

## REPORT ITU-R M.2033

**Radiocommunication objectives and requirements  
for public protection and disaster relief**

(2003)

**1 Scope**

The purpose of the Report is to define the public protection and disaster relief (PPDR) objectives and requirements for the implementation of future advanced solutions to satisfy the operational needs of PPDR organizations around the year 2010. Specifically, it identifies objectives, applications, requirements, a methodology for spectrum calculations, spectrum requirements and solutions for interoperability.

This Report has been developed in preparation for WRC-03 agenda item 1.3:

“to consider identification of globally/regionally harmonized bands, to the extent practicable, for the implementation of future advanced solutions to meet the needs of public protection agencies, including those dealing with emergency situations and disaster relief, and to make regulatory provisions, as necessary, taking into account Resolution **645 (WRC-2000)**.”

Resolution 645 (WRC-2000) invited the ITU-R to “study, as a matter of urgency, identification of frequency bands that could be used on a global/regional basis by administrations intending to implement future solutions for public protection agencies and organizations, including those dealing with emergency situations and disaster relief,” and “to study, as a matter of urgency, regulatory provisions necessary for identifying globally/regionally harmonized frequency bands for such purposes;”. Resolution 645 (WRC-2000) also invited the ITU-R to “... conduct studies for the development of a resolution identifying the technical and operational basis for global cross-border circulation of radiocommunication equipment in emergency and disaster relief situations,”. Recommendation ITU-R M.1637 provides additional guidance on this element.

**2 Background**

Radiocommunications have become extremely important to public protection and disaster relief (PPDR) organizations to the extent that PPDR communications are highly dependent upon it. At times, radiocommunication is the only form of communications available.

In order to provide effective communications, PPDR agencies and organizations have a set of objectives and requirements that include interoperability, reliability, functionality, security in operation and fast call set-up<sup>1</sup> in each area of operation. Considering that the radiocommunication

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<sup>1</sup> Fast call set-up indicates reducing the response time to access the particular network.

needs of PPDR agencies and organizations are growing, future advanced solutions used by PPDR will require higher data rates, along with video and multimedia capability.

This Report forms part of the process of specifying these objectives and the requirements of PPDR organizations to meet their future needs. PPDR organizations will operate their communications in a complex environment, which requires the recognition of the following factors:

- a) the involvement of a number of interests (such as governments, service providers, manufacturers);
- b) the changing regulatory framework for those involved in supplying systems supporting PPDR;
- c) that PPDR applications may be narrowband, wideband or broadband, or a mixture of these;
- d) the need for interoperability and interworking between networks;
- e) the need for high levels of security;
- f) the needs of developing countries;
- g) the ITU-D Handbook on Disaster Communications;
- h) the needs of countries, particularly for developing countries, for low-cost communications equipment for public protection and disaster relief agencies and organizations;
- i) that the 1998 Intergovernmental Conference on Emergency Telecommunications (ICET-98), with the participation of 76 countries and various intergovernmental and non-governmental organizations, adopted the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations. In 1998, thirty-three States signed this comprehensive Convention that also contains an article dealing with the removal of regulatory barriers;
- j) that the *Working Group on Emergency Telecommunications* (WGET), which is also the *Reference Group on Telecommunications* (RGT) of the *Inter-Agency Standing Committee* (IASC) on humanitarian affairs has adopted frequencies in the VHF and UHF bands allocated to the land mobile service for inter-agency coordination of relief operations and safety and security communications in international humanitarian assistance as listed in Annex 3 to this Report;
- k) that many disaster relief organizations require independence to fulfill their humanitarian mandate by maintaining their operational autonomy while fully respecting the laws of the countries in which they operate;
- l) that in times of disasters, when most terrestrial based networks may be destroyed or impaired, amateurs, satellite and other non-ground based networks may be able to provide communications services to assist in public protection and disaster relief efforts;

- m) that systems operating within various radiocommunication services, including mobile, fixed, mobile satellite, fixed satellite and/or amateur, could support both current and future advanced PPDR applications;
- n) that in some countries, national regulations and/or legislation may affect the ability of PPDR organizations to use commercial wireless systems or networks;
- o) that in some countries, commercial wireless systems currently offer and will probably continue to support PPDR applications;
- p) that there is potential for new technologies such as IMT-2000 systems and beyond, and intelligent transportation systems (ITS), which may support or supplement advanced PPDR applications and that such complementary use would be in response to market demands.

### 3 Harmonization of spectrum

Significant amounts of spectrum are already in use in various bands in various countries for narrowband PPDR applications, however, it should be noted that sufficient spectrum capacity will be required to accommodate future operational needs including narrowband, wideband and broadband applications. Experience has shown that spectrum that is harmonized has benefits that include 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;
- stability in band planning, that is, evolving to globally/regionally harmonized spectrum arrangements may assist in more efficient planning of land mobile spectrum; and
- increased effective response to disaster relief.

When considering appropriate frequencies for PPDR, it should be recognized that the propagation characteristics of lower frequencies allow them to travel farther than higher frequencies, making low frequency systems potentially less costly to deploy in rural areas. Lower frequencies are also sometimes preferred in urban settings due to their superior building penetration. However, these lower frequencies have become saturated over time and to prevent overcrowding some administrations now use more than one frequency band in different parts of the radio spectrum.

