Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

PUBLIC PROTECTION AND DISASTER RELIEF SPECTRUM REQUIREMENTS

Helsinki, January 2007

EXECUTIVE SUMMARY

Public Protection and Disaster Relief is a priority subject for the citizens, the Governments and the European Union and radio solutions are an essential element for Public Safety operations.

The mandatory services and facilities required by public safety organisations can only be partially provided on commercial networks. There is therefore a need for dedicated Public Protection and Disaster Relief spectrum to support wideband and broadband operational requirements.

The objective of this report is to describe the existing situation and to develop spectrum requirements for Public Protection and Disaster Relief for wideband applications (e.g. wireless transmission of large blocks of data and video) and/or broadband applications (e.g. high-speed data, high quality digital real time video and high volume data exchange) with channel bandwidths dependent on the use of spectrally efficient technologies insuring interoperability. The aim of this report is also to identify possible candidate bands for these applications as requested in ETSI TR 102 491 (TETRA TEDS system reference document) and ETSI TR 102 485 (BBDR system reference document)

It is expected that having appropriate tuning ranges identified for wideband and broadband applications will:

- Facilitate European-wide and possibly worldwide compatibility;
- Facilitate international circulation of PPDR equipment and systems;
- Reduce the overall cost of PPDR equipment by providing economies of scale.

Wideband systems are expected to be nation-wide systems to be used on a permanent basis whereas broadband systems are expected to be local hot-spot type of systems to be used on a temporary basis.

It is proposed to identify the band 380 - 470 MHz as a tuning range for wideband PPDR. Within this tuning range the most suitable sub-band is 380 – 430 MHz, at least for the moment, taking into account the technology currently available. When identifying spectrum for wideband systems (e.g. TEDS) within the tuning range on a national basis, the WG SE studies on TEDS compatibility should be taken into account. Results of these studies are given in ECC Report 99.

It is proposed to identify 4940-5925 MHz as a tuning range for broadband PPDR. In the ETSI SRDoc on BBDR (TR 102 485) the following preferred sub-bands within the tuning range have been identified: 4940-4990 MHz, 5150-5250 MHz, 5470-5725 MHz, 5725-5875 MHz and 5875-5925 MHz. However, in all of these bands there may be compatibility and sharing issues and further studies are required before the final identification of the preferred sub-bands. One specific question to be studied in detail is the possible requirement of mitigation techniques.

Further to this ECC Report there may be a need to develop ECC Recommendation(s) or Decision(s) on PPDR. This, however, should be considered after all the necessary studies are finalised.

ABBREVIATIONS

For the purposes of the present document, the following abbreviations apply:

- AGA Air Ground Air
- BB Broadband
- BBDR Broad Band Disaster Relief
- CEPT European Conference of Post and Telecommunications administrations
- ECC Electronic Communications Committee
- ETSI European Telecommunications Standards Institute
- EMTEL EMergency TELecommunications (ETSI special committee)
- e.i.r.p equivalent isotropically radiated power
- GSC10 Global Standard Collaboration
- ITU-R International Telecommunications Union - Radio sector
- MESA Mobility Emergency Safety Applications (Partnership project ETSI-TIA)
- NATO North Atlantic Treaty Organisation
- NB Narrowband
- PMR Professional Mobile Radio
- PS Public safety
- PSA Public safety Agency
- PSWAC Public Safety Wireless Advisory Committee (US)
- PPDR Public Protection and Disaster Relief
- REC RECommendation
- RES RESolution
- RF Radio Frequency
- SDR Software Defined Radio
- SRDoc System Reference Document
- TETRA Terrestrial Trunked Radio
- WB Wideband.

Table of contents

Public Protection and Disaster Relief Spectrum Requirements

1 DEFINITIONS

1.1 Emergency service or public safety agency

For the purpose of this ECC Report the following definition has been found to be appropriate:
A service or agency, recognized as such by the Member State, that provides immediate and rapid assistance in situations where there is a direct risk to life or limb, individual or public health or safety, to private or public property, or the environment but not necessarily limited to these situations (Source: Commission Recommendation C(2003)2657)).

1.2 Public Protection (PP) radiocommunications[1]:

Radiocommunications used by responsible agencies and organizations dealing with maintenance of law and order, protection of life and property, and emergency situations.

1.3 Disaster Relief (DR) radiocommunications[2]:

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.

1.4 Mission Critical vs non mission critical

Public Safety organisations addresses two types of situations:

1.4.1 Mission critical situations

The expression *"Mission Critical"* is used for situations where human life, rescue operations and law enforcement are at stake and public safety organizations cannot afford the risk of having transmission failures in their voice and data communications or for police in particular to be 'eave-dropped'.

1.4.2 Non mission critical situations

Where communication needs are non critical: human life and properties are not at stake, administrative tasks for which the time and security elements are not critical.

1.5 Public safety operations

Public Safety organizations addresses three (PP1, PP2, DR) types of operations. (Source: ITU-R M.2033). Furthermore it should be noted that training exercises will also take place and consequently have to be taken into account when considering frequency planning and harmonisation. In order to avoid unnecessary use of spectrum, a training mode may be required for BB.

1.5.1 Public Protection (PP1 and PP2) operations

Day-to-day operations (PP1)

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.

PP1 networks are for general public protection and require reliable, available, secure systems provided by dedicated systems permanently available and covering all necessary wide areas (regional, country, continent) on a permanent basis.

---

1 Report ITU-R M.2033 "Radiocommunication objectives and requirements for public protection and disaster relief"

2 Report ITU-R M.2033 "Radiocommunication objectives and requirements for public protection and disaster relief"

These operations insure primarily voice and messaging communications which can be fulfilled by narrowband and wideband communications.

Large emergency and/or public events (PP2)

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. London, Paris) 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.

It is to be noted that the equipment used for large extraordinary local incidents is likely to request reinforced communications means including BB equipment as described in 1.5.2.

1.5.2 Disaster Relief (DR) operations

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.

These require efficient rapid deployment incident networks. Applications are used temporarily by emergency services in all aspects of disaster situations, including disaster prevention. For instance, they provide simultaneous hot spot type of robust communications, video or robotic data information, telemetry parameters, critical data base queries, location information exchange and other heavy data communications.

Futhermore interoperability of equipment to insure joint operations is a mandatory requirement.

1.6 Narrowband, wideband and broadband definitions

It has been found to be appropriate to use in this Report the narrowband, wideband and broadband definitions as given in the Report ITU-R M.2033. The definitions are in annex E.

2 RECALL OF THE ECC/WGFM WORK PROGRAMME

During the June 2005 ECC meeting in Reykjavik FM doc. ECC(05)051 containing a proposal to study the issue of frequency requirements for wideband and broadband Public Protection and Disaster Relief was introduced:

It was noted that the wideband PPDR issue is at least partly covered by TEDS (e.g.TETRA) whereas requirements for broadband PPDR need further studies. It was also noted that broadband PPDR deals mostly with hot-spot type services operating in limited time periods while wideband PPDR networks would cover larger areas on a permanent basis.

WGFM requested advice from the ECC on whether or not to proceed with a study on the wideband and broadband frequency requirements for PPDR.

In conclusion the ECC agreed that WGFM should add the task to their work programme and then input a document later to the ECC on what type of deliverable should be produced if necessary.

ECC agreed that WGFM should proceed with the work on PPDR as follows:

- Quantify spectrum needs in wideband and broadband PPDR in CEPT;
- identify possible candidate bands for wideband and broadband PPDR to meet these needs on the basis of tuning ranges;
- Initiate the necessary sharing and compatibility studies both in the civil and military bands (this would involve liaison with WGSE);

- If appropriate, develop proposals for ECC deliverables on wideband and broadband spectrum allocations for public safety across CEPT countries.

Following the FM meeting 26-30 of September 2005 (Koblenz, Germany) it was decided to treat PPDR in two phases:

a) FM38 develops a ECC report.
b) Develop deliverables if any.

3 OBJECTIVE

The objective of this report is to describe the existing situation and to develop spectrum requirements for Public Protection and Disaster Relief for wideband applications (e.g. wireless transmission of large blocks of data and video) and/or broadband applications (e.g. high-speed data, high quality digital real time video and high volume data exchange) with channel bandwidths dependent on the use of spectrally efficient technologies insuring interoperability. The aim of this report is also to identify possible candidate bands for these applications as requested in ETSI TR 102 491 (TETRA TEDS system reference document and ETSI TR 102 485 (BBDR system reference document)

This Report is also related to the ITU-R Resolution 646, which invites administrations to continue the work with PPDR (see annex B).

4 NEW DEMANDS ON PUBLIC SAFETY ACROSS EUROPE

4.1 European civil protection changing environment

- The Public Safety services, including fire brigades, police forces, ambulance services, maritime and coastguard services, are the primary protector of life and property in cities, towns, and beyond, throughout the world. These organisations provide individual and professional response to incidents and disaster situations.

Since 11 September 2001, and even more since the Atocha (Madrid) bombings of 11 March 2004 and London attacks 7 July 2005, security and counter-terrorism have been on top of the agenda of the European decision-makers, at national as well as at EU level.

