80.00  | 　 |
| 　 | Activity factor | 　 | 1.00  | 1.00  | 　 |
| B6 | Average traffic in call-seconds generated by each user during busy hour  | 　 | 2400.00  | 2400.00  | 　 |
| B7 | Average traffic generated by all userswithin a cell during the busy hour (3 600 s)Erlangs Throughput(kbps) | 　 | 0.67  | 0.67  | 　 |
| B8 | Establish quality of service (QOS) function parameters | 　 | 1.5 | 1.5 | 　 |
| 　 | Frequency reuse factor | 　 | 1 | 1 | 　 |
| 　 | Traffic/user in a cell Throughput/ kbps | 　 | 1.00  | 1.00  | 　 |
|  |  |  |  |  |  |
| C | Technical and system considerations | 　 | 　 | 　 | 　 |
| C1 | Total Throughput / Mbps | 　 | 0.07  | 0.07  | 　 |
| C2 | Frequency Efficiency | 　 | 1.200  | 1.600  | 　 |
|  |  |  |  |  |  |
| D | Spectrum results | 　 | 　 | 　 | 　 |
| D1 | 　 | 　 | 0.06  | 0.04  | 　 |
| D2 | Weighting factor for each environment （α） | 　 | 1.00  | 1.00  | 　 |
| D3 | Adjustment factor（β ） | 　 | 1.00  | 1.00  | 　 |
| D4 | Total Spectrum(MHz) | 　 | 0.10  |

Table A3-8

Spectrum requirement of TD-LTE image

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | Geographic considerations | 　 | 　 | 　 | 　 |
| A1 | Select operational environment typeEach environment type basically forms a column in calculation spreadsheet. Do not have to consider all environments, only the most significant contributors to spectrum requirements. Environments may geographically overlap.No user should occupy any two operational environments at one time | 　 | Urban pedestrian and mobile | Urban pedestrian and mobile | 　 |
| A2 | Select direction of calculation, uplink vs downlink or combined | 　 | Uplink | Downlink | 　 |
| A3 | Representative cell area and geometry for each operational environment type，(radius of vertex for sectored hexagonal cells km） | 　 | 1.3 | 　 |
| A4 | Calculate representative cell area hexagonal = 2.6 • r\*r | 　 | 5.85 | 　 |
|  |  |  |  |  |  |
| B | Market and traffic considerations | 　 | 　 | 　 | 　 |
| B1 | Telecommunication services offered(kbit/s) | 　 | 　 | 　 | 　 |
| B2　 | Total population  | 　 | 58157 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| 　 | 　 | Police | 25848 | 0.6 | 　 |
| 　 | 　 | Special police function | 5169 | 0.05 | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.01 | 　 |
| 　 | 　 | Fire | 7755 | 0.3 | 　 |
|  |  | Emergency medical service | 1292 | 0.2 |  |
|  |  | General government service | 130 | 0.2 |  |
|  |  | Other PPDR users | 5039 | 0.24 |  |
| 　 | 　 | 　 | 19908.4 | 　 | 　 |
| 　 | Area under consideration | 　 | 1550 | km2 | 　 |
| 　 | Number of persons per unit of area within the environment under consideration. Population density may vary with mobility Potential user per km2 | 　 | 37.5 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| B3 | Penetration rate | Police | 25848 | 0.289  | 　 |
| 　 | 　 | Special police function | 5169 | 0.006  | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.002  | 　 |
| 　 | 　 | Fire | 7755 | 0.046  | 　 |
|  |  | Emergency medical service | 1292 | 0.005 |  |
|  |  | General government service | 130 | 0 |  |
|  |  | Other PPDR users | 5039 | 0.023 |  |
| 　 | 　 | 　 | 0.40  | 　 | 　 |
| B4 | The number of cell | 　 | 265 | 　 | 　 |
| Users/cell | 　 | 75.19  | 　 | 　 |
| B5 | Traffic parameters | 　 | Uplink | Downlink | 　 |
| 　 | Busy hour call attempts (BCHA) (Calls/busy hour) | 　 | 6.00  | 6.00  | 　 |
| 　 | kbit /Image | 　 | 8000.00  | 8000.00  | 　 |
| 　 | Activity factor | 　 | 1.00  | 1.00  | 　 |
| B6 | Average traffic in call-seconds generated by each user during busy hour  | 　 | 48000.00  | 48000.00  | 　 |
| B7 | Average traffic generated by all userswithin a cell during the busy hour (3 600 s)Erlangs Throughput(kbps) | 　 | 13.33  | 13.33  | 　 |
| B8 | Establish quality of service (QOS) function parameters | 　 | 1.5 | 1.5 | 　 |
| 　 | Frequency Reuse factor | 　 | 1 | 1 | 　 |
| 　 | Traffic/user in a cell Throughput/ kbps | 　 | 20.00  | 20.00  | 　 |
|  |  |  |  |  |  |
| C | Technical and system considerations | 　 | 　 | 　 | 　 |
| C1 | Total Throughput / Mbps | 　 | 1.50  | 1.50  | 　 |
| C2 | Frequency Efficiency | 　 | 1.200  | 1.600  | 　 |
|  |  |  |  |  |  |
| D | Spectrum results | 　 | 　 | 　 | 　 |
| D1 | 　 | 　 | 1.25  | 0.94  | 　 |
| D2 | Weighting factor for each environment (α) | 　 | 1.00  | 1.00  | 　 |
| D3 | Adjustment factor（β） | 　 | 1.00  | 1.00  | 　 |
| D4 | Total Spectrum(MHz) | 　 | 2.19  |