The more bands that may be identified with different propagation characteristics the more difficult it becomes to benefit from economies of scale. Therefore, a balance needs to be struck between the number and location of the bands identified.

## 4 Aspects of frequency bands for PPDR

Based upon an ITU-R survey of PPDR communications conducted in the 2000-2003 study period from over 40 ITU members and international organizations and consequent considerations, the following comments should be noted:

- a) There is little uniformity in regard to frequency bands that are used for PPDR in different countries.
- b) While in most countries the bands used for public protection are the same as those used for disaster relief, in some countries separate bands are used.
- c) Many administrations have designated one or more frequency bands for narrowband PPDR operations. It should be noted that only particular sub-bands of the frequency ranges or parts thereof listed below are utilized in an exclusive manner for PPDR radiocommunications: 3-30 MHz, 68-88 MHz, 138-144 MHz, 148-174 MHz, 380-400 MHz (including CEPT designation of 380-385/390-395 MHz), 400-430 MHz, 440-470 MHz, 764-776 MHz, 794-806 MHz, and 806-869 MHz (including CITEL designation of 821-824/866-869 MHz). One administration has designated PPDR spectrum for wideband and broadband applications.
- d) Some administrations in Region 3 are using or plan to use or have identified parts of the frequency bands 68-88 MHz, 138-144 MHz, 148-174 MHz, 380-399.9 MHz, 406.1-430 MHz and 440-502 MHz, 746-806 MHz, 806-824 MHz and 851-869 MHz for PPDR applications. Some administrations in Region 3 are also using the bands 380-399.9 MHz, 746-806 MHz and 806-824 MHz paired with 851-869 MHz for Government communications.

The bands which are listed in § c) and d) above and other potential candidate bands are discussed in detail in the CPM-02 Report (§ 2.1.2.6) together with their advantages and disadvantages and are listed in Annex 2.1-1 of the CPM-02 Report.

## 5 Summary

Based on the studies undertaken in ITU-R on PPDR, this Report focuses on the numerous radiocommunication objectives and requirements that may be required to support future advanced solutions for PPDR applications. The following areas of interest were generated during the process of developing this report:

- Annex 1 Radiocommunication objectives for public protection and disaster relief
- Annex 2 Radiocommunication requirements for public protection and disaster relief
- Annex 3 Narrowband frequencies for inter-agency coordination and safety and security communications in international humanitarian assistance presently in use

- Annex 4    Spectrum requirements for public protection and disaster relief
- Annex 5    Existing and emerging solutions to support interoperability for public protection and disaster relief

## **Annex 1**

### **Radiocommunication objectives for public protection and disaster relief**

#### **1        General objectives**

Public protection and disaster relief (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;
- 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 one 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 organizations.

## 2 Technical objectives

Systems for PPDR aim to achieve the following technical objectives:

- a) to support the integration of voice, data, and image communication;
- b) to provide additional level(s) of security associated with the type of information carried over the communication channels associated with the various PPDR applications and operations;
- c) to support equipment that operates in extreme and diverse operational conditions (rough road, dust, extreme temperature, etc.);
- d) 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;
- e) to provide fast call set-up, one touch broadcasting and group call features.

## 3 Operational objectives

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

- a) to provide security including end-to-end encryption, terminal/network authentication;
- b) to enable communications management to be controlled by PPDR agencies and organizations such 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;
- 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 underground 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, prompt capacity increase to survive partial loss of infrastructure crucial to effective mission compliance and the safety and security of PPDR personnel;
- 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.

## Annex 2

### Radiocommunication requirements for public protection and disaster relief

#### 1 Terminology

##### 1.1 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 responsible agencies and organizations 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.

##### 1.2 Applicability of voice, data, graphics 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, firefighters 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 current PPDR applications. The availability of future advanced solutions is expected to be of benefit to PPDR operations.

### 1.3 Consideration of advantages with future 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 land 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 future technologies were implemented globally, it could reduce the cost of equipment, increase availability of equipment, increase potential for interoperability, may provide for a wider range of capabilities and reduce network infrastructure rollout time.

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 future technologies may require that consideration be given to spectrum aspects for PPDR applications.

If PPDR applications used IMT-2000 technology, it may be possible to use commercial IMT-2000 networks in regions where it was not cost-effective to deploy a dedicated network. IMT-2000 is intended for deployment in a wide range of environments, from rural to the densest urban areas. Commercial systems that are being deployed using IMT-2000 technologies may not meet all of the identified needs for PPDR. However, the use of these technologies and systems should be considered, particularly in terms of the potential associated cost savings and advanced features that they offer.

### 1.4 Narrowband, wideband, broadband

Communications supporting PPDR operations cover a range of radiocommunication services such as fixed, mobile, amateur and satellite. Typically, narrowband technologies are used for PPDR communications within the terrestrial mobile service, while wideband and broadband technologies are finding 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 terms described in § 1.4.1, 1.4.2 and 1.4.3 appropriate for the purpose of discussing this issue:

### 1.4.1 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 technologies, with typical channel bandwidths up to 25 kHz, that are currently used to deliver narrowband PPDR applications. Some countries do not mandate specific technology, but promote the use of spectrum-efficient technology.