- Other catastrophic events such as the Tsunami in Asia of December 26 2004 and the US Gulf Coast by Hurricane Katrina on 29 August 2005 brought into prominence and provided further evidence of the importance of having efficient communications facilities for Telecommunications for Disaster Relief. They have also reinforced the imperative need to be prepared to face natural catastrophies.
- Within the European Union the Vademecum of Civil Protection (pages 16 through 39) lists natural disasters per member state since 1950 (and provides as well recommendations for emergency planning and the national organization for civil protection). http://europa.eu.int/comm/environment/civil/pdfdocs/vademec.pdf

Awareness and preparedness for Public Protection and Disaster Relief operations has translated into several legislative proposals, programs and projects[3] impacting all business sectors and the defense and public security industry. An extraordinary session of the European Council issued a press release dated January 7th 2005 [5142/05] stating (§12): *The Council stresses the need for appropriate coordination between all the players concerned for the assessment of medium-term needs in order to optimise the effectiveness and quality of aid. It emphasises that reconstruction efforts must be based on the national priorities of the countries concerned and must respect the principle of ownership.*

Further it is also important to recall that most national security networks are merging into one common network. There is a trend for more integration between public safety communication networks with other security related agencies including defense.

All the above reasons underline the need to describe and stipulate these new public safety communication requirements in the report.

---

[3] The Commission has engaged several initiatives in R & D such as WIDENS. This project is under the IST Framework Programme 6. The overall objective of the WIDENS project is to design, prototype and validate a high data-rate, rapidly deployable and scalable wireless ad-hoc communication system for future public safety, emergency and disaster applications

4.2 The EU "Mechanism" framework

The European Council recently issued a framework to improve security and efficiency of intervention for Civil Protection called the Mechanism. The following quotes are extracted from this document[4]:

"In its extraordinary meeting of 7 January 2005, the General Affairs and External Relations Council decided to examine possible improvements of the Mechanism, including its analytical capacity, and to investigate the possibility of developing an EU rapid response capability to deal with disasters."

"1.3 In addition, structural reforms of the Mechanism are proposed, aimed at developing a more robust protection capability that enables the Union to react more rapidly and effectively to any type of disaster in the future."

"1.4 [...] Civil protection is about immediate relief in the first hours or days of a disaster. Like EC humanitarian aid, its purpose is to save lives and alleviate the effects of a disaster during the first days."

"3.3. […] *Coordination with military counterparts*
The use of military resources in support of civil protection operations outside the EU must be based on the relevant international rules […]"

4.3 Public safety and HomeLand Security

The changing threat from man-made disasters and the ever bigger natural disasters are forcing governments to utilize their resources in a different manner. An aspect of importance is that the traditional Military objectives are changing to include peace keeping missions, better integration and co-operation with the national emergency services.

The concept of Homeland Security is being adopted across Europe in the context of a framework for increased cooperation between Police, Fire, Rescue, Health and Military.

In practice there are more and more situations where different agencies need to work together for co-ordination and intervention. These situations require intensive communications between these agencies due to the number of involved parties and the type of applications. Therefore there are two major consequences:

- interoperability of different radio communication systems or deployment of a unique PPDR communication system
- necessity of identifying adequate spectrum.

4.4 Management of Public Safety operations

Due to the different services involved in PPDR operations, there is a requirement for coordination and interoperability between the communication systems.

4.5 Evolution of Public Safety radio networks

4.5.1 Mobile narrowband radio networks

Across Europe most Public Safety national agencies have decided to invest into dedicated narrowband digital mobile networks for voice and data communications. Most have deployed or are today deploying a wide area network. It is expected that around 2010 most of the European countries will operate a national narrowband digital radio network.

4.5.2 Mobile data development

Due to the intensive use of data applications in the fixed environment, public safety agencies are now using such data applications in the mobile environment as well. However these are usually used over commercial networks which can be limiting in critical situations. In such cases there is a requirement for higher data rates on dedicated networks.

---

[4] http://europa.eu.int/comm/environment/civil/pdfdocs/com_2005_137_en.pdf.

4.6 Conclusion

Public Protection and Disaster Relief is a priority subject for the citizens, the Governments and the European Union and radio solutions are an essential element for Public Safety operations.

5 ANTICIPATED EVOLUTION OF THE USE OF WIRELESS TECHNOLOGY

According to its Terms of Reference the ETSI Special Committee (SC) on Emergency Communications (EMTEL) has, inter alia, responsibility to:

- solicit and capture the requirements from the stakeholders (including National Authorities responsible for provisioning emergency communications, End Users, the European Commission, Communication Service Providers, network operators, manufacturers and other interested parties).
- The scenarios to be considered include communication
    - of citizens with authorities/organisations,
    - between authorities/organisations,
    - from authorities/organisations to the citizens,
    - amongst citizens,
- co-ordinate the ETSI positions on EMTEL related issues.

Most relevant document to this ECC Report is TS 102 181 "***Requirements for communication between authorities/ organisations during emergencies"***

"Data services are used to provide a large number of applications which can have widely differing requirements in terms of capacity, timeliness and robustness of the data service.

Sufficient data bandwidth, in both fixed and wireless networks, shall be provided to support a wide variety of data applications required for EMTEL purposes.

Ideally, this bandwidth shall support the required data throughput and minimise end to end delay, especially for applications such as real time video. In the normal emergency case this would require that at a minimum the networks shall deliver to the emergency services the level of service as required by the specific regulation. Noting the extreme circumstances which may be in force during an emergency, it may be desirable for networks to degrade gracefully when user requirements exceed the agreed levels of service.

Table 1: Requirements on data applications (Source: TS 102 181) :

Service	Throughput	Timeliness	Robustness
Email	Medium	Low	Low
Imaging	High	Low	Variable
Digital mapping / Geographical info services	High	Variable	Variable
Location services	Low	High	High
Video (real time)	High	High	Low
Video (slow scan)	Medium	Low	Low
Data base access (remote)	Variable	Variable	High
Data base replication	High	Low	High
Personnel monitoring	Low	High	High

Throughput - data volume in a given time (kbps, Mbps etc). see table in annex A.3.

Timeliness - importance of the information arriving in an agreed space of time. e.g. position information needs to be delivered within 5 s.

Robustness - how reliable the information transmission needs to be. E.g. a bitmap image with some errors is still usuable, a JPG image with some bit errors may be unreadable.

Table 1 shows the diverse needs of data applications. Where data applications share the use of a data transmission capability, provision of sufficient capacity and effective management must be provided to ensure application data is communicated appropriately.

It could, however, be noted that the robustness requirement for video may be qualified as "high", as it could be dangerous to have interruptions in a video stream e.g. in a hostage situation.

Some applications may be used with dedicated communication assets which will be tuned to the particular needs of that application, although interfaces may be necessary to exchange data from such dedicated systems with other applications e.g. screen capture one frame from dedicated video transmission equipment and email the resulting still image. Where appropriate, such applications should be based on appropriate standards to facilitate information exchange".

EMTEL has focussed on these requirements for public safety in particular although it is understood its scope is for emergency communications in general. EMTEL does take into account the needs of the citizen and of the public safety agencies. More detailed infomation on data applications, on the anticipated evolution of use of wireless technology is available in annex A.3 (limited to the public safety applications) The requirements underline some of the reasons why dedicated spectrum (tuning range) is needed.

6 OPERATIONAL REQUIREMENTS FOR PUBLIC SAFETY RADIO COMMUNICATION SYSTEMS

As stated in 1.4.1 Mission critical operations for public safety organizations addresses situations where human life, rescue operations and law enforcement are at stake and public safety organizations cannot afford the risk of having transmission failures in their voice and data communications. Likewise Public Protection organizations require reliable, high-availibility, secure systems provided by dedicated systems, permanently or temporarily operational and covering all necessary geographic areas (local, regional, country, continent). These are therefore unique situations that cannot be fulfilled without meeting demanding communications and other technical requirements.

Where there is use of communication networks that are not specifically designed to meet these requirements the reason is mainly because no specific public safety system is available to respond to a disaster or public safety demand. In the future, as the specifications developed for public safety and disaster relief are becoming more and more specialised and demanding, the use of commercial systems will become even more challenging.

6.1 System operational requirements

A list of operational requirements to be fulfilled by Public Safety radio communication systems is given below:[5]

Radio communication systems to be used in a Mission Critical emergency, whether fixed or mobile, voice or data, need to fulfil the following essential requirements:

- Resilience: available all the time (very high level of reliability);
- Coverage: available in all locations (stations with fixed antenna and handheld portable/ mobile);
- Grade of service: network access instantly available when required (network never too busy); that can include flexibility managed by the relevant agency (hierarchical command and control management)
- Security and interoperability: secure communications between all parties that need to be involved.
- Radio networks for PPDR should provide high quality end to end encryption with key autonomy for each user group.

[5] Additional requirements in Annex C

6.1.1 Resilience

It is a key requirement that the mobile infrastructure has sufficient levels of redundancy such that no single failure will cause a major network outage. Systems must have built-in redundancy including power back up to provide resilience to cope with almost any intervention or disaster. Minor equipment damage - from an earthquake or a flood for instance - should have no detrimental effect on wide area communication.

As a further enhancement to resilience, mobile equipment must be able to work effectively in a 'set-to-set', 'direct' mode or an independent and isolated repeater for larger areas to ensure, as a minimum, that localised communications would continue to be available without the need for any network infrastructure support. In order to have full operational flexibility, mobile infrastructure must immediately connect to the existing digital infrastructure

6.1.2 Wide area coverage for wideband applications

One of the most important characteristics of a radio system is to have numerous interconnected small areas networks or one wide area network providing coverage for narrowband and wideband applications. The Emergency Services require effective levels of geographical coverage for mobile communications adapted to potential events. Disaster scenarios can, and do, occur in remote or difficult to access locations. It is important that there is extensive radio coverage provided by the communications network and that this is not limited by the geographical nature of the area, including, for example, mountainous regions.