Table A3-9

Spectrum requirement of TD-LTE video

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | Geographic considerations | 　 | 　 | 　 | 　 |
| A1 | Select operational environment typeEach environment type basically forms a column in calculation spreadsheet. Do not have to consider all environments, only the most significant contributors to spectrum requirements. Environments may geographically overlap.No user should occupy any two operational environments at one time | 　 | Urban pedestrian and mobile | Urban pedestrian and mobile | 　 |
| A2 | Select direction of calculation, uplink vs downlink or combined | 　 | Uplink | Downlink | 　 |
| A3 | Representative cell area and geometry for each operational environment type，(radius of vertex for sectored hexagonal cells km） | 　 | 1.5 | 　 |
| A4 | Calculate representative cell area hexagonal = 2.6 • r\*r | 　 | 5.85 | 　 |
|  |  |  |  |  |  |
| B | Market and traffic considerations | 　 | 　 | 　 | 　 |
| B1 | Telecommunication services offered(kbit/s) | 　 | 　 | 　 | 　 |
| B2 | Total population  | 　 | 58157 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| 　 | 　 | Police | 25848 | 0.2 | 　 |
| 　 | 　 | Special police function | 5169 | 0.04 | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.02 | 　 |
| 　 | 　 | Fire | 7755 | 0.4 | 　 |
|  |  | Emergency medical service | 1292 | 0.1 |  |
|  |  | General government service | 130 | 0.3 |  |
|  |  | Other PPDR users | 5039 | 0.1 |  |
| 　 | 　 | 　 | 9694.4 | 　 | 　 |
| 　 | Area under consideration | 　 | 1550 | km2 | 　 |
| 　 | Number of persons per unit of area within the environment under consideration. Population density may vary with mobility Potential user per km2 | 　 | 37.5 | 　 | 　 |
| 　 | 　 | 　 | Population (POP) by PPDR category  | Penetration (PEN) rate within PPDR category | 　 |
| B3 | Penetration rate | Police | 25848 | 0.096  | 　 |
| 　 | 　 | Special police function | 5169 | 0.005  | 　 |
| 　 | 　 | Police civilian support | 12924 | 0.005  | 　 |
| 　 | 　 | Fire | 7755 | 0.061  | 　 |
|  |  | Emergency medical service | 1292 | 0.002 |  |
|  |  | General government service | 130 | 0.001 |  |
|  |  | Other PPDR users | 5039 | 0.009 |  |
| 　 | 　 | 　 | 0.33  | 　 | 　 |
| B4 | The number of cell | 　 | 265 | 　 | 　 |
| Users/cell | 　 | 36.58  | 　 | 　 |
| B5 | Traffic parameters | 　 | Uplink | Downlink | 　 |
| 　 | Busy hour call attempts (BCHA) (Calls/busy hour) | 　 | 6.00  | 3.00  | 　 |
| 　 | Average traffic in call-seconds generated by each user during busy hour  | 　 | 60.00  | 60.00  | 　 |
| 　 | Activity factor | 　 | 1.00  | 1.00  | 　 |
| B6 | Average traffic generated by all userswithin a cell during the busy hour (3 600 s)Erlangs Throughput(kbps) | 　 | 360.00  | 180.00  | 　 |
| B7 | Average traffic generated by all userswithin a cell during the busy hour (3 600 s)Erlangs Throughput(kbps) | 　 | 3.66  | 1.83  | 　 |
| B8 | Establish quality of service (QOS) function parameters | 　 | 1.5 | 1.5 | 　 |
| 　 | Frequency Reuse factor | 　 | 1 | 1 | 　 |
| 　 | Traffic of all users in a cell Throughput/ kbps | 　 | 3.66  | 1.83  | 　 |
| 　 | Total traffic in a cell Throughput/ kbps | 　 | 5.49  | 2.74  | 　 |
|  |  |  |  |  |  |
| C | Technical and system considerations | 　 | 　 | 　 | 　 |
| C1 | Total Traffic per cell | 　 | 5.49  | 2.74  | 　 |
| C2 | Bitrate（kbit/s)(2MHz) | 　 | 2000.00  | 2000.00  | 　 |
| C3 | Total Throughput / Mbps | 　 | 10.975  | 5.487  | 　 |
| C4 | Frequency Efficiency | 　 | 0.430  | 0.550  | 　 |
|  |  |  |  |  |  |
| D | Spectrum results | 　 | 　 | 　 | 　 |
| D1 | 　 | 　 | 25.52  | 9.98  | 　 |
| D2 | Weighting factor for each environment ( α ) | 　 | 1.00  | 1.00  | 　 |
| D3 | Adjustment factor（β） | 　 | 1.00  | 1.00  | 　 |
| D4 | Total Spectrum(MHz) | 　 | 35.50  |

Frequency prediction is summarised in Table A3-10.