### 1.4.2 Wideband (WB)

It is expected that the wideband technologies will carry data rates of several hundred kilobits per second (e.g. in the range of 384-500 kbit/s). Since it is expected that networks and future technologies may require higher data rates, 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 gives a wide base of technology availability and will therefore spur the development of specialist mobile data applications. Short message and e-mail are now being seen as a fundamental part of any communications control and command system and therefore could most likely be an integral part of any future 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. It is expected that this will initiate the development of a range of new and secure applications for PPDR organizations.

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.1221 and ITU-R M.1457 and with channel bandwidths dependent on the use of spectrally efficient technologies.

### 1.4.3 Broadband (BB)

Broadband technology could be seen as a natural evolutionary trend from wideband. 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 deployed in a localized area with intensive on-scene requirements (often referred to as “hot spot” areas) where PPDR personnel are operating.

Broadband applications could typically be tailored to service localized areas (e.g. 1 km<sup>2</sup> or less) providing 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 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.

Broadband systems may have inherent noise and interference tradeoffs with data rates and associated coverage. Depending on the technology deployed, a single broadband network may have different coverage areas in the range of a few metres up to hundreds of metres, providing a wide range in spectrum reuse capability. Collectively, the high data speeds and localized coverage area open up numerous new possibilities for PPDR applications (tailored area networks, hot spot deployment and ad-hoc networks).

Finally, it should be noted that various standards organizations are beginning work on systems for broadband applications including Project MESA.

## 2 Radio operating environments for PPDR

Various radio operating environments are applicable to PPDR and are 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 estimates for spectrum.

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.

### 2.1 Day-to-day operations

Day-to-day operations encompass the routine operations that PPDR agencies conduct within their jurisdiction. Typically, these operations are within national borders. Generally, most PP spectrum and infrastructure requirements are determined using this scenario with extra capacity to cover unspecified emergency events. For the most part day-to-day operations are minimal for DR. In Tables 2 and 3, day-to-day operations are referred to as PP (1).

## 2.2 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 2 and 3, large emergencies or public events are referred to as PP (2).

## 2.3 Disasters

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.

Even in areas where suitable terrestrial services exist, MSS systems will play a significant role in disaster situation. The terrestrial services which do exist may have been damaged by the disaster itself, or may be unable to cope with the increased traffic demands resulting from a disaster situation. In these situations, satellite solutions can offer a reliable solution. The frequency bands used by 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 MSS 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 GMPCS-MoU.

Some PPDR agencies/organizations and amateur radio groups use HF narrowband systems including the use of data modes of operation as well as voice. Other technologies such as digital voice, high-speed data and video are in early implementations either using terrestrial or satellite network services.

In Tables 2 and 3, disasters are referred to as DR.

### 3 Requirements

Tables 2 and 3 summarize § 3.1 and 3.2, which describe PPDR application and user requirements.

When considering these sections, it is important to note that public protection organizations currently use various arrangements of mobile systems or a combination thereof, as described below in Table 1.<sup>2</sup>

TABLE 1  
**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        | Commercial      | Shared with PP treated as ordinary customer | Commercial          |

Items b), c), d) and e) of Table 1 in some countries are currently used by PP organizations to supplement their own systems or in some cases to provide all their communications requirements, but not necessarily all the items 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-2000.

Some of the applications listed in § 3.1.3 and Table 2 may depend significantly on commercial systems, while other applications for the same PP organizations may be totally independent of commercial systems.

<sup>2</sup> Examples of the types of mobile systems can be found in Recommendations ITU-R M.1073, ITU-R M.1457 and in Report ITU-R M.2014.

### 3.1 Applications

#### 3.1.1 General

- a) Applications associated with the routine day-to-day and emergency operations for public protection applications as outlined in Table 2 could be offered.
- b) Applications associated with disaster relief operations as outlined in Table 2 could be offered.
- c) Regional and/or international harmonization of spectrum for the provision of PPDR applications could be allowed 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 environments for PPDR is provided in § 2 of this Annex.

#### 3.1.2 Application accessibility requirements

The eventual accessibility of applications for PPDR may depend on various issues. These include the cost, the regulatory and the national legislative climate, the nature of mandates PPDR, 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.

#### 3.1.3 Envisioned applications

Table 2 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. Furthermore, for each example, the importance (high, medium or low) of that particular application and feature to PPDR is indicated. This importance factor is listed for the three radio operating environments identified in Annex 2, § 2.1 “Day-to-day operations”, § 2.2 “Large emergency and/or public events”, and § 2.3 “Disasters”, represented by PP (1), PP (2) and DR, respectively.