Coverage should be reliable and intelligible in all urban and rural environments, within vehicles and buildings, offshore and airborne.

It will also, from time to time, be necessary to provide additional coverage, sometimes at short notice, for specific events where the Emergency Services are required to ensure the safety of large groups of people and the environs in which the event is taking place. This is especially the objective of broadband communications networks. **6**

Certain locations will also require the provision of radio coverage for instance: health care facilities, shopping centres, underground railway networks, road and rail tunnels, major motorway tunnels, critical industrial sites, etc. Many of these could contain high-risk operations with the attendant need for high specification communications facilities, often mission critical in nature.

The provision of coverage for such locations, by their very nature requires detailed planning to maximise achievable coverage, and, therefore, mitigate the risk to those who are required to work in these locations.

The coverage improvement may require supplementary infrastructure and also additional frequency resources.

6.1.3 Grade of service

Another key requirement for the Emergency Services is that users can gain access to voice and data services with an agreed, and operationally acceptable, grade of service. The grade of service provided by the mobile communication system must be sufficient to manage the anticipated traffic and yet be flexible enough in its functional design to also support communication during 'surge' conditions which exceed the anticipated traffic, e.g. by using additional transportable switch and base stations.

6.1.4 Security and interoperability

By the very nature of its role in society, the security and confidentiality of information is fundamental to the operation of the Emergency Services. Advances in technology provide benefits to the Emergency Services; they also expose their radio systems to security vulnerabilities (eavesdropping, cyber attacks, etc.).

---

6 A NIST study of public safety communications (narrowband voice) following the terrorists attacks on the World Trade Center may provide a useful example: "After the first aircraft struck WTC 1, there was an approximate factor of 5 peak increase in traffic level over the normal level of emergency responder radio communications, followed by an approximate factor of 3 steady increase in level of subsequent traffic".

Source: Presentation by James R. Lawson, Building and Fire Research Laboratory, National Institute of Standards and Technology, U.S. Department of Commerce: Investigation Findings of the Emergency Response at the WTC. June 2006

The Schengen Agreement has reinforced the requirements for security and standardisation of secure mobile communications within Europe. This agreement enables the free movement of citizens across borders and the removal of common borders. The treaty calls for exchange of information through the Schengen Information System and cross border police pursuit. This will require the inter-operation and close co-operation of the Emergency Services across national borders.

Further, the use of national public safety networks by military organisations is under serious consideration in most European countries. Supporting military users will additionally require that the infrastructure and associated ground sites are physically protected to an appropriate level. The need to support this level of protection is also now being seen as a common requirement for the Emergency Services following recent terrorist initiatives and attacks.

7 OPEN VS. DEDICATED NETWORKS FOR PPDR

Because of the stringent Mission Critical communication requirements, public safety organisations have always procured their own private mobile radio networks. National public safety networks are being deployed in Europe, offering shared communication facilities for several independent public safety organisations. The design of these networks is such as to provide optimum coverage, interoperability, sufficient capacity/GoS as well as high reliability with different levels of fallback communications. These networks are designed for Mission Critical communications, but they are also used to support routine "day to day" communications for obvious operational and economic benefits. PPDR infrastructure networks can not totally be replaced by commercial networks and the PPDR infrastructure ought to cover the entire national territory Including mountainous areas, tunnels, etc.

	PP	**DR**
Non mission critical	Large coverage dedicated networks with dedicated spectrum or commercial networks	Hot spot coverage dedicated networks with dedicated spectrum or commercial networks
mission critical	Large coverage dedicated networks with dedicated spectrum	Hot spot coverage dedicated networks with dedicated spectrum (permanent or temporary/pre-empted)

In non mission critical PP and DR situations both dedicated and commercial networks could be used.

In mission critical PP and DR situations commercial networks do not fulfill the requirements and therefore dedicated networks with dedicated spectrum are required.

7.1 Benefit of sharing a dedicated Communications Network

When Public Safety organisations share the same communication network it enables them to work closely together. From operational point of view this has big advantages when managing large-scale emergency situations. Learning from each other's experiences and using the same terminology helps users to further develop an advanced, common approach towards the use of communication equipment. And very practically: it enables them to exchange communication equipment on scene.

Sharing the same network with several user organisations also has the advantage that it creates a large market for end-user equipment. With the larger numbers of equipment, economy of scale brings the following advantages:

- end-user equipment becomes more advanced and/or cheaper;
- it is cheaper to implement and run the network and/or performance can be better.

This is not only of great benefit for the end-users. Equipment manufacturers can serve a large market with one type of equipment. Frequency regulators can cover the needs of multiple user groups with one license.

When the concept of sharing a network is adopted internationally the advantages above become even more evident.

To be able to start a project for a shared Public Safety network it is necessary to have a long-term commitment of all involved parties. This can only be achieved if the communication network fulfils the user requirements of all the parties. In general, only a dedicated network can meet these collected Public Safety user requirements.

7.2 Commercial (open to public) Wireless Communication Networks

It is recognized that some commercial terrestrial and satellite systems are complementing the dedicated systems in support of PPDR. The use of commercial solutions will be in response to technology development and market demands. This may affect the spectrum required for those applications and for commercial networks.

Because of the stringent Mission Critical communication requirements, public networks have not been used in Europe for this type of communication even though many public safety personnel often use public network for routine "day to day" communications.

Wideband/broadband infrastructure is primarily needed for data communication, not for voice communication. For a certain (long) time, the actual infrastructure for voice will remain in parallel with the expected wideband/broadband infrastructures. If wideband/broadband coverage reaches the whole national territory, voice may become an additional feature to the wideband/broadband communication using VoIP for example. However, the reliability and appropriateness of VoIP for mission critical wireless voice communications has not been sufficiently proven in a public safety environment.

With regards to the functional requirements discussed in this document commercial solutions such as IMT2000, WiFi, WIMAX and public networks are offering some inherents limits for public protection and mission critical situations:

- in the case of emergencies and disasters saturation, congestion or sometimes even a complete crash of the network due to growing need for the public to be able to continue to communicate (public to public, public to authorities, authorities to public)
- possible use by terrorists organisations (SMS triggered devices in Atocha, Madrid);
- limited encryption capabilities built in.
- public systems do not offer tactical components such as auxiliary basestations, independent repeaters and it should be possible to connect the emergency service network to public cellular network
- vulnerability for intentional interference

Also due to the transition from circuit to packet based technology public networks are more subject to data network attacks unless they are specifically designed to address such situations.

7.3 Benefits of spectrum planning

Preparedness and inter-agencies coordination are key factors for any rapid intervention Public Protection and Disaster Relief scenario. However, absence of appropriate equipment, resources and adequate communications capabilities can greatly diminishing effectiveness. Those resources include radios and equipment that can provide seamless interoperability between different public safety agencies , which can only be enabled by using common technologies and most importantly, harmonized frequency spectrum bands (tuning ranges).

Within nations the need for harmonized frequency tuning ranges is undoubtedly important. However, the need for global spectrum identification is also important to allow Disaster Relief communications to be provided worldwide by different national organisations as well as for cross border assistance scenarios.

This need is of the importance to developing nations, which often rely on the help of international relief organizations.

Besides the obvious operational benefits of global harmonized spectrum, there are also "economies of scale" and "multiple choice" benefits to user organizations. For example, a large harmonized market will attract a broader manufacturing base and increased volume of equipment resulting in lower equipment prices, expanded equipment availability and choice, In the absence of a harmonized frequency band, European manufacturers will be delayed in their design and development of PPDR equipment.

7.4 Conclusion

The mandatory services and facilities required by public safety organisations can only be partially provided on commercial networks. There is therefore a need for dedicated Public Protection and Disaster Relief spectrum to support wideband and broadband operational requirements. This can be achieved by tuning range approach and pre-emption mechanisms.

7.5 New developments

New standards for wideband and broadband PPDR applications are being developed in various standards organizations[7]; In Europe the ETSI standard TETRA, with its new TETRA Enhanced Data Service (TEDS), is expected to be used to provide wideband data applications for Public Protection as well as Disaster Relief wireless communications.

Within ETSI there is also a joint project initiative between TIA and ETSI called Mobility Emergency Safety Applications (MESA), which is looking at wireless broadband for PPDR applications. A document MESA DRT 70.0008, titled "Project MESA; [170 001] Technology Specification Group System; Technologies with Potential Applicability to Project MESA", list a wide variety of current technologies that could be used for PPDR applications.

PPDR user groups are involved in the standardisation process which ensures that the user requirements will be presented and considered in the standardisation fora.

The Global Standard Collaboration (GSC)10 status:

At the GSC#10 meeting hosted by ETSI in Sophia Antipolis, France, the following resolves listed in the GSC-10/10 (GRSC) Public Protection and Disaster Relief (PPDR) document number GSC10/Closing(05)18, dated 1 September 05, were agreed.