Table A3-10

Example narrowband and wideband calculation summaries

|  |  |  |
| --- | --- | --- |
| **PPDR category** | **Wuhan population** | **Penetration rates** |
| **Narrowband voice** | **Narrowband data** | **Wideband image** | **broadband video** |
| Police | 25848 | 1 | 0.5 | 0.6 | 0.2 |
| Special police function | 5169 | 0.2 | 0.05 | 0.05 | 0.04 |
| Police civilian support | 12924 | 0.1 | 0.05 | 0.01 | 0.02 |
| Fire | 7755 | 0.7 | 0.35 | 0.3 | 0.4 |
| Emergency medical service | 1292 | 0.5 | 0.2 | 0.2 | 0.1 |
| General government service | 130 | 0.4 | 0.2 | 0.2 | 0.3 |
| Other PPDR users | 5039 | 0.4 | 0.21 | 0.24 | 0.1 |
| Total – PPDR users | 58157 | 36870 | 18162 | 19908 | 9673 |
| Spectrum (MHz) |  | 1.55 | 0.1 | 2.19 | 35.50 |
| Spectrum in total (MHz) | 39.34 |  |  |  |  |
| Other parameters: |  |  |  |  |  |
| Environment | Urban pedestrian and mobile |  |  |  |  |
| Cell radius (km) | 1.5 |  |  |  |  |
| Study area (km2) | 1550 | (Calculated) |  |  |
| Cell area (km2) | 5.85 | (Calculated) |  |  |
|  |  | NB Voice | NB data | WB image | BB Video |
|  |  | Uplink | Uplink | Uplink | Uplink |
| Erlangs per busy hour |  | 0.007328 |  |  | 0.1 |
| Busy hour call attempts |  | 3.54 | 30 | 6 | 6 |
| Effective call duration |  | 7.88s | 80kbit | 8000kbit | 60s |
| Activity factor |  | 1 | 1 | 1 | 1 |
|  | NB Voice | NB data | WB image | BB Video |
|  | DL PTP | DL PTM | Downlink | Downlink | Downlink |
| Erlangs per busy hour | 0.00771 | 0.03859 | 　 | 　 | 0.05 |
| Busy hour call attempts | 1.05 | 5.24 | 30 | 6 | 3 |
| Effective call duration | 26.53s | 26.53s | 80kbit | 8000kbit | 60s |
| Activity factor | 1 | 1 | 1 | 1 | 1 |
| Group size | 1 |  |  |  |  |
| Grade of service factor | 1.5 |  |  |  |  |
| α factor | 1 |  |  |  |  |
| β factor | 1 |  |  |  |  |

Considering narrow band voice, narrow band data, wide band image and broad band video, total 39.34 MHz is maybe minimum PPDR spectrum according to requirement development of Wuhan city in 2020.

Table A3-11

Total spectrum requirement of TD-LTE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Voice/MHz | Narrow data/MHz | Image/MHz | Video/MHz | Total spectrum /MHz |
| 1.55 | 0.1 | 2.19 | 35.5 | 39.34 |

Annex 4

Scenario of LTE based technology for PPDR broadband
provided by China

This is a study of a typical PPDR incident, a bank robbery, which happened in China. Wireless bandwidth requirements of PPDR agencies in this mission critical scenario are analyzed.

Process to handle the incident:

1. 110 command center receives emergency call and dispatches nearby police officers to the scene.
2. The dispatched police officers contact the command center and ask for the aid of SWAT Police officers in accordance with the situation and set up a command center on the scene.
3. Firefighters and medical team arrive on the scene.
4. Police helicopter arrives on the scene. The helicopter transmits panoramic high definition images to the on-scene command center and the on-scene command center transmits the images through wireless network to remote command center. The remote command center transmits large amount of data concerning the incident and the scene to the on-scene command center, which in turn broadcasts the data to each emergency team.
5. The SWAT Police officers arrive on the scene. They deploy surveillance equipment to conduct covert surveillance and collect information. Critical information is transmitted to the on-scene command center in a manner of high definition images while general information is transmitted through two channels standard definition images. The on‑scene command center broadcasts the video images to whichever emergency team that needs the video.
6. The SWAT Police officers deploy remote-controlled reconnaissance robots and transmit indoor video in two manners, high definition and standard definition.
7. Negotiation experts arrive on the scene. To make sure the experts can see and hear every detail of the scene; assistants for the negotiation monitor the negotiation by making full use of videos collected through all equipment.
8. SWAT Police officers make the strategy for strike and ten of them prepare to start the strike. Two head-mounted cameras of standard definition are carried with them.
9. The operation is finished.

Throughout the whole process, the peak spectrum demand happens when the SWAT Police team strike. Only when bandwidth requirement during this period is met, the emergency can be properly handled.

Tests have proved that for video of standard definition, at a distance of about 15 meters, CIF 352×288p, 25fps, only gender, figure, and motions can be identified, whereas D1 704×576p, 25 fps, face, details of figure, and license plate numbers can be identified; for videos of high definition, at a distance of over 30 meters, 720P 1280×720p, only gender, figure, and motions can be identified, whereas 1080P, face, details of figure, and plate numbers can be identified.

Table 1 lists the bandwidth requirements of different personnel and equipment during the strike. Compared to the bandwidth for video transmission, the bandwidth for uploading and downloading voice and data can be ignored. Thus, table 1 only lists the statistics for downlink and uplink bandwidth required by video.

Annex 5

Methodology for the calculation of broadband PPDR
spectrum requirements within CEPT[[5]](#footnote-5)

The frequency ranges used for estimating the necessary spectrum bandwidth are the 400 MHz and 700 MHz ranges. It is assumed that a wide area network would be deployed below 1 GHz in order to reduce the number of necessary cell sites.

A brief description of the methodology used for calculation of spectrum requirements is presented below.