TABLE 2

PPDR Applications and Examples

| Application          | Feature                           | PPDR Example                                                                             | Importance <sup>(1)</sup> |        |    |
|----------------------|-----------------------------------|------------------------------------------------------------------------------------------|---------------------------|--------|----|
|                      |                                   |                                                                                          | PP (1)                    | PP (2) | DR |
| 1. <i>Narrowband</i> |                                   |                                                                                          |                           |        |    |
| Voice                | Person-to-person                  | Selective calling and addressing                                                         | H                         | H      | H  |
|                      | One-to-many                       | Dispatch and group communication                                                         | H                         | H      | H  |
|                      | Talk-around/direct mode operation | Groups of portable to portable (mobile-mobile) in close proximity without infrastructure | H                         | H      | H  |

TABLE 2 (cont.)

| Application                                | Feature                                                             | PPDR Example                                                 | Importance <sup>(1)</sup> |        |    |
|--------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------------------|---------------------------|--------|----|
|                                            |                                                                     |                                                              | PP (1)                    | PP (2) | DR |
| Voice (cont.)                              | Push-to-talk                                                        | Push-to-talk                                                 | H                         | H      | H  |
|                                            | Instantaneous access to voice path                                  | Push-to-talk and selective priority access                   | H                         | H      | H  |
|                                            | Security                                                            | Voice encryption/scrambling                                  | H                         | H      | M  |
| Facsimile                                  | Person-to-person                                                    | Status, short message                                        | L                         | L      | H  |
|                                            | One-to-many (broadcasting)                                          | Initial dispatch alert (e.g. address, incident status)       | L                         | L      | H  |
| Messages                                   | Person-to-person                                                    | Status, short message, short e-mail                          | H                         | H      | H  |
|                                            | One-to-many (broadcasting)                                          | Initial dispatch alert (e.g. address, incident status)       | H                         | H      | H  |
| Security                                   | Priority/instantaneous access                                       | Man down alarm button                                        | H                         | H      | H  |
| Telemetry                                  | Location status                                                     | GPS latitude and longitude information                       | H                         | M      | H  |
|                                            | Sensory data                                                        | Vehicle telemetry/status                                     | H                         | H      | M  |
|                                            |                                                                     | EKG (electrocardiograph) in field                            | H                         | H      | M  |
| Database interaction (minimal record size) | Forms based records query                                           | Accessing vehicle license records                            | H                         | H      | M  |
|                                            |                                                                     | Accessing criminal records/missing person                    | H                         | H      | M  |
|                                            | Forms based incident report                                         | Filing field report                                          | H                         | H      | H  |
| 2. Wideband                                |                                                                     |                                                              |                           |        |    |
| Messages                                   | E-mail possibly with attachments                                    | Routine e-mail message                                       | M                         | M      | L  |
| Data Talk-around/direct mode operation     | Direct unit to unit communication without additional infrastructure | Direct handset to handset, on-scene localized communications | H                         | H      | H  |

TABLE 2 (cont.)

| Application                                  | Feature                                    | PPDR Example                                                                | Importance <sup>(1)</sup> |        |    |
|----------------------------------------------|--------------------------------------------|-----------------------------------------------------------------------------|---------------------------|--------|----|
|                                              |                                            |                                                                             | PP (1)                    | PP (2) | DR |
| Database interaction<br>(medium record size) | Forms and records query                    | Accessing medical records                                                   | H                         | H      | M  |
|                                              |                                            | Lists of identified person/missing person                                   | H                         | H      | H  |
|                                              |                                            | GIS (geographical information systems)                                      | H                         | H      | H  |
| Text file transfer                           | Data transfer                              | Filing report from scene of incident                                        | M                         | M      | M  |
|                                              |                                            | Records management system information on offenders                          | H                         | M      | L  |
|                                              |                                            | Downloading legislative information                                         | M                         | M      | L  |
| Image transfer                               | Download/upload of compressed still images | Biometrics (finger prints)                                                  | H                         | H      | M  |
|                                              |                                            | ID picture                                                                  | H                         | H      | M  |
|                                              |                                            | Building layout maps                                                        | H                         | H      | H  |
| Telemetry                                    | Location status and sensory data           | Vehicle status                                                              | H                         | H      | H  |
| Security                                     | Priority access                            | Critical care                                                               | H                         | H      | H  |
| Video                                        | Download/upload compressed video           | Video clips                                                                 | M                         | L      | L  |
|                                              |                                            | Patient monitoring (may require dedicated link)                             | M                         | M      | M  |
|                                              |                                            | Video feed of in-progress incident                                          | H                         | H      | M  |
| Interactive                                  | Location determination                     | 2-way system                                                                | H                         | H      | M  |
|                                              |                                            | Interactive location data                                                   | H                         | H      | H  |
| 3. Broadband                                 |                                            |                                                                             |                           |        |    |
| Database access                              | Intranet/Internet access                   | Accessing architectural plans of buildings, location of hazardous materials | H                         | H      | H  |

TABLE 2 (end)

| Application                | Feature                           | PPDR Example                                                                       | Importance <sup>(1)</sup> |        |    |
|----------------------------|-----------------------------------|------------------------------------------------------------------------------------|---------------------------|--------|----|
|                            |                                   |                                                                                    | PP (1)                    | PP (2) | DR |
| Database access<br>(cont.) | Web browsing                      | Browsing directory of PPDR organization for phone number                           | M                         | M      | L  |
| Robotics control           | Remote control of robotic devices | Bomb retrieval robots, imaging/video robots                                        | H                         | H      | M  |
| Video                      | Video streaming, live video feed  | Video communications from wireless clip-on cameras used by in building fire rescue | H                         | H      | H  |
|                            |                                   | Image or video to assist remote medical support                                    | H                         | H      | H  |
|                            |                                   | Surveillance of incident scene by fixed or remote controlled robotic devices       | H                         | H      | M  |
|                            |                                   | Assessment of fire/flood scenes from airborne platforms                            | M                         | H      | M  |
|                            |                                   | Assessment of fire/flood scenes from airborne platforms                            | M                         | H      | M  |
| Imagery                    | High resolution imagery           | Downloading Earth exploration-satellite images                                     | L                         | L      | M  |
|                            |                                   | Real-time medical imaging                                                          | M                         | M      | M  |

<sup>(1)</sup> 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.