Resolves:

1) *to encourage ongoing cooperation and collaboration among national, regional and international activities that relate to PPDR.*
2) *to encourage PSOs to contribute to the ITU-T PCP-TDR in support of the Action Plan for global standards on TDR/EW*
3) *to encourage PSOs to develop standards for new wireless, fixed and mobile digital wideband (voice and data) and broadband (voice, data, high quality video, multimedia) communications for PPDR and to support ITU-R activities towards global harmonized solutions, including providing input to ITU-R in the identification of spectrum options that are appropriate for PPDR use of the new technologies;*
4) *to encourage the consideration of incorporating SDR and cognitive functions in PPDR radio equipment to improve interoperability.*

From this GSC#10 resolves, the following conclusion can be made:

Identification of appropriate spectrum (tuning range) is needed to enable European harmonisation and to stimulate European stardardisation of wideband and broadband PPDR applications.

Because of the growing need for wireless broadband data in support of numerous applications and the resulting large market, the number of both standardized and proprietary new technology developments are expected to increase over the next few years.

Many countries in ITU Regions 2 and 3 have already identified spectrum for wideband and broadband PPDR. CEPT countries have received spectrum requests and need also to identify spectrum for wideband and broadband PPDR.

---

7 For example, a joint standardization programme between the European Telecommunications Standards Institute (ETSI) and the Telecommunications Industry Association (TIA), known as Project MESA (Mobility for Emergency and Safety Applications) has commenced for broadband public protection and disaster relief. Also, the Working Group on Emergency Telecommunications (WGET), convened by the United Nations Office for Humanitarian Affairs (OCHA), is an open forum to facilitate the use of telecommunications in the service of humanitarian assistance comprising United Nations entities, major non-governmental organizations, the International Committee of the Red Cross (ICRC), ITU and experts from the private sector and academia. Another platform for coordination and to foster harmonized global Telecommunication for Disaster Relief (TDR) standards is the TDR Partnership Coordination Panel, which has just been established under the coordination of ITU with participation of international telecommunication service providers, related government departments, standards development organizations, and disaster relief organizations.

7.6 New requirements for PPDR Spectrum

7.6.1 Environmental conditions

Introduction

For the past decades, public safety spectrum has always been designated on the view of protecting the citizen and guaranteeing societal order. This view has not changed and is even been reinforced by the latest dramatic events which have happened and the citizens having increased expectations on rapid and efficient intervention. Therefore new policy trends should not be directly translated into the Public Safety arena as there is no commercial dimension to public safety interventions (cost effective approach). To maintain an up-to-date operational capability it is important for the Public Safety agencies to be able to access the lastest technology developments.

Status

Current PPDR applications are mostly narrowband supporting voice and low data-rate applications, typically in channel bandwidths of 25, 12.5 or 10kHz.

Although there will continue to be narrowband requirements, many future applications will be wideband (indicative data rates in the order of 384-500 kbit/s) and/or broadband (indicative data rates in the order of 1-100 Mbit/s) with channel bandwidths dependent on the use of spectrally efficient technologies;

International environment

Internationally the following positions that are guiding decision in the deployment of public safety networks need to be recalled:

- Resolution 36 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference urges Member States to facilitate use of telecommunications for the safety and security of the personnel of humanitarian organizations;
- Recommendation ITU-R M.1637 offers guidance to facilitate the global circulation of radiocommunication equipment in emergency and Disaster Relief situations;
- Some administrations may have different operational needs and spectrum requirements for PPDR applications depending on the circumstances;
- The Tampere Convention on the Provision of Telecommunications Resources for Disaster Mitigation and Relief Operations (Tampere, 1998), an international treaty deposited with the United Nations Secretary-General and related United Nations General Assembly resolutions and reports are also relevant in this regard,

Conclusion

It is therefore expected that having suitable tuning ranges identified for wideband and broadband applications will:

- **Facilitate European-wide and possibly worldwide compatibility;**
- **Facilitate international circulation of PPDR equipment and systems;**
- **Reduce the overall cost of PPDR equipment by providing economies of scale.**

7.6.2 Conditions for new PPDR spectrum

When developing frequency arrangements for public safety needs the criteria considered are different than for commercial or public services in the sense that the assessment is driven by high availability of capacity in the areas of incident rather than by business case or population density. The following should also be taken into account:

- possible **technological constraints** (e.g. cost efficiency, size and complexity of terminals, high speed/low power digital signal processing;
- **guard bands** should be minimized to avoid wasting spectrum;
- availability of **low cost technologies** such as wireless LAN and economy-of-scale in production line will decrease equipment manufacturing costs . (Considerings of Resolution 646 of WRC ‘ 03 [2])
- any **channel plan** adopted should provide the greatest potential to support the variety of needs across multiple PPDR agencies. The width of the channels needed and the total amount of spectrum assigned for a given PPDR agency should depend on that agency’s operational requirements;

- the essentiality of the **harmonisation of spectrum (tuning range approach provides flexibility and sufficient level of harmonisation within and across countries)** to allow cross border circulation of terminals and to provide more effective co-operation when dealing with PPDR activities.

7.6.3 Candidate bands

7.6.3.1 Wideband

A typical technology for wideband PPDR implementation is considered to be TETRA TEDS (as described in ETSI TR 102 491). TEDS principal objective is to offer higher data rates through high speed data channels that utilise common control channel with narrowband 25 kHz TETRA networks to provide an integrated, backward compatible voice + data solution.

TEDS standard supports radio channel widths 25, 50, 100, 150 kHz and allows user bit rates between 30 and 400 kbit/sec depending on which carrier bandwidth is being chosen and on the distance t/from the base station site[8]. Detailed information on the TEDS modulation and possible bits rates can be found in annex D.

To gain any substantial improvement in data rate compared with narrowband technology, a channel width of 50 kHz in minimum should be used in network implementation.

Assuming a 20 cell repeat pattern the minimum spectrum requirement for a useful wide area TEDS implementation as one layer of 50 kHz channels is thus 2 X (20 x 50 kHz) = 2 X1 MHz. The actual spectrum requirement naturally depends on the traffic load and response time requirements, and in cases of higher load, will be a multiple of the minimum requirement. Consequently, a request for 1-3 MHz (duplex) could be considered.

The potential candidate bands are in line with the bands listed in the WRC03 Resolution 646, i.e. 380 - 470MHz.

A review of the 400 MHz bands has shown that a single harmonised band could not be identified amongst CEPT countries at the estimated period for the deployment of these wideband systems. In particular WGFM had sent in early 2006 a questionnaire to administrations. In this questionnaire administrations were requested to study the possibilities to identify 2*(1-3) MHz for wideband emergency systems (e.g. TEDS) within the range 410-430 MHz. The analysis of the 26 administration answers concluded that it was not possible to identify a common band within this frequency range.

Thus the tuning range approach is the only possible solution for wideband emergency systems.

It is also to be noted that results from the coexistence studies performed in SE7, (ECC Report 99) show that in NATO countries sharing with military AGA services in the 385 – 390/395 – 399.9 MHz band would not be possible in many instances.

ETSI TC TETRA[9] has studied the feasibility of using a “tuning range” concept of operating a Public Safety Sector (PSS, Emergency Services) TETRA Enhanced Data Service (TEDS) in either the 410 - 430 MHz band or the 450 - 470 MHz band, in case frequency spectrum could not be made available in the 385 - 390/395 - 399.9 MHz band. (ETSI TR 102 513)

In carrying out the feasibility study and analysing its findings ETSI TC TETRA**9** listed a number of conclusions and recommendations, the most significant recommendation being that CEPT ECC WGFM should continue exploring the possibility of assigning adequate frequency spectrum from the 385 – 390/395 – 399.9 MHz band to accommodate TEDS,

---

8 Agreed modulation schemes (see annex D):
- DQPSK for common control channel
- Q8PSK for early migration requiring modest increase in speed.
- 4 QAM for efficient links at edge of coverage
- 16 QAM for moderate speeds
- 64 QAM for high speed

Carrier bandwidths: 25, 50, 100 and 150 kHz.
Expected user bit rates in the region between 30 to 400 kbit/s

9 *ETSI TC TETRA is one of the ETSI Technical Committees. Its Terms of Reference are available at http://portal.etsi.org/tetra/TETRA_ToR.asp. Conclusions or views expressed by ETSI TC TETRA on spectrum issues might not necessarily be shared by all ETSI members*

as it has been concluded that the single frequency band solution is the most cost effective and practical solution that meets the needs of existing PSS users of TETRA V+D wishing to upgrade to TEDS.

The main factor that resulted in this recommendation from ETSI TC TETRA[9] was that the most common base station antenna (high gain collinear) used today in TETRA by PPS organisations was limited to a RF bandwidth of 32 MHz, which was insufficient to accommodate TETRA V+D and TEDS in the 410 - 430 MHz band or the 450 - 470 MHz band operating on an antenna system comprising one transmit (Tx) antenna and one receive (Rx) antenna (1 x Tx and 1 x Rx).

As a consequence both existing TETRA networks and new TETRA networks with TEDS would require two antenna systems (2 x Tx and 2 x Rx) at each base station site, which, according to the feasibility study is not considered acceptable for cost and practical reasons.

However, the ETSI TC TETRA9 feasibility study did identify the possibility of using a split band operation solution, which is considered acceptable for new TETRA users but not suitable for existing PSS users of TETRA wishing to upgrade to TEDS. To remove the need for two independent antenna systems at each TETRA base station site a decision is made during the network planning phase to assign chosen base stations sites to operate in either the 380 - 385/390 - 395 MHz band or the 410 - 430 MHz band.

This solution means that each base station site will only need one antenna system (1 x Tx and 1 x Rx). However, this solution does create a number of problems, details of which are provided in the ETSI TC TETRA[9] feasibility study.