This methodology can be considered as an incident based approach where traffic is summed over several separate incidents and background traffic is then added in order to define the total spectrum requirements.

Methodology for PP1

The methodology used for PP1 scenarios consists of the following 5 steps:

Step 1: Definition of the incidents (scenarios).

Step 2: Estimate the total traffic requirement per incident including background traffic.

Step 3: Calculate the link budgets and cell size.

Step 4: Estimate the number of incidents that should be taken into account simultaneously per cell.

Step 5: Estimate the total spectrum requirement based on assumptions on number of incidents per cell, location of incidents within a cell and spectrum efficiency per incident.

Methodology for PP2

The methodology used for PP2 scenarios consists of the following 3 steps:

Step 1: Definition of the PP2 scenarios.

Step 2: Estimate of the PP2 scenarios traffic.

Step 3: Estimate the total spectrum requirement based on assumptions on location of users within the cell and spectral efficiency.

Annex 6

Definitions

Editor's Note: These definitions will need to be reviewed for their relevance and be cross-checked with similar or existing definitions already used within the ITU.

Public protection and disaster relief

The term Public Protection and Disaster Relief (PPDR) is defined in ITU-R Resolution **646** **(WRC‑12)** as a combination of two key areas of emergency response activity:

• Public Protection – dealing with the maintenance of law and order, protection of life and property, and emergency situations.

• Disaster Relief – dealing with a serious disruption of the functioning of society, posing a significant widespread threat to human life, health, property, or the environment, whether caused by accident, natural phenomena, or human activity, and whether developing suddenly or as a result of complex, long-term processes.

Broadband PPDR scenario

A PPDR scenario is an operational situation in which a combination of different applications is used to manage the event or incident. Scenarios include average day-to-day operations, large emergencies or public events and disasters. Separate scenarios are identified since they are distinct in terms of their characteristics and may impose different requirements for PPDR communications. Scenarios may differ from country to country because they are based on individual sovereign national instructions or guidelines.

Commercial communication network

A commercial communication network is one that is built and operated by profit-oriented operators in order to offer public communication services.

Commercial technology standard

A technical standard e.g. GSM, LTE, that is initially or primarily developed as platform for the operation of commercial communication networks.

Cross-border

PPDR organisations have to assist each other in certain cases, meaning they have to be able to work in foreign countries with the local PPDR organisations and at the same time with their own organisation.

Day-to-day operation

Day-to-day operations encompass the routine tasks that PPDR agencies conduct within their jurisdiction. Typically these tasks are conducted inside national borders. Generally most PP spectrum and infrastructure requirements are determined using this scenario with the addition of extra capacity to cover unspecified and sudden emergency events.

PPDR dedicated network

A network solely designed to fulfil the specific PPDR requirements: this can be a GoGo model (Government Owned, Government Operated), but also a service delivered by a third party (CoCo: Company Owned, Company Operated). Another model is GoCo (network owned by Government, but operated by a third party).

Disaster

Disasters are situations caused by either natural or human activity. For example, natural disasters include an earthquake, major tropical storm, a major ice storm, floods, etc. Examples of disasters caused by human activity include large-scale criminal incidents or situations of armed conflict. Generally, both the existing PP communications systems and special on-scene communications equipment brought by DR organisations are deployed.

IMT

International Mobile Telecommunication Systems. IMT specifications and standards are defined in Recommendations ITU-R M.1457 and ITU-R M.2012.

PPDR interoperability

PPDR interoperability is described in Report ITU-R M.2033 as the ability of PPDR personnel from one agency/organisation to communicate by radio with personnel from another agency/organisation, on demand (planned and unplanned) and in real time. There are several elements/components which affect interoperability including, spectrum, technology, network, standards, planning, and available resources. Systems from different vendors, or procured for different countries, should be able to interoperate at a predetermined level without any modifications or special arrangements in other PPDR or commercial networks. Interoperability is also needed in a ‘multi-vendor’ situation where terminals from different suppliers are working on infrastructures from other suppliers.

Large emergency/public events

Large emergencies and/or public events are those that PP and potentially DR agencies respond to in a particular area of their jurisdiction. However, they are still required to perform their routine operations elsewhere within their jurisdiction. The size and nature of the event may require additional PPDR resources from adjacent jurisdictions, cross-border agencies, or international organisations. In most cases there are either plans in place or there is some time to plan and coordinate the requirements.

LTE

LTE (Long Term Evolution), marketed as 4G LTE, is a standard for wireless communication of high-speed data for mobile phones and data terminals. The LTE specifications are developed by the 3GPP (3rd Generation Partnership Project, while the standards are written regionally such as in ETSI, TIA, ARIB and other regional Standard Development Organizations.

Roaming

In wireless telecommunications, roaming is a general term referring to the extension of connectivity service in a network that is different from the home network where the service was registered. Roaming ensures that the wireless device is kept connected to a network, without losing the connection. Traditional (GSM)-Roaming is defined as the ability for a cellular customer to automatically make and receive voice calls, send and receive data, or access other services, including home data services, when travelling outside the geographical coverage area of the home network, by means of using a visited network. This can be done by using a communication terminal or simply just by using the subscriber identity in the visited network.

Data throughput

A data throughput and spectrum bandwidth calculator should be developed based on the requirements of PPDR agencies. This calculator would use a set of PPDR applications and be based on current operational experience and vision of future working practices.