### 3.2 User requirements

This section includes the requirements from the perspective of the PPDR end users. General technology, 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.

Table 3, at the end of this section, is a general summary of the user requirements. The requirements are grouped under the same headings as § 3.2.1 through 3.2.8 and any key attributes related to the requirement are listed in the second column. Furthermore, the importance (high, medium or low) of that particular requirement to PPDR is indicated. This importance factor is listed for the three radio operating environments identified in § 2.1 “Day-to-day operations”, § 2.2 “Large emergency and/or public events”, and § 2.3 “Disasters”, represented by PP (1), PP (2) and DR, respectively.

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 the following requirements.

### **3.2.1 System requirements**

#### **3.2.1.1 Support of multiple applications**

As desired by PPDR organizations, systems serving PPDR should be able to support a broad range of applications, as identified in § 3.2.

#### **3.2.1.2 Simultaneous use of multiple applications**

As desired by the PPDR organization, systems serving PPDR should be able to support the simultaneous use of several different applications with a range of bit rates.

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.

#### **3.2.1.3 Priority access**

As desired by the PPDR organizations, 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 the exclusive use of frequencies or equivalent high priority access to other systems.

#### **3.2.1.4 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.

#### **3.2.1.5 Coverage**

The PPDR system is usually required to provide complete coverage (for “normal” traffic within the relevant jurisdiction and/or 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 and wide fluctuations in use. Additional resources, enhancing system capacity 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 (NB, WB, BB), 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). Appropriate redundancy to continue operations when the equipment/infrastructure fails is extremely beneficial.

PPDR systems are not generally installed inside numerous 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 personal stations outdoors with limited access indoors by direct propagation through the building walls. Sub-systems may be installed in specific building or structures, like tunnels, if penetration through the walls is insufficient. PPDR systems tend to use larger radius cells and higher power mobile and personal stations than commercial service providers.

### 3.2.1.6 Capabilities

PPDR users require control (full or in part) of their communications, including centralized dispatch (command and control center), 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 are also required. Equipment may also require high audio output (high noise environment), unique accessories, such as special microphones, operation while wearing gloves, operation in hostile environments (heat, cold, dust, rain, water, shock, vibration, explosive environments, etc.) and long battery life.

PPDR users may require the system to have capability for fast call set-up, instant push-to-talk operations or one touch broadcasting/group call. Talk-around (direct mode, simplex), communications to aircraft and marine equipment, control of robotic devices, vehicular repeater (on-scene repeater, extend network to remote locations) may also be required.

As the trend continues to move towards IP based solutions, PPDR systems may be required to be IP compatible or be able to interface with IP based solutions.

Appropriate levels of interconnection to the public telecommunications network may also be required<sup>3</sup>. 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.

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<sup>3</sup> A description of an international emergency preference scheme (IEPS) is described in ITU-T Recommendation E.106.

There may be additional requirements for simulcast (quasi-synchronous broadcast), receiver operating (in-bound path diversity) that have not been covered in Table 3.

### 3.2.2 Security related requirements

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.

Furthermore, it should be noted that many administrations have regulations limiting the use of secure communications for visiting PPDR users.

### 3.2.3 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 permanent network infrastructure.

### 3.2.4 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.

### 3.2.5 Operational requirements

This section defines the operational and functional requirements for PPDR users and lists key attributes in Table 3.

#### 3.2.5.1 Scenario

Greater safety of personnel can be accomplished through improved communications. Systems supporting PPDR should be able to operate in the various scenarios, as described in § 2. PPDR radiocommunication equipment should be able to support at least one of these operating environments, however, it is preferable that PPDR radiocommunication 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.

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.

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### 3.2.5.2 Interoperability

Interoperability is the seamless, coordinated, and integrated PPDR communications for the safe, effective, and efficient protection of life and property. Communications interoperability can be achieved at many levels of a PPDR operation. From the most basic level, i.e., a fire fighter of one organization communicating with a fire fighter of another, up to the highest levels of command and control.

Various options are available to facilitate communications interoperability between multiple agencies. These include, but are not limited to:

- a) the use of common frequencies and equipment,
- b) utilizing local, on-scene command vehicles/equipment/procedures,
- c) via dispatch centres/patches, or
- d) utilizing technologies such as audio switches or software defined radios. Typically multiple agencies use a combination of options.

Annex 5 provides a more detailed explanation of interoperability and possible solutions.

How these options are used to obtain interoperability depends how the PPDR organizations want to talk to 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.

Notwithstanding, while the importance of interoperability 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.

### 3.2.6 Spectrum usage and management

Depending on national frequency allocations, PPDR users must share 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, interference to systems supporting PPDR from non-PPDR users should be minimized as much as possible.