It should also be noted that the assumption of this approach is that radio terminals can operate across 380-430 MHz with acceptable degradation. According to the ETSI TC TETRA[9] feasibility study for increased development and manufacturing cost reasons and possible reduced performance as well as reduced economies of scale it is unlikely that any TETRA MS manufacturer will develop products spanning 380-470 MHz.

Even recognising the above described implications of a wide tuning range, it is considered necessary to provide a solution with flexibility and technology neutrality and therefore the tuning range for wideband systems should be 380-470 MHz.

An important result from the questionnaire distributed to administrations was the fact that many could not identify a dedicated spectrum at the given time. However, the expectation was that having a request from the relevant domestic PPDR services for wideband PPDR in the future in their hands would change this situation. The time span for wideband PPDR implementation may be very wide among countries. Consequently, the could also be understood as a driver for the frequency tuning range concept rather than for the identification of dedicated harmonized frequencies.

It is therefore proposed to identify the band 380-470 MHz as a tuning range for wideband PPDR. Within this tuning range the most suitable sub-band is 380 – 430 MHz, at least for the moment, taking into account the technology currently available. It should be noted that ETSI is developing a new harmonised standard for wideband equipment.

7.6.3.2 Broadband

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 DR applications (examples are: tailored area networks, hot spot deployment and ad-hoc networks).

We need to underline another time than most of these applications are not frequently used up to now. With the constant development of technologies the services which can be offered to the public safety users are triggering new applications that can help more efficient interventions. Comparison with existing spectrum usage may be misleading.

The infrequent nature and localised areas of disasters means that RF spectrum for Disaster Relief (DR) applications as well as infrequent localized PP usage during extraordinary events (PP2 usage as defined in Report ITU-R M.2033) could utilise a frequency band used by other users, on the basis that these users accept loss of service in the affected area during disasters. It is to be noted that this usage does not include frequent (daily) usage for Public Protection services (PP1 usage as defined in Report ITU-R M.2033).

However, this approach will require some restrictions in the usage. The users of these broadband systems need to be well trained in order to be efficient under severe and dangerous situation/environment. PP2 and DR Operations cannot be considered as “training phases”. Moreover military involvement is likely to increase in PP2 and DR situations. In this case simultaneous use of civil and military equipment shall be possible. Consequently sufficient spectrum must be available to support the needs of both organisations.

Thus, the exact usage conditions for BBDR usage need to be accurately identified.

Consideration of the spectrum requirement for BBDR

In the ITU-R Report M.2033 it is calculated that 39.2-69.2 MHz of spectrum is required to cover the spectrum needs of BB DR. These figures are based on various assumptions and scenarios whereby the methodology in the Recommendation ITU-R M. 1390 was used. The bandwidth needed ultimately depends on national requirements and the exact user requirements in terms of number of channels required for the incident and the selected technical solution. Therefore it is quite difficult to estimate the minimum amount of spectrum, which would cover these BBDR requirements. The frequency requirement of 50 MHz, as requested in the ETSI TR 102 485, is derived from the ITU-R Report M. 2033. In order to harmonise with other regions it is to be noted that 50 MHz have been identified in the USA and in countries in Region 3. It is estimated that several hundreds of systems have already been deployed in these regions. Users and industry would benefit from similar regulations that provide the basis for a more cost effective solution.

Furthermore, as the band 4940-4990 MHz is proposed to be a part of the tuning range, it would facilitate global use of BBDR equipment thus supporting joint international activities.

The spectrum options must take account of the above[10].

BB-DR applications may not claim protection like a radio service. However, an adequate power level or the designation of more than one frequency slot may may result in a certain effective protection.

Among other technologies, the ones covered by ETSI EN 301 893 for WAS/RLANs and ETSI EN 302 502 for FWA may be used for Broad Band Disaster Relief (BB-DR) Applications.

It needs to be highlighted that the spectrum is for temporary and local usage by emergency services only. BBDR users should make use of wideband PPDR (or other facilities) for communications requiring larger coverage (e.g. normal daily public safety usage).

It is proposed to identify 4940-5925 MHz as a tuning range for broadband PPDR.

It is to be noted that in the ETSI TR 102 485 a number of preferred sub-bands have been identified within the tuning range. The sub-bands are:

- **4940-4990 MHz**
- **5150-5250 MHz**
- **5470-5725 MHz**
- **5725-5875 MHz**
- **5875-5925 MHz**

Further studies are required to assess the sharing and compatibility issues with existing services (e.g. applicability of DFS to be discussed).

It should also be noted that ETSI is developing a new harmonised standard for BBDR.

8 SUMMARY OF CONCLUSIONS

- Public Protection and Disaster Relief is a priority subject for the citizens, the Governments and the European Union and radio solutions are an essential element for Public Safety operations.

- In non mission critical PP1, PP2 and DR situations both dedicated and commercial networks could be used.

- In mission critical PP1, PP2 and DR situations commercial networks do not fulfill the requirements and therefore dedicated networks with dedicated spectrum are required

- The mandatory services and facilities required by public safety organisations can only be partially provided on commercial networks. There is therefore a need for dedicated Public Protection and Disaster Relief spectrum to support

---

10 Equipment already developed for WAS/RLANs (ETSI EN 301 893, IEEE802.11a/h) and FWA (ETSI EN xxx xxx, IEEE802.16-2004) can also be used for Broadband Disaster Relief (BB DR) applications on channels within the core candidate bands. Other frequency usage parameters (eg higher e.i.r.p. limits) based on individual radio licences are possible because of the temporary usage (during a disaster or for disaster prevention) and the regional operation (disaster region, training areas). Coordination between DR and military users is possible (both may be involved in DR activities).

wideband and broadband operational requirements. This can be achieved by tuning range approach and pre-emption mechanisms.

- It is expected that having appropriate tuning ranges identified for wideband and broadband applications will:

  - Facilitate European-wide and possibly worldwide compatibility;

  - Facilitate international circulation of PPDR equipment and systems;

  - Reduce the overall cost of PPDR equipment by providing economies of scale.

- As a conclusion it is proposed to identify the band 380-470 MHz as a tuning range for wideband PPDR. Within this tuning range the most suitable sub-band is 380 – 430 MHz, at least for the moment, taking into account the technology currently available. When identifying spectrum for TEDS within the tuning range on a national basis, the WG SE and SE PT7 studies on TEDS compatibility should be taken into account. Results of these studies are given in ECC Report 99. In order to cover the spectrum requirements of wideband systems, one option could be to revise ERC Decision (96)01, which would then encompass both the narrowband and wideband emergency service systems in the 400 MHz frequency range.

- As a conclusion it is proposed to identify 4940-5925 MHz as a tuning range for broadband PPDR. In the ETSI SRDoc on BBDR (TR 102 485) the following preferred sub-bands within the tuning range have been identified: 4940-4990 MHz, 5150-5250 MHz, 5470-5725 MHz, 5725-5875 MHz and 5875-5925 MHz. However, in all of these bands there may be compatibility and sharing issues to be studied.

9 REFERENCES

For the purposes of the present input document the following references have been consulted and apply:

CEPT and EUROPEAN UNION REFERENCES

- CEPT/ERC Report 25: "The European Table of Frequency Allocations and Utilisations Covering the Frequency Range 9 kHz to 275 GHz", Lisboa January 2002 - Dublin 2003 - Turkey 2004 - Copenhagen 2004.
- European Council framework to improve security and efficiency of intervention for Civil Protection http://europa.eu.int/comm/environment/civil/pdfdocs/com_2005_137_en.pdf
- Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services (Framework Directive).
- Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive).
- Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications). [10] ETSI EG 202 116: "Human Factors (HF); Guidelines for ICT products and services; Design for All".
- Commission Recommendation C(2003)2657)
- Vademecum of Civil protection within th European Union http://europa.eu.int/comm/environment/civil/pdfdocs/vademec.pdf

ETSI REFERENCES:

- ETSI TS 123 271: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Location Services (LCS); Functional description; Stage 2 (3GPP TS 23.271 version 5.7.0 Release 5)".
- EN300 403, ETSI TS 124.0087
- Draft TS/EMTEL 102 181 “Requirements to Communications between Authorities”.
- ETSI TS 102 164: "Services and Protocols for Advanced Networks (SPAN); Emergency Location Protocols

- User Requirement Specification TETRA Release 2; Part 2: High Speed Data
- TS 100 392-18-1 Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D) and Direct Mode Operation (DMO; Part 18: Air interface optimized applications; Sub-part 1: Location Information Protocol (LIP)
- ETSI TS 101 109 (V7.2.0): "Digital cellular telecommunications system (Phase 2+); Universal Geographical Area Description (GAD) (3GPP TS 03.32 version 7.2.0 Release 1998)".
- ETSI SR 002 299: "Emergency communications; Collection of European Regulatory Principles".
- ETSI SR 002 180: "Emergency communications; Requirements for communication of citizens with authorities/organizations in case of distress (emergency call handling)".
- ETSI TR 102 021-2 V1.2.1 (2002-10) Technical Report Terrestrial Trunked Radio

ITU REFERENCES

- ITU-T Recommendation E.115: "Computerized directory assistance". [17] ITU-T Recommendation E.409 (formerly E.sec.2) 2004 Incident Organisation and Security Incident Handling (Guidelines) for Telecommunications Organisations
- ITU-R 8A PPDR conclusions
- ITU-R M.2033 For data application.
- ITU-R Res. 36, Rev. Marrakech 2002
- ITU-R M.1637 Global circulation of equipment
- ITU-R Recommendation M. 1390