Mission critical communications

Mission critical Communications are those communications that are used by PPDR organisations in situations where human life, property and other values for the society are at risk, especially when time is a vital factor. Mission critical communications are secure, reliable and readily available and as a consequence responders cannot afford the risk of having failures in their individual and group communications (e.g. voice and data or video transmissions).”

PPDR specific standard

A radio communication standard that has been developed specifically for PPDR applications or that is a further development of an already existing (commercial) standard.

ANNEX 7Table of technical requirements for mission critical
PPDR broadband communications

Editor’s Note: The majority of the material of Annex 7 of this report was taken from the Annex 3 of Report ITU-R M.2033 under the section “systems requirements”. The blue highlights are new. Should parts of this Annex be handled as a separate sub-section in section 6.2 of this report?]

| **Technical Requirement** | **Specifics** | **Importance[[6]](#footnote-6)** |
| --- | --- | --- |
|  |  | P1 | P2 | P3 |
| Functional | Simultaneous use of multiple applications | H | H | M |
| Integration of multiple applicationsVoice, data & videoMulticast and unicast servicesReal time instant messagingScene video transmissionMobile office functionsVPN servicesTelemetryRemote controlLocation of terminals | H | H | M |
| Integration of local voice, high speed data and video on high speed networks |
| Priority access | Manage levels of priority in traffic with load shedding during high traffic periods | H | H | H |
| Accommodate increased traffic loading during major operations and emergencies | H | H | H |
| Exclusive use of frequencies or equivalent high priority access to other systems | H | H | H |
| Grade of service | Suitable grades of service to support a prioritized range of services (see Appendix 1 below) | H | H | H |
| Guaranteed throughput | H | H | H |
| Rapid response times for accessing network and information directly at the incident scene, including fast subscriber/network authentication and session set up | H | H | H |
| Coverage | PPDR system should provide complete coverage within relevant jurisdiction and/or operation | H | H | M |
| Coverage of relevant jurisdiction and/or operation of PPDR organization whether at national, provincial/state or at local level | H | H | M |
| Systems designed for peak loads and widefluctuations in use | H | H | M |
| Enhancing system capacity during PP emergency or DR by techniques such as reconfiguration of networks with intensive use of direct mode operation | H | H | H |
| Vehicular repeaters (NB, WB, BB) for coverage oflocalized areas | H | H | H |
| Very good reliable indoor/outdoor coverage | H | H | H |
| Coverage of remote areas, underground and inaccessible areas | H | H | H |
| Appropriate redundancy to continue operations, when equipment/infrastructure fails | H | H | H |
| RAN shall utilize maximum frequency reuse efficiency.  | H | H | M |
| Capabilities | Rapid dynamic reconfiguration of system | H | H | H |
| Control of communications including centralized dispatch, access control, dispatch group configuration, priority level setting and pre-emption. | H | H | H |
| Network system level management capability | M | H | H |
| Stable & easy to operate management system | H | H | H |
| Robust OAM offering status reporting and dynamic reconfiguration.  | H | H | H |
| Network to perform basic self –recovery, expediting service restoration and a return to redundant operations. | H | H | H |
| Packet data capability  | H | H | H |
| Internet Protocol compatibility (complete system or interface with) | M | M | M |
| Robust equipment (hardware, software, operational and maintenance aspects) | H | H | H |
| Portable equipment (equipment that can transmit while in motion) | H | H | H |
| Equipment requiring special features such as high audio output, unique accessories (e.g. special microphones, operation while wearing gloves, operation in hostile environments and long battery life) | H | H | H |
| Fast session set-up and instant “push-to-talk” operation | H | H | H |
| Communications to aircraft and marine equipment, control of robotic devices | M | H | L |
| One touch broadcasting/group session establishment | H | H | H |
| Terminal-to-terminal communications without infrastructure, (e.g. direct mode operation/talk-around), vehicular repeaters. | H | H | H |
| Rapid deployment capability – infrastructure & terminals | L | H | H |
| The Network shall provide seamless coverage (via handoff/handover mechanisms) and continuous connectivity within the 95th percentile coverage area at stationary and vehicular speeds up to 120 kph.  | H | H | H |
| A single common air interface (CAI) shall be utilized for the mobile broadband network.  | H | H | H |
| Mobile/portable station nominal transmit power shall be 0.25W ERP (24 dBm) and shall not exceed 3 W ERP (34.8 dBm) in rural areas for portable devices.  | L | L | L |
| Support | 24-hour and 7 days-a-week (24/7) support for fixed and user equipment | H | H | H |
| The network operations centre to operate on a 24x7x365 basis | H | H | H |
| 24/7 operations including field based support as necessary to maintain the availability of the network. In all cases, 24/7 access to call centre support for issue resolution and assistance is also required | H | H | H |
| Reliability and adaptability  | Ability to operate in accordance with national EMC regulations | H | H | H |
| Adaptable to extreme natural and electromagnetic environments. No functional network failure during climate events, operational vibration, earthquake, EMI/ESD, and supplied power events. | H | M | L |
| Support operation of PPDR communications in any environment | H | H | H |
| Fixed, mobile & terminal equipment adaptable to a wide range of natural environments, with any physical facilities supporting network equipment meeting contemporary standards for electric surge suppression, grounding and EMP Protection | H | H | H |
| PPDR systems operation in accordance with national EMC regulations | H | H | H |
| Robust network and management system | H | H | H |
| Stable, resilient working platform | H | H | H |
| Self-managed network | H | H | H |
| Coordinated development of business continuity plans. | H | H | H |
| Resilient service delivery | H | H | H |
| High availability design – e.g. Diversity, redundancy, automated failover protection, backup operational processes. | H | H | H |
| Network & operational testing to ensure data/call processing functionality is restored within predetermined and guaranteed time period following an outage | H | H | H |
| The above should result in PPDR broadband networks at least matching the level of robustness displayed by the current public safety land mobile radio (i.e., P-25 or TETRA). | H | H | H |
| Availability | Service availability shall not be calculated to allow a prolonged outage even in one service area. | H | H | H |
| Power backup using battery backup and /or power generation. Redundant backhaul circuits from the RAN to the core and to the base stations. High wind loading for the cell towers (Availability 99.995% at year 10) | H | H | H |
| Highly reliable (99.999%) individual network elements. Ensuring adequate supply and easy access to spares to reduce Mean Time To Repair (MTTR). Operational readiness assured even in a maintenance window. | H | H | H |
| Redundant elements should automatically detect failure and activate to provide service upon failures of primary network components | H | H | H |
| Security  | End to end encryption. The network shall provide cryptographic controls to ensure that transmissions can only be decoded by the intended recipient. This must include data encryption over all wireless links.  | H | H | L |
| Support for domestic encryption arithmetic | H | H | L |
| The encryption should support both point‐to‐point traffic and point‐to‐multipoint traffic.  | H | H | L |