Depending on the national regulations, systems supporting PPDR may be required to use specific channel spacing between mobile and base station transmit frequencies.

Each administration has the discretion to determine suitable spectrum for PPDR. Annexes 3 and 4 provide additional information on spectrum usage and requirements.

### 3.2.7 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.

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

For disaster relief communications, administrations are encouraged to adhere to the principles of the Tampere Convention.

Flexibility should be afforded to PPDR users to employ various types of systems (e.g. HF, satellite, terrestrial, amateur, Global Maritime Distress and Safety System (GMDSS) at the scene of the incident in times of large emergencies and disasters.

### 3.2.8 Planning

Planning and pre-coordination activities can greatly support PPDR communications. Planning should take into account readily available equipment that could be provided for unpredictable events and disasters through existing inventory thereby reducing the reliance on supplies. 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.

TABLE 3  
User requirements

| Requirement                               | Specifics                                                                                                                                        | Importance <sup>(1)</sup> |           |    |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------|----|
|                                           |                                                                                                                                                  | PP<br>(1)                 | PP<br>(2) | DR |
| 1. <i>System</i>                          |                                                                                                                                                  |                           |           |    |
| Support of multiple applications          |                                                                                                                                                  | H                         | H         | M  |
| Simultaneous use of multiple applications | Integration of multiple applications (e.g. voice and low/medium speed data)                                                                      | H                         | H         | M  |
|                                           | Integration of local voice, high speed data and video on high speed network to service localized areas with intensive on-scene activity          | H                         | H         | M  |
| Priority access                           | Manage high priority and low priority traffic load shedding during high traffic                                                                  | 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 grade of service                                                                                                                        | H                         | H         | H  |
|                                           | Quality of service                                                                                                                               | H                         | H         | H  |
|                                           | Reduced response times of accessing network and information directly at the scene of incidence, including fast subscriber/network authentication | H                         | H         | H  |

TABLE 3 (cont.)

| Requirement  | Specifics                                                                                                                                                                                              | Importance <sup>(1)</sup> |           |    |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------|----|
|              |                                                                                                                                                                                                        | PP<br>(1)                 | PP<br>(2) | DR |
| 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 wide fluctuations 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 of localized areas                                                                                                                                       | H                         | H         | H  |
|              | 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  |
| Capabilities | Rapid dynamic reconfiguration of system                                                                                                                                                                | H                         | H         | H  |
|              | Control of communications including centralized dispatch, access control, dispatch (talk) group configuration, priority levels and pre-emption.                                                        | H                         | H         | H  |
|              | Robust OAM offering status and dynamic reconfiguration                                                                                                                                                 | 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 call set-up and instant push-to-talk operation                                                                                                                                                    | H                         | H         | H  |
|              | Communications to aircraft and marine equipment, control of robotic devices                                                                                                                            | M                         | H         | L  |

TABLE 3 (cont.)

| Requirement          | Specifics                                                                                                                               | Importance <sup>(1)</sup> |           |    |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------|----|
|                      |                                                                                                                                         | PP<br>(1)                 | PP<br>(2) | DR |
| Capabilities (cont.) | One touch broadcasting/group call                                                                                                       | H                         | H         | H  |
|                      | Terminal-to-terminal communications without infrastructure (e.g. direct mode operations/talk-around), vehicular repeaters               | H                         | H         | H  |
|                      | Appropriate levels of interconnection to public telecommunication network(s)                                                            | M                         | M         | M  |
| 2. Security          | End-to-end encrypted communications for mobile-mobile, dispatch and/or group calls communications                                       | H                         | H         | L  |
| 3. Cost related      | Open standards                                                                                                                          | H                         | H         | H  |
|                      | Cost effective solution and applications                                                                                                | H                         | H         | H  |
|                      | Competitive marketplace                                                                                                                 | H                         | H         | H  |
|                      | Reduction in deployment of permanent network infrastructure due to availability and commonality of equipment                            | H                         | H         | L  |
| 4. EMC               | PPDR systems operation in accordance with national EMC regulations                                                                      | H                         | H         | H  |
| 5. Operational       |                                                                                                                                         |                           |           |    |
| Scenario             | Support operation of PPDR communications in any environment                                                                             | H                         | H         | H  |
|                      | Implementable by public and/or private operator for PPDR applications                                                                   | H                         | H         | M  |
|                      | Robust OAM offering status and dynamic reconfiguration                                                                                  | H                         | H         | H  |
|                      | 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 the operational control center and specialist knowledge centers                       | H                         | H         | H  |
|                      | Greater safety of personnel through improved communications                                                                             | H                         | H         | H  |
| Interoperability     | Intra-system: Facilitate the use of common network channels and/or talkgroups                                                           | 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 the multiple PPDR agencies                                | H                         | H         | H  |