MISCELLANOUS REFERENCES

- Report PS Wireless Committee, September 11, 1996, USA, (805 pages)
- MESA TS 70.001 V3.1.2 (2005-01)

ANNEXES

- Annex A: Market information and Applications;
  - A1 Market Size
  - A2 Types of Public safety Users
  - A3 Applications
- Annex B: Policy and regulatory information;
  - B1 Resolution ITU 646 (WRC-03)
- Annex C: Other functional requirements
- Annex D: TEDS types of modulations
- Annex E: Narrowband, wideband and broadband definitions

ANNEX A: MARKET INFORMATION AND APPLICATIONS

A.1 Market size

Source: Eurostat (except Norway)

A. 1.1 Core addressable market for Mission Critical

Approximate number of **professional / radios** (analogue & digital PMR) in 2003-2004

Country	Total Inh (million) Source: Eurostat except Norway	Police and gendarm ('000)	Fire ('000) and civil protection Road security	Ambulances & paramedics ('000)	Total profession/ Total radios* ('000)
Belgium (Digital rad. only)	10.4	30 / 25	16 / 7	1.5 / 2	47.5 / 34
Czech Rep	10.2				
Denmark	5.3	12	6	0.5	18.5 / 4.7
France	60.2	130 / 104	230	100 / 50	
Germany	82.3	283 / 250	27 (pro) / 300	114 / 100	424 / 423
Finland	5.2	10 / 6	21 / 10 (digital)	Incl. in Fire	31 / 16
Hungary	10.1				
Italy	57.8	308 /	33 /		341 / 150
Ireland	4.0	11 /	30 /	62 /	103 /
Netherlands	16.2	50 / 35	25 / 8	3.5 / 3	78.5 / 46
Norway	4.5	15 /	3 /	5 /	23 / 5.8
Poland	38.1	98 /	29 /		127 / 110
Portugal	10.4	29 /	30 /	7 /	66 / 15.5
Spain	42.3	180 /	15 /	18 /	213 / 90
Sweden	8.9	14 /	13 /	3 /	30 / 40
Switzerland	7.3	25	5	18	48 / 12.1
UK	60	153 /	61 /		274 / 180
Total					**1728.5 / 1191.4**

See also Vademecum of Civil Protection within the Euroepan Union
http://europa.eu.int/comm/environment/civil/pdfdocs/vademec.pdf

A2 Types of Public Safety Users (source: ETSI)

This part of the annex describes the overall requirements of most user agencies in Europe providing General mission statements and the technology needs of each type of user discipline. The spectrum and further the specifications and requirements created should take into account, but are not limited to, the following security and PS/PP providers, services, and functions provided throughout the world. Public Safety have indicated the need for the providers, services, and functions stated below because the type of wireless communications support is crucial to ensure quality services can be provided to the constituents they serve. The following providers, services, and functions are included, along with their "Mission Statements" relative to Public safety Requirements:

- **Criminal Justice Providers**: Requirements should provide the technology necessary to support new telecommunications and automation tools that are aimed at reducing crime and its impact on the health, welfare, and safety of the citizenry.

- **Emergency Management or Disaster Response/Recovery Agencies**: Communications system requirements for emergency management and disaster services are characterized by a very low usage pattern during routine operations and extremely high usage patterns during major disasters or events. Special operations needs include response functions to an event requiring specialized training for safe and effective operations, consisting of hazardous materials leak and/or spill remediation, mountain rescue and associated technical rescue, collapse search and rescue, swift water rescue, blue water rescue, trench and confined space rescue, and heavy rescue.

- **Health Services**: This service encompasses the missions of two areas, including Emergency Medical Services (EMS) and disaster medicine. Doctors, paramedics, medical technicians, nurses, or volunteers can supply health services, including critical invasive and supportive care of sick and injured citizens and the ability to transfer the people in a safe and controlled environment.

- **Fire Services**: With variations from region to region and country to country, the primary areas of responsibility of the fire services include structural fire fighting and wild land fire fighting, fire safety and prevention, life saving through search and rescue, rendering of humanitarian services, management of hazardous materials and protection of the environment, salvage and damage control, safety management, and mass decontamination.

- **Coast Guard Services** (and related PS/PP functions): These services include search and rescue (at sea and other waterways), protection of coastal waters, criminal interdiction, illegal immigration, and disaster and humanitarian assistance in areas of operation.

- **Airport Security** Services (and related PS/PP functions): Airport security should include the capability to communicate by secure radio or wireless data services with "Airport Management" and "Control Tower" operations. Airport operations must be able to effectively communicate with various PS/PP organizations for routine and disaster incident communications.

- **Hazardous Materials (HAZMAT) (and related PS/PP functions):** HAZMAT incidents can be complex and may involve resources of many different PS/PP organizations, including coordination and management, analysis and material classification, handling, and cleanup and rectification.

- **Correctional Institutions**: Requirements should include specifications and proposed standards to ensure the enhanced long-term wireless communications needs of prisons, jails, and other correctional institutions.

- **Correctional Enforcement and Probation Officers**: Specifications and standards will provide correctional and parole officers a full range of high-speed, high-data-rate wireless public safety/public protection services and applications to effectively support their mission.

- **Special Event Planning Groups**: SoR outlines some of the more urgently needed mobile data communications tools that will help PS/PP agencies be prepared and effectively coordinate response with efficient communications tools to predictable large-scale events simultaneously at various locations.

- **General Governmental and/or Government Administration**: The technological requirements included will greatly assist general government services providers in their efforts to offer effective and innovative water, sewage, electrical, public parks, schools, pest abatement and control, building code enforcement, planning and zoning and enforcement, and public health services.

- **Land and Natural Resource Management**: Governmental agencies at all levels are responsible for the oversight of a nation's environmental, land, forestry and conservation, and agricultural development. These entities fall into this unique but broad-based PS/PP category. The specifications and standards should define technology capable of operating in these sometimes extremely harsh conditions.

- **Transportation's Organizational Mandates and Missions:** Organizations at all levels of government are responsible for the planning, construction, management, and maintenance of many forms of transportation systems. To meet this requirement, these agencies must be able to effectively communicate and respond to events such as snowstorms, mudslides, flooding, earthquakes, and hazardous material spills that impact the world's transportation infrastructures.

- **Intelligent Transportation Systems (ITS):** Many PS/PP transportation organizations interact with what is commonly designated as an ITS, which provide a plethora of information about transportation systems, corridors, and transport vehicles traversing these arteries.

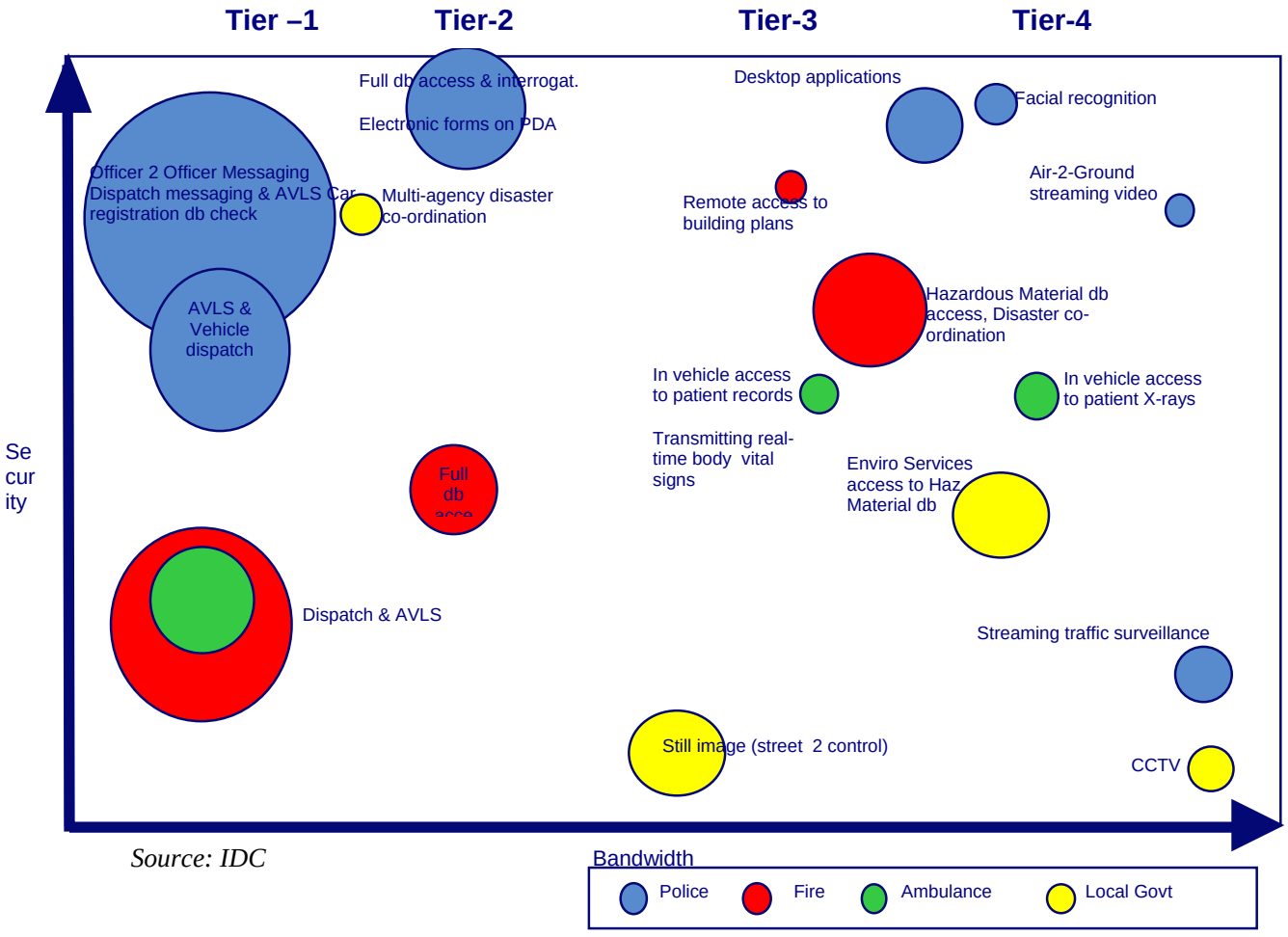
A3 Wideband and broadband applications

Introduction of digital narrowband systems have shown their interest (cipher, data, data base connections) and the data rates are increasing more or less quickly as shown below.