| The network shall support periodic re‐keying of devices such that traffic encryption keys may be changed without re‐authentication of the device and without interruption of service. | H | H | H |
| The network shall provide cryptographic controls to ensure that received transmissions have not been modified in transit.  | H | H | L |
| Access to public safety services and applications shall be provided only to those authenticated users and/or devices as specifically authorized by each PPDR organization. | H | H | M |
| The network shall require each device that attempts to connect to the network to prove its identity prior to granting access to network resources. Each device shall be assigned a unique identifier, and the authentication method must provide strong assurance (e.g. by public key cryptography) of the device's identity in a manner that requires no user interaction.  | H | H | M |
| The device authentication service shall utilize an open standard protocol.  | H | H | H |
| To protect against both malicious devices and malicious network stations, the authentication must be mutual, with the device proving its identity to the network and the network proving its identity to the device.  | H | H | H |
| Each PPDR organization shall be granted the option to require user authentication in addition to device authentication for certain devices assigned to that organization. When user authentication has been selected as a requirement, the network shall require each of the organization's designated devices to prove its user's identity prior to granting access to network resources. | H | H | H |
| For organizations requiring user authentication, the network must facilitate sequential authentication of multiple users from a single device.  | H | H | H |
| System authorization management. Each organization shall be granted control over authorization by means of an administrative interface. | H | H | H |
| For organizations requiring user authentication, the organization shall be granted via administrative interface (e.g. Web based) the ability to add, remove, and manage user accounts that are permitted to access the network. | H | H | H |
| For organizations requiring user authentication, the network must facilitate sequential authentication of multiple users from a single device | H | H | H |
| 3rd party key management system | L | L | L |
| The network shall maintain a record of all device and user access attempts and all authentication and authorization transactions, including changes to authentication and authorization data stores.  | H | H | H |
| Over the air key update | L | L | L |
| The network shall enforce a configurable time‐out, imposing a maximum time that each device may be connected to the network. | H | H | H |
| The network shall enforce an inactivity time‐out, imposing a maximum time that each device may be connected to the network without transmitting data. | H | H | H |
| Each PPDR organization shall be granted control of the network time‐out and inactivity time‐out setting for individual devices assigned to that organization. | H | H | H |
| Each organization shall also be granted via administrative interface the means to manually and forcibly terminate access, including active sessions, to the network for any of its assigned devices individually. | H | H | H |
| The network shall be capable of attack monitoring.  | H | H | H |
| Terminal Requirements for preventing unauthorized use  | Devices shall support the network's device authentication protocol. Each device shall be assigned a unique identifier, and the authentication method must provide strong assurance (e.g. by public key cryptography) of the device's identity in a manner that requires no user interaction.  | H | H | H |
| To protect against both malicious devices and malicious network stations, the authentication must be mutual, with the device proving its identity to the network and the network proving its identity to the device. The device must not permit connectivity to the PPDR network unless the network is authenticated.  | H | H | H |
| Each PPDR organization shall have the option to require user authentication for device access. When user authentication has been selected as a requirement, the device shall require each user to prove his or her identity prior to granting access to applications or network resources.  | H | H | H |
| Devices may support a means of erasing (via best practice multiple pass overwriting of data storage media) all data stored on the device.  | H | H | H |
| Devices may support a means of encrypting data stored on the device such that user authentication is required for decryption.  | H | H | H |
| Cost | Scalable system | L | H | M |
| Open standards | H | H | H |
| Open system architecture | H | H | H |
| Cost effective solution & applications | H | H | H |
| Competitive marketplace for supply of equipment and terminals | H | H | H |
| Reduction in deployment of permanent network infrastructure due to availability and commonality of equipment | H | H | L |
| Implementable by public and/or private operator for PPDR applications | H | H | M |
| Rapid deployment of systems and equipment for large emergencies, public events and disasters (e.g. large fires, Olympics, peacekeeping) | H | H | H |
| Information to flow to/from units in the field to theoperational control centre and specialist knowledge centers | H | LH | LH |
| Operational scenario | Greater safety of personnel through improved communications | H | H | H |
| Intra-system: Facilitate the use of common network channels and/or “talk groups” | H | H | H |
| Inter-system: Promote and facilitate the options common between systems | H | H | H |
| Coordinate tactical communications between on-scene or incident commanders of multiple PPDR agencies | H | H | H |
| Share with other terrestrial mobile users | L | L | M |
| Interoperability | Interoperable/Interconnection with narrowband trunked systems. Interconnection required with:Inter RF subsystem Interface Voice service and Supplementary servicesConsole supplementary Interface Voice service and Supplementary services | M | H | H |
| Interoperable/ Interconnection with other broadband systems | H | H | H |
| Interoperable/ Interconnection with satellite systems | H | H | H |
| Interconnection with other information systems | H | H | H |
| Interfaces that interconnect to esoteric systems | H | H | H |
| API compatible with standard interfaces | H | H | H |
| Appropriate levels of interconnection to public telecommunication network(s) – fixed and mobile | M | M | M |
| Spectrum usage & management | Suitable spectrum availability (BB channels) | H | H | H |
| Minimize interference to PPDR systems | H | H | H |
| Increased efficiency in use of spectrum | M | M | M |
| Appropriate channel spacing between mobile and base station frequencies | M | M | M |
| Dynamic spectrum allocation | H | H | H |
| Comply with relevant national regulations | H | H | H |
| Reallocation of upstream and downstream rates | H | H | H |
| Regulatory compliance | Coordination of frequencies in border areas | H | H | M |
| Provide capability of PPDR system to support extended coverage into neighboring countries (subject to agreements) | M | M | M |
| Ensure flexibility to use various types of systems in other Services (e.g. HF, satellites, amateur) at the scene of large emergency | M | H | H |
| Adherence to principles of the Tampere Convention | L | L | H |
| Planning  | Reduce reliance on dependencies (e.g. power supply, batteries, fuel, antennas, etc.) | H | H | H |
| As required, have readily available equipment (inventoried or through facilitation of greater quantities of equipment) | H | H | H |
| Provision to have national, state/provincial and local (e.g. municipal) systems | H | H | M |
| Pre-coordination and pre-planning activities (e.g. specific channels identified for use during disaster relief operation, not on a permanent, exclusive basis, but on a priority basis during periods of need) | H | H | H |
| Maintain accurate and detailed information so that PPDR users can access this information at the scene | M | M | M |