TABLE 3 (end)

| Requirement                             | Specifics                                                                                                                                                                                                      | Importance <sup>(1)</sup> |        |    |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------|----|
|                                         |                                                                                                                                                                                                                | PP (1)                    | PP (2) | DR |
| 6. <i>Spectrum usage and management</i> | Share with other terrestrial mobile users                                                                                                                                                                      | L                         | L      | M  |
|                                         | Suitable spectrum availability (NB, WB, BB channels)                                                                                                                                                           | H                         | H      | H  |
|                                         | Minimize interference to PPDR systems                                                                                                                                                                          | H                         | H      | H  |
|                                         | Efficient use of spectrum                                                                                                                                                                                      | M                         | M      | M  |
|                                         | Appropriate channel spacing between mobile and base station frequencies                                                                                                                                        | M                         | M      | M  |
| 7. <i>Regulatory compliance</i>         | Comply with relevant national regulations                                                                                                                                                                      | H                         | H      | H  |
|                                         | Coordination of frequencies in border areas                                                                                                                                                                    | H                         | H      | M  |
|                                         | Provide capability of PPDR system to support extended coverage into neighbouring country (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  |
| 8. <i>Planning</i>                      | 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  |

<sup>(1)</sup> 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 PP (1), PP (2) and DR, respectively.

### Annex 3

#### **Narrowband frequencies for inter-agency coordination and safety and security communications in international humanitarian assistance presently in use**

The Working Group on Emergency Telecommunications (WGET), which is also the Reference Group on Telecommunications (RGT) of the Inter-Agency Standing Committee (IASC) on humanitarian affairs for the United Nations, has adopted and uses the following frequencies whenever the situation permits.

*Within the spectrum allocated to land-mobile service in the VHF range:*

##### **Primary channel (A):**

Simplex: 163.100 MHz

Duplex: Repeater transmits on 163.100 MHz  
Repeater receives on 158.100 MHz

##### **Alternative channel (B):**

Simplex: 163.025 MHz

Duplex: Repeater transmits on 163.025 MHz  
Repeater receives on 158.025 MHz

##### **Alternative channel (C):**

Simplex: 163.175 MHz

Duplex: Repeater transmits on 163.175 MHz  
Repeater receives on 158.175 MHz

*Within the spectrum allocated to land-mobile service in the UHF range:*

##### **Primary channel (UA):**

Simplex: 463.100 MHz

Duplex: Repeater transmits on 463.100 MHz  
Repeater receives on 458.100 MHz

##### **Alternative channel (UB):**

Simplex: 463.025 MHz

Duplex: Repeater transmits on 463.025 MHz  
Repeater receives on 458.025 MHz

##### **Alternative channel (UC):**

Simplex: 463.175 MHz

Duplex: Repeater transmits on 463.175 MHz  
Repeater receives on 458.175 MHz

## Annex 4

### Spectrum requirements for public protection and disaster relief

#### 1 Introduction

This Annex addresses the estimation of the spectrum requirements for public protection and disaster relief (PPDR), particularly within the context of WRC-03 agenda Item 1.3. The Annex provides:

- a method of calculating amounts of spectrum;
- system scenarios and assumptions;
- validation of the method with respect to existing applications;
- examples of several administrations projections of their requirements by 2010;
- determining the amount of spectrum which should be harmonized in the context of future applications; and,
- conclusions.

The calculation method given in this Annex is provided for assisting in consolidating spectrum requirements.

A number of administrations have used the modified methodology in Appendix 1 to this Annex to estimate their national spectrum requirements for PPDR. That methodology, however, is not the only means by which administrations may calculate their national PPDR spectrum needs. Administrations have the discretion to use whatever method, including the modified methodology; they choose to determine their own spectrum requirements for PPDR.

Many PPDR entities around the world are currently evaluating the migration from analog wireless systems to digital for current telecommunication services. The migration to digital will also allow these entities to add some advanced services to these first generation PPDR digital systems. However, there are many more advanced services that PPDR users are likely to demand as they become available to commercial users. While spectrum demand has been estimated and allotted for 2nd and 3rd generation commercial wireless services, similar analysis has not been done for PPDR users.

The greatest demand for public protection and disaster relief telecommunication services is in large cities where different categories of traffic can be found, i.e. that generated by mobile stations (MS), vehicle mounted or portable stations, and personal stations (PS) (hand-held portable radios). The trend is toward designing the PPDR telecommunication network to provide services to personal stations both outdoor and indoor (building penetration).

Maximum demand will be created after a disaster, when many PPDR users converge on the emergency scene utilizing existing telecommunication networks, installing temporary networks, or utilizing vehicle mounted or portable stations. Additional spectrum may be required for

interoperability between various PPDR users and/or additional spectrum may be required for installation of temporary disaster relief systems.

Considerations on spectrum demand should take into account the estimated traffic, the available and foreseeable techniques, the propagation characteristics and the time-scale to meet the users' needs to the greatest possible extent. Consideration on frequency matters should take into account that the traffic generated by mobile systems, as well as the number and diversity of services, will continue to grow. Any estimation of the traffic should take into consideration that in the future, non-voice traffic will constitute an increasing portion of the total traffic and that traffic will be generated indoors as well as outdoors by personal and mobile stations.

## 2 Methods of projecting spectrum requirements

### 2.1 Description of the methodology

This public protection and disaster relief spectrum calculation methodology (Appendix 1 to this Annex) follows the format of the generic methodology that was used for the calculation of IMT-2000 terrestrial spectrum requirements (Recommendation ITU-R M.1390). The use of the methodology can be customized to specific applications by selecting values appropriate to the particular terrestrial mobile application. Another model based on a generic city approach was also used (see Appendix 2 to this Annex)

The values selected for the PPDR applications must take into account the fact that PPDR utilizes different technologies and applications (including dispatch and direct mode).