Wideband and broadband applications are a growing trend for emergency services in all aspects of public protection and disaster situations, including disaster prevention (e.g. during special events) and post event scenarios.

These applications provide incident communication, data and location information exchange, on the spot communications. Common sense classifies these mobile (vehicle, body worn, object to object, hand portable) data applications into four types from light (SMS, simple data) to heavy data rates (Videos, CCTV). Annex A.3 illustrates applications examples.

- Tier 1 and Tier 2 in use with narrowband digital system or through commercial networks;
- Tier 3 developing today through commercial 3G networks only;
- Tier 4 corresponds to applications for live and video streaming, telecontrol, numerous biometrics transmissions, etc. Only experimentations are running. It is expected that Tier 4 applications will naturally evolves rapidly as usage develops on fixed networks.



Source: IDC

Anticipated Evolution of the use of wireless technology

As recalled earlier, most Public Safety Organisations are using digital narrowband systems. Those systems are allowing only low rate data communications. Today to meet new data needs the public safety users are using more and more GPRS or 3G commercial systems not fully ensuring secure transmissions. The increasing needs for data transmission are calling for wideband wide area network therefore wideband spectrum. Furthermore, in Public Protection situations (PP2) and for Disaster Relief, heavy data needs are anticipated (tier 4 in Annex 4) due to either applications or number of users in hot spots. For security and availability these commercial services are not appropriate.

Therefore as demand for medium data rate and large data rate applications are increasing, there is a clear need for wideband and broadband spectrum within the next few years.

ANNEX B: Regulatory INFORMATION

Resolution 646 (WRC-03)

Public Protection and Disaster Relief

The World Radiocommunication Conference (Geneva, 2003),

considering

a) that the term "public protection radiocommunication" refers to radiocommunications used by responsible agencies and organizations dealing with maintenance of law and order, protection of life and property and emergency situations;

b) that the term "disaster relief radiocommunication" refers to 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, natural phenomena or human activity, and whether developing suddenly or as a result of complex, long-term processes;

c) the growing telecommunication and radiocommunication needs of public protection agencies and organizations, including those dealing with emergency situations and disaster relief, that are vital to the maintenance of law and order, protection of life and property, disaster relief and emergency response;

d) that many administrations wish to promote interoperability and interworking between systems used for public protection and disaster relief, both nationally and for cross-border operations in emergency situations and for disaster relief;

e) that current public protection and disaster relief applications are mostly narrow-band supporting voice and low data-rate applications, typically in channel bandwidths of 25 kHz or less;

f) that, although there will continue to be narrow-band requirements, many future applications will be wideband (indicative data rates in the order of 384-500 kbit/s) and/or broadband (indicative data rates in the order of 1-100 Mbit/s) with channel bandwidths dependent on the use of spectrally efficient technologies;

g) that new technologies for wideband and broadband public protection and disaster relief applications are being developed in various standards organizations[1];

h) that continuing development of new technologies such as IMT-2000 and systems beyond IMT-2000 and Intelligent Transportation Systems (ITS) may be able to support or supplement advanced public protection and disaster relief applications;

i) that some commercial terrestrial and satellite systems are complementing the dedicated systems in support of public protection and disaster relief, that the use of commercial solutions will be in response to technology development and market demands and that this may affect the spectrum required for those applications and for commercial networks;

j) that Resolution 36 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference urges Member States to facilitate use of telecommunications for the safety and security of the personnel of humanitarian organizations;

k) that Recommendation ITU-R M.1637 offers guidance to facilitate the global circulation of radiocommunication equipment in emergency and disaster relief situations;

---

1 For example, a joint standardization programme between the European Telecommunications Standards Institute (ETSI) and the Telecommunications Industry Association (TIA), known as Project MESA (Mobility for Emergency and Safety Applications) has commenced for broadband public protection and disaster relief. Also, the Working Group on Emergency Telecommunications (WGET), convened by the United Nations Office for Humanitarian Affairs (OCHA), is an open forum to facilitate the use of telecommunications in the service of humanitarian assistance comprising United Nations entities, major non-governmental organizations, the International Committee of the Red Cross (ICRC), ITU and experts from the private sector and academia. Another platform for coordination and to foster harmonized global Telecommunication for Disaster Relief (TDR) standards is the TDR Partnership Coordination Panel, which has just been established under the coordination of ITU with participation of international telecommunication service providers, related government departments, standards development organizations, and disaster relief organizations.

l) that some administrations may have different operational needs and spectrum requirements for public protection and disaster relief applications depending on the circumstances;

m) that the Tampere Convention on the Provision of Telecommunications Resources for Disaster Mitigation and Relief Operations (Tampere, 1998), an international treaty deposited with the United Nations Secretary-General and related United Nations General Assembly resolutions and reports are also relevant in this regard,

recognizing

a) the benefits of spectrum harmonization such as:

- increased potential for interoperability;
- a broader manufacturing base and increased volume of equipment resulting in economies of scale and expanded equipment availability;
- improved spectrum management and planning; and
- enhanced cross-border coordination and circulation of equipment;

b) that the organizational distinction between public protection activities and disaster relief activities are matters for administrations to determine at the national level;

c) that national spectrum planning for public protection and disaster relief needs to have regard to cooperation and bilateral consultation with other concerned administrations, which should be facilitated by greater levels of spectrum harmonization;

d) the benefits of cooperation between countries for the provision of effective and appropriate humanitarian assistance in case of disasters, particularly in view of the special operational requirements of such activities involving multinational response;

e) the needs of countries, particularly the developing countries[2], for low-cost communications equipment;

f) that the trend is to increase the use of technologies based on Internet Protocols;

g) that currently some bands or parts thereof have been designated for existing public protection and disaster relief operations, as documented in Report ITU-R M.2033[3];

h) that for solving future bandwidth requirements, there are several emerging technology developments such as software-defined radio, advanced compression and networking techniques that may reduce the amount of new spectrum required to support some public protection and disaster relief applications;

i) that in times of disasters, if most terrestrial-based networks are destroyed or impaired, amateur, satellite and other non-ground-based networks may be available to provide communication services to assist in public protection and disaster relief efforts;

j) that the amount of spectrum needed for public protection on a daily basis can differ significantly between countries, that certain amounts of spectrum are already in use in various countries for narrow-band applications, and that in response to a disaster, access to additional spectrum on a temporary basis may be required;

k) that in order to achieve spectrum harmonization, a solution based on regional frequency ranges[4] may enable administrations to benefit from harmonization while continuing to meet national planning requirements;

l) that not all frequencies within an identified common frequency range will be available within each country;

m) that the identification of a common frequency range within which equipment could operate may ease the interoperability and/or inter-working, with mutual cooperation and consultation, especially in national, regional and cross-border emergency situations and disaster relief activities;

---

2 Taking into account, for example, the ITU-D Handbook on disaster relief.

3 3-30, 68-88, 138-144, 148-174, 380-400 MHz (including CEPT designation of 380-385/ 390-395 MHz), 400-430, 440-470, 764-776, 794-806 and 806-869 MHz (including CITEL designation of 821-824/866-869 MHz).