APPENDIX 1 OF ANNEX 7 **Definition of Grades of Service**

|  |  |
| --- | --- |
| QoS Class of Service | Description/Definition |
| QoS Class of Service 0 | The network shall support a QoS class of service for real-time, jitter-sensitive, high interaction (cellular voice, push-to-talk voice, etc.). |
| QoS Class of Service 1 | The network shall support a QoS class of service for real-time, jitter-sensitive, interactive (cellular voice, push-to-talk voice, etc.). |
| QoS Class of Service 2 | The network shall support a QoS class of service for transaction data, highly interactive (signalling). |
| QoS Class of Service 3 | The network shall support a QoS class of service for transaction data, interactive. |
| QoS Class of Service 4 | The network shall support a QoS class of service for low-loss, real-time video. |
| QoS Class of Service 5 | The network shall support a QoS class of service for low-loss only (short transactions, bulk data). |
| QoS Class of Service 6 | The network shall support a QoS class of service for traditional applications of default IP networks. |

ANNEX 8Information from international standardisation organisation on activities with regards to public protection and disaster relief (PPDR)

**ATIS** would like to draw attention to two ATIS WTSC Issues (i.e., work items) concerning PPDR:

* Issue P0032, Support of Public Safety Requirements in LTE Networks.
* Issue P0039, Public Safety Mission Critical Push to Talk (PTT) Voice Interoperation between Land Mobile Radio (LMR) and Long Term Evolution (LTE) Systems.

Furthermore, ATIS is working on activities related to PPDR as shown below:

| **Issue #** | **Title** | **Output** |
| --- | --- | --- |
| P0018 | Proposed Joint ATIS/TIA Standards on Commercial Mobile Alerts Service (CMAS) | J-STD-100J-STD-101 |
| [P0019](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0019.doc) | ATIS Standard on Commercial Mobile Alerts Service (CMAS) Specification for GSM/UMTS Using Cell Broadcast Service | ATIS-0700006 |
| [P0021](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0021.doc) | Canadian LAES Location Reporting | ATIS-0700009 |
| [P0024](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0024.doc) | ATIS Implementation Guidelines and Best Practices for GSM/UMTS Cell Broadcast Service | ATIS-0700007 |
| [P0026](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0026.doc) | CMAS via Evolved Packet System (EPS) Public Warning System (PWS) | ATIS-0700010 |
| [P0027](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0027.doc) | Cell Broadcast Entity (CBE) to Cell Broadcast Center (CBC) Interface Protocol | ATIS-0700008 |
| [P0028](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0028.doc) | Certification and Testing of the CMAS C-Interface | J-STD-102 |
| [P0030](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0030.doc) | Implementation of 3GPP Common IMS Emergency Procedures for IMS Origination and ESInet/Legacy Selective Router Termination | ATIS-0700015 |
| [P0031](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0031.docx) | CMAS C1 Interface between PBS and CMSP Gateway | J-STD-101.a |
| [P0033](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0033.docx) | Support for Delivery of Spanish Language Commercial Mobile Alerts System (CMAS) Alerts | ATIS-0700012ATIS-0700013 ATIS-0700014 |
| [P0034](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0034.docx) | Automating Location Acquisition for Non-Operator-Managed Over-the-Top VoIP Emergency Services Calls | *Under development* |
| [P0037](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0037.docx) | SMS-to-9-1-1 | J-STD-110 |
| [P0038](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0038.docx) | Errata for ATIS and Joint ATIS/TIA Standards on Commercial Mobile Alerts Service (CMAS) | ATIS-0700006.aATIS-0700010.aJ-STD-100.aJ-STD-101.aJ-STD-101.bJ-STD-102.a |
| [P0040](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0040.docx) | Canadian Commercial Mobile Alerts Service (CMAS) | *Under development* |
| [P0041](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0041.docx) | Commercial Mobile Alerts Service (CMAS) International Roaming | *Under development* |
| [P0042](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0042.docx) | CMRS and TCC Provider Implementation Guidelines for the Joint ATIS/TIA SMS to 911 Standard (J-STD-110) | J-STD-110.01 |
| [P0043](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0043.docx) | Implementability Fixes for J-STD-110 | J-STD-110.a |
| [P0044](http://www.atis.org/0160/_Com/Docs/IssueStatements/P0044.doc) | Extending ATIS-0700015 to address Multimedia Emergency Services (MMES) | *Under development* |