### 2.2 Required input data

The ITU-R M.1390 based model and the generic city model require a number of input values which can be categorized as environment, traffic or network systems. In applying the model to PPDR the main data elements required are:

- the identification of PPDR user categories, e.g. police, fire, ambulance;
- the number of users in each category;
- the estimated number of each user category in use in the busy hour;
- the type of information transmitted, e.g. voice, status message and telemetry;
- the typical area to be covered by the system under study;
- the average cell size of base stations in the area;
- the frequency reuse pattern;
- the grade of service;
- the technology used including RF channel bandwidth.
- the demographic population of the city.

## 2.3 Validity of the methodology

### 2.3.1 Discussion

Several aspects of the methodology, the assumptions inherent in the model as presented, timing, method of calculation, frequency reuse, possibility of separating the calculations for PPDR, urban as opposed to rural situations, and the nature of the operating environments were clarified in the ITU-R study period 2000-2003.

Specifically, the following issues were raised in connection with the methodology:

- a) Applicability of IMT-2000 methodology to PPDR?
- b) Substituting the geographic areas (e.g. urban, in-building, etc.) in the IMT-2000 methodology by service categories (NB, WB, BB)?
- c) Use of assumptions of PSWAC Report<sup>4</sup> with regard to assessment of traffic for PPDR?
- d) Treatment of traffic for PP and DR together?
- e) Use of cellular configurations/hotspots in estimating spectrum requirements for PPDR?
- f) Applicability of the methodologies for the simplex/direct mode operations?

In response, the following points should be noted:

- 1 While the document is based on the methodology used for IMT-2000, the method is capable of including all technologies from simplex to cellular and beyond. Further work will be required to establish appropriate classifications of service environment categories (e.g. for fire, police, emergency medical services) and model systems for those environments, in order to make the calculations needed for each type of use and technology.
- 2 Terms of the calculation of spectrum requirements public protection activities could be separated from disaster relief activities, with separate and appropriate parameter values and assumptions being applied for each case. However, it was noted that there are instances where public protection equipment, which is used for routine operations on a day-by-day basis, may also be employed in times of disaster. In these cases, there would need to be some means established to avoid double counting when undertaking calculations of spectrum requirements.
- 3 In considering the service environments (i.e. narrowband, wideband and broadband), it was noted that those used for IMT-2000 may also have some applicability to PPDR communications.

### 2.3.2 Validity study

One administration undertook the performance of a study of the validity of the results predicted by this methodology. This was done by inputting the parameters of a working narrowband PPDR system into a calculator spreadsheet and checking that the amount of spectrum it predicted was the same as that actually used by the system. It was concluded that this methodology is valid, provided it is used carefully and correctly. It was also concluded that although not validated by actual measurement, one might extrapolate that model works as well for wideband and broadband as long

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<sup>4</sup> United States Public Safety Wireless Advisory Committee, Attachment D, Spectrum Requirements Subcommittee Report, September 1996.

as the input parameters are carefully considered and applied. Another administration reported on a similar study undertaken in which examples were developed for typical cities, obtaining spectrum estimates that are consistent with other examples previously reported. Using two examples of the application of the methodology – one referred to a middle-sized city and the other to an industrial district – it was concluded that the methodology is appropriate for the evaluation of spectrum needed for PPDR radiocommunication.

## 2.4 Critical parameters

In assessing the validity of the methodology several critical parameters were identified which must be selected with care. Studies in estimating spectrum requirements for terrestrial land mobile systems were conducted by some administrations showed that the most influential input parameters are:

- cell radius/frequency reuse;
- number of users.

The results of the studies were shown to be heavily dependent upon cellular architecture parameters. The studies show that changes in cell radius will change the spectrum estimate significantly. While it is true that reducing the size of the cell radius will increase the reuse of the spectrum and thereby reduce the spectrum requirement, the cost of the infrastructure will also significantly increase. Similar considerations apply to other parameters, e.g. using sectorized cells decreases the necessary spectrum by a factor of three. For these reasons it is advisable that careful studies of cellular structures are undertaken prior to the final specification of the spectrum to be reserved to PPDR.

In preparing the estimate of spectrum amounts, it will be necessary to get consensus on the input data to put into the generic methodology. Noting the sensitivity of the results to such critical parameters, the input data will need to be selected carefully and will need to reflect a balance between the amount of spectrum sought and the infrastructure cost. Countries that need less spectrum than the full amount identified will have greater freedom in network design, the degree of frequency reuse and infrastructure cost.

## 2.5 Extrapolated upper limit

Korea undertook a parametric analysis of the result of spectrum calculations made for Bhopal, Mexico City, and Seoul. The analysis also used data for other cities taken from other contributions to the work of the ITU-R. The parametric analysis provided insight into PPDR spectrum requirements and it showed that considering the worst case/dense user situation a maximum of 200 MHz (Narrowband: 40 MHz, Wideband: 90 MHz, Broadband: 70 MHz) is needed for the PPDR spectrum requirement for WRC-03 Agenda item 1.3.