4 In the context of this Resolution, the term “frequency range” means a range of frequencies over which a radio equipment is envisaged to be capable of operating but limited to specific frequency band(s) according to national conditions and requirements.

n) that when a disaster occurs, the public protection and disaster relief agencies are usually the first on the scene using their day-to-day communication systems, but that in most cases other agencies and organizations may also be involved in disaster relief operations,

noting

a) that many administrations use frequency bands below 1 GHz for narrow-band public protection and disaster relief applications;

b) that applications requiring large coverage areas and providing good signal availability would generally be accommodated in lower frequency bands and that applications requiring wider bandwidths would generally be accommodated in progressively higher bands;

c) that public protection and disaster relief agencies and organizations have an initial set of requirements, including but not limited to interoperability, secure and reliable communications, sufficient capacity to respond to emergencies, priority access in the use of non-dedicated systems, fast response times, ability to handle multiple group calls and the ability to cover large areas as described in Report ITU-R M.2033;

d) that, while harmonization may be one method of realizing the desired benefits, in some countries, the use of multiple frequency bands can contribute to meeting the communication needs in disaster situations;

e) that many administrations have made significant investments in public protection and disaster relief systems;

f) that flexibility must be afforded to disaster relief agencies and organizations to use current and future radiocommunications, so as to facilitate their humanitarian operations,

emphasizing

a) that the frequency bands identified in this Resolution are allocated to a variety of services in accordance with the relevant provisions of the Radio Regulations and are currently used intensively by the fixed, mobile, mobile satellite and broadcasting services;

b) that flexibility must be afforded to administrations:

- to determine, at national level, how much spectrum to make available for public protection and disaster relief from the bands identified in this Resolution in order to meet their particular national requirements;
- to have the ability for bands identified in this Resolution to be used by all services having allocations within those bands according to the provisions of the Radio Regulations, taking into account the existing applications and their evolution;
- to determine the need and timing of availability as well as the conditions of usage of the bands identified in this Resolution for public protection and disaster relief in order to meet specific national situations,

resolves:

1 to strongly recommend administrations to use regionally harmonized bands for public protection and disaster relief to the maximum extent possible, taking into account the national and regional requirements and also having regard to any needed consultation and cooperation with other concerned countries;

2 that for the purposes of achieving regionally harmonized frequency bands/ranges for advanced public protection and disaster relief solutions, administrations are encouraged to consider the following identified frequency bands/ranges or parts thereof when undertaking their national planning:

- in Region 1: 380-470 MHz as the frequency range within which the band 380-385/390-395 MHz is a referred core harmonized band for permanent public protection activities within certain countries of Region 1 which have given their agreement;
- in Region 2[5]: 746-806 MHz, 806-869 MHz, 4 940-4 990 MHz;
- in Region 3[6]: 406.1-430 MHz, 440-470 MHz, 806-824/851-869 MHz, 4 940-4 990 MHz and 5 850-5 925 MHz;

---

5 Venezuela has identified the band 380-400 MHz for public protection and disaster relief applications.

6 Some countries in Region 3 have also identified the bands 380-400 MHz and 746-806 MHz for public protection and disaster relief applications.

3 that the identification of the above frequency bands/ranges for public protection and disaster relief does not preclude the use of these bands/frequencies by any application within the services to which these bands/frequencies are allocated and does not preclude the use of nor establish priority over any other frequencies for public protection and disaster relief in accordance with the Radio Regulations;

4 to encourage administrations, in emergency and disaster relief situations, to satisfy temporary needs for frequencies in addition to what may be normally provided for in agreements with the concerned administrations;

5 that administrations encourage public protection and disaster relief agencies and organizations to utilize both existing and new technologies and solutions (satellite and terrestrial), to the extent practicable, to satisfy interoperability requirements and to further the goals of public protection and disaster relief;

6 that administrations may encourage agencies and organizations to use advanced wireless solutions taking into account considering h) and i) for providing complementary support to public protection and disaster relief;

7 to encourage administrations to facilitate cross-border circulation of radiocommunication equipment intended for use in emergency and disaster relief situations through mutual cooperation and consultation without hindering national legislation;

8 that administrations encourage public protection and disaster relief agencies and organizations to utilize relevant ITU-R Recommendations in planning spectrum use and implementing technology and systems supporting public protection and disaster relief;

9 to encourage administrations to continue to work closely with their public protection and disaster relief community to further refine the operational requirements for public protection and disaster relief activities;

10 that manufacturers should be encouraged to take this Resolution into account in future equipment designs, including the need for administrations to operate within different parts of the identified bands,

invites ITU-R

1 to continue its technical studies and to make recommendations concerning technical and operational implementation, as necessary, for advanced solutions to meet the needs of public protection and disaster relief radiocommunication applications, taking into account the capabilities, evolution and any resulting transition requirements of the existing systems, particularly those of many developing countries, for national and international operations;

2 to conduct further appropriate technical studies in support of possible additional identification of other frequency ranges to meet the particular needs of certain countries in Region 1 which have given their agreement, especially in order to meet the radiocommunication needs of public protection and disaster relief agencies.

ANNEX C: OTHER FUNCTIONAL REQUIREMENTS (SOURCE ETSI)

Specialis**ed communications facilities**

In addition to the essential requirements seen previously in section 6, the nature in which emergency activities are carried out often necessitates the use of specialised communication facilities (source: ETSI):

	User Service and Facility Requirement	Technology Solution
	The ability for a number of radio users to be able to communicate with each as an all informed net	**Group Call**
	The ability for a dispatcher to inform all users on the network at the same time of important information	**Broadcast call**
	The ability of the network to support different user priority levels that best meet their operational GoS requirements during busy periods	**Priority**
	The ability for radio users to gain immediate access to the network in an emergency even if the network is busy	**Pre-emptive Priority Call (Emergency Call)**
	The ability for radio users to talk to other radio users in the same localised area if coverage from the network is not provided, or coverage is lost through network failure, or to provide additional capacity if communications cannot be supported on the main network, or provide autonomous communications outside the main network	**Direct Mode Operation (DMO)** ***(See note 1)***
	The ability for radio users and/or dispatchers to dynamically bring together specific users for operation as part one all informed net	**Dynamic Group Number Assignment (DGNA)**
	Support for mission critical communications for the Emergency Services requires immediate call set-up	**Fast call set up**
	Voice communication will remain a priority requirement for the Emergency Services during times of critical operation.	**Voice quality**
	The ability for a radio user and/or dispatcher to send voice or data information over the air waves without it being overheard or decoded by an unauthorised radio user	**Over The Air Encryption**
	The ability for a radio user and/or dispatcher to send voice or data information anywhere within the network without it being overheard or decoded by an unauthorised radio user	**End to End Encryption**

Necessary bandwidth:

Bandwith is the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions

Access network

Portion of the Telecommunications Network that provides access to the switching function, and terminates the User Access signalling, in a PLMN this is a radio access via a Base Station
(Source. : Q.931, EN 300 403, ETSI TS 124.008).

Improvements in spectrum efficiencies

Affords immediate significant and evolutionary improvements in radio bandwidth and spectrum efficiency through the cooperative use of a broadband specification and standards that will ensure full utilization of all the bandwidth allocated.

Consistency with existing standards

Any new specifications and standards that are developed from those existing specifications and standards should be consistent with creating full and complete interoperability with technologies built to the specifications.

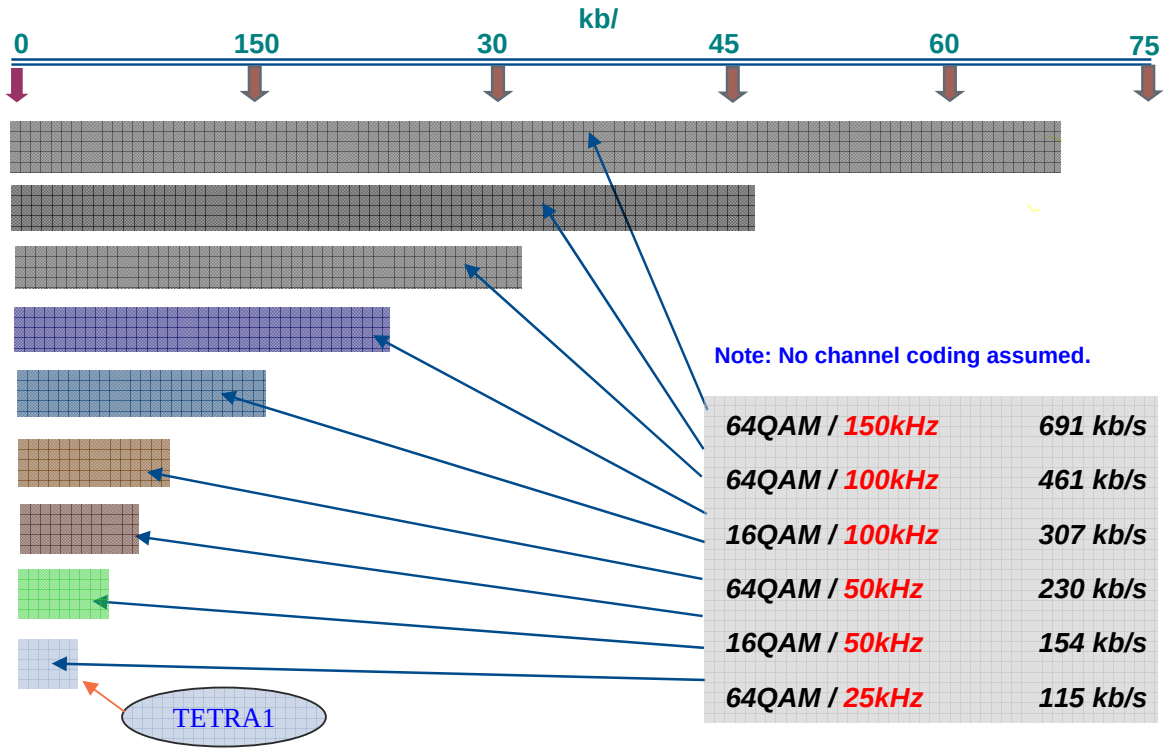
Compatible for multiple international standards

Specifications and standards should provide a technology architecture that is transparent to the applications the technology is intended to carry. It is understood under that definition that the specifications and standards created will be capable of transporting multiple international standards-based data protocols.

Compliant with the need of the participating nations

Specifications and standards written to comply will also be written to comply with the specific baseline requirement of the national governments that are active in the process. Those requirements will be articulated within the body of the SoR or any of its subordinate annexes or related documents and may, as appropriate, be identified as a specific need of a specific nation, government, governmental agency or organization.

ANNEX D: TEDS types OF MODULATIONS



Annex E: Narrowband, wideband and broadband definitions

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 below 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 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.

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.

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 km2 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).