**CCSA** is working on four work items for TD-LTE based Broadband Trunking System, which can support PPDR communications.

**Work Item 1**: Technical specifications for TD-LTE based Broadband Trunking System: General requirements and architecture. The WI was approved in November 2012 and the specification was approved in August 2013.The specification defines the services, scenario, functions, performance, architecture and interfaces for TD-LTE based Broadband Trunking System.

**Work Item 2**: Technical specifications for TD-LTE based Broadband Trunking System: Radio interface. The WI was approved in May 2013. The scope of the technical specification is of the physical layer protocol, Medium Access Control protocol, Radio Link Control protocol, Packet Data Convergence Protocol and Radio Resource Control protocol of radio interface for TD-LTE based Broadband Trunking System.

**Work Item 3**: Technical specifications for TD-LTE based Broadband Trunking System: Interface between Trunking Core Network and Dispatch. The WI was approved in May 2013. The scope of the technical specification is the application layer protocol of the interface between Trunking Core Network and Dispatch.

**Work Item 4**: Technical specifications for TD-LTE based Broadband Trunking System: Interface between UE and Trunking Core Network. The WI was approved in May 2013. The scope of the technical specification is the application layer protocol of the interface between UE and Trunking Core Network.

3GPP is currently working on activities related to public protection and disaster relief. 3GPP SA WG1 has developed requirements in Rel 12 for standards to support Public Safety needs for Proximity Services and Group Communications.

[1] 3GPP TS 22.115: “Service aspects; Charging and billing” http://www.3gpp.org/ftp/Specs/archive/22\_series/22.115/

[2] 3GPP TS 22.278: “Service requirements for the Evolved Packet System (EPS)” http://www.3gpp.org/ftp/Specs/archive/22\_series/22.278/

[3] 3GPP TS 22.468: “Group Communication System Enablers for LTE (GCSE\_LTE)” http://www.3gpp.org/ftp/Specs/archive/22\_series/22.468/

[4] 3GPP TS 22.268: Public Warning System (PWS) requirements

 <http://www.3gpp.org/ftp/Specs/archive/22_series/22.268/>

The 3GPP SA WG1 requirements are based on the current needs expressed by various regional and national Public Safety organizations. As these needs are more recent than Report ITU-R M.2033, the list of source material is provided below

[5] 3GPP website announcement "FCC selects LTE for USA Public Safety" http://www.3gpp.org/FCC-selects-LTE-for-USA-Public

[6] 3GPP website link to FCC announcement of selection of LTE for USA public safety "FCC TAKES ACTION TO ADVANCE NATIONWIDE BROADBAND COMMUNICATIONS FOR AMERICA’S FIRST RESPONDERS" http://www.3gpp.org/IMG/pdf/psltedoc-304244a1.pdf

[7] TETRA Release 1: Direct Mode Operation http://www.tetramou.com/about/page/12026

1. Reference to be added to ECC Report 199. [↑](#footnote-ref-1)
2. 2 Examples of the types of mobile systems can be found in Recommendations ITU-R M.1073, ITU‑R M.1457, ITU‑R M.1801, ITU‑R M.2012, and in Report ITU-R M.2014. [↑](#footnote-ref-2)
3. 3GPP TS 36.104 version 11.4.0 Release 11 – Table 6.2.1. [↑](#footnote-ref-3)
4. Specifically Posen, Illinois was used and their MABAS (Multi-Agency Box Alarm System) “Box Card” was evaluated with interpretation from Posen PS employees. [↑](#footnote-ref-4)
5. See ECC Report 199 for more details on methodology used in CEPT. [↑](#footnote-ref-5)
6. The importance of that particular requirement to PPDR is indicated as high (H), medium (M) or low (L). This importance factor is listed for the three radio operating environments:

 “Day-to-day operations”, “Large emergency and/or public events”, and “Disasters”, represented by P1, P2 and P3, respectively. The importance levels contained in this column have been based on table included in Report ITU-R M.2033 and have been updated based on input contributions. [↑](#footnote-ref-6)