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**APT REPORT ON**

**GENERIC REQUIREMENTS FOR MISSION CRITICAL BROADBAND PPDR COMMUNICATIONS**

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**1. Purpose**

The Purpose of this report is define the generic requirements for mission critical broadband Public Protection and Disaster Relief (PPDR) communications The notion of PPDR is defined in ITU-R Resolution 646 (WRC-03) as a combination of two key areas of emergency response activity:

1. **Public Protection** – dealing with the maintenance of law and order, protection of life and property, and responding to local emergency events – in some countries also referred to as the ‘public safety’ or ‘emergency service’ sector (police, fire, ambulance, etc); and
2. **Disaster Relief** – dealing with a serious disruption of the functioning of society, posing a significant and 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.

Resolution 646 (Rev.WRC-15) also outlines the importance of radiocommunications to PPDR agencies, in particular to the text in *considerings c)* and *d)*.

**2. Scope**

The scope of this Report is limited to high-level operational and technical requirements only, by way of guidance to national administrations. It offers only minimal guidance on bandwidth allocations to meet specific national deployment arrangements, reflecting the different local demographics, urban and rural geographies, and consequent structure and size of relevant agencies.

In the context of differing funding and network ownership options, this Report also makes no recommendation in regard to how these operational and technical requirements might be achieved. For example, a mobile wireless broadband PPDR application may be realized either by: a) deployment of a dedicated network; or b) priority access to a public network; or c) a combination of a dedicated network in urban areas and priority access to a public network in all other areas. Further, a dedicated network may be funded and owned by government agencies; or funded and owned by another entity with the network services provided to PPDR agencies under specific contractual arrangements.

The purpose of this Report is to define and recommend a common suite of technical requirements for mobile wireless broadband PPDR communications. It is anticipated that administrations will find this Report useful to assist in commencing and guiding their own national discussions and planning activities. The structure of this Report may be useful as a framework for the development of more detailed documents, and to ensure that all relevant issues associated with mobile wireless broadband systems for PPDR applications are subsequently addressed and fully defined.

This Report complements the APT AWG Report 27 on "PPDR Applications Using IMT Based Technologies and Networks."

**3. Background**

Radio communications plays a critical and profound role for information exchange within and between PPDR agencies and interaction with other organizations.

By their nature, PPDR operations gain significant benefit from the ability to access a wide variety of information, including informational databases, access to instant messaging, high-quality images and video, mapping and location services, remote control of robots, and other applications. All of these sources of information can be more efficiently conveyed using wireless IP systems. While it is expected that conventional voice dispatch and co-ordination traffic is also destined to be integrated (via VoIP, or VoLTE) into future broadband PPDR radiocommunications systems, it is noted that there may be a longer-term transition, and that administrations may see a role for mission critical narrowband voice communications for some time yet. In any emergency scenario, the ability of PPDR agencies to react quickly and coordinate appropriate resources will largely determine the final outcome and level of impact on local communities of the emergency.

Moreover, the increasing internationalization of crime, and the wider impact of natural disasters, has also highlighted a greater need of cross-border PPDR coordination and cooperation between countries. So harmonization of technical infrastructure to facilitate greater interoperability between agencies is increasingly seen as a matter of high priority.

The emergence of mobile broadband systems based on standardized IMT technologies (such as LTE) offering high-capacity data, video streaming and multimedia functionality, can significantly benefit PPDR organizations. Such benefits include expanded operational capabilities, greater technical innovation and opportunities for economies of scale, particularly in the area of data and video to augment their communication facilities with broadband capabilities - eventually supplementing current narrowband PPDR voice/data networks.

**4. System requirements for PPDR multimedia applications**

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

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

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

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

**4.1 Support of multiple applications**

Systems serving PPDR should be able to support a broad range of applications.

**4.2 Simultaneous use of multiple applications**

Systems serving PPDR must be able to support the simultaneous use of several different applications with various bit rate requirements. Some PPDR users may require the integration of multiple applications (e.g. voice and low/medium speed data) over the complete network or on a high speed network to service localized areas with intensive on-scene activity.

**4.3 Priority access**

As desired by the PPDR organizations, systems serving PPDR users must have the ability to manage high priority traffic and possibly manage low priority traffic load shedding during high traffic situations. PPDR users require either the exclusive use of frequencies or equivalent high priority access to other broadband systems or a combination thereof.

**4.4 Grade of service (GoS) requirements**

Suitable grades of service should be provided for PPDR applications. PPDR users require rapid response times for accessing the network and sourcing information directly at the scene of incident(s), including fast subscriber/network authentication.

**4.5 Coverage and Capacity**

The PPDR systems typically aim to provide complete geographic coverage (for “normal” traffic within the relevant jurisdiction and/or area of operation (national, provincial/state or at the local level). Such coverage is required on a continuous basis (24 hrs/day, 365 days/year). Additional resources, enhancing either coverage, system capacity or both may be added during a PP emergency or DR event by techniques such as reconfiguration of networks with intensive use of direct mode of operation (DMO) and vehicular repeaters, which may be required for coverage of localized areas.

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

To date, traditional PPDR systems have not generally been installed inside buildings. Urban PPDR systems are designed for highly reliable coverage of subscribers outdoors, and indoors by direct propagation through the building walls. Sub-systems may be installed in specific buildings or structures, such as tunnels, if penetration through the walls is insufficient. Traditionally and in current practice, narrowband PPDR systems have tended to use larger radius cells. Tradeoffs between coverage, capacity and spectrum reuse against infrastructure cost will likely be a decision for each Administration to consider within their own particular context, noting that some administration may favor a larger cell model for PPDR networks.

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

**4.6 Reliability of Communication**

PPDR applications must be provided on a stable and resilient working platform. Reliability requirements should include a stable and easy to operate management system, offer resilient service delivery and a high level of availability (commonly achieved using redundancy and backup, fall-back and auto-recovery, self-organization). In the event of the network failure or loss of network coverage, Direct Mode Operation between PPDR users is required as an immediate solution for reestablishing communications

**4.7 Capabilities**

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

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

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

PPDR users require the system to have capability for fast call set-up and dialing, including instant push-to-talk operations[[1]](#footnote-1) (internally or to different technologies) or a one-touch broadcasting/group call and Direct mode (also known as talk-around or simplex) operations., PPDR users also require commu­nications with aircraft and marine vessels, control of robotic devices, vehicular coverage extenders (deployable base stations, to extend network coverage to remote locations).

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

Appropriate levels of interconnection to the public telecommunications network may also be required[[2]](#footnote-2). The decision regarding the level of interconnection (i.e. all mobile terminals vs. a percentage of terminals) may be based on specific local/national PPDR operational requirements. Furthermore, the specific access to the public telecommunications network (i.e., directly from mobile or through the PPDR dispatch) may also be based on the local/national PPDR operational requirements.

**4.8 Security requirements**

PPDR networks must provide a secure operational environment. Security requirements should include encryption technology, support for domestic encryption algorithms, authentication for users, terminals and networks, user identification and location, air interface encryption, integrity protection against unauthorized intrusion, end-to-end encryption, support for third-party key management center, system authorization management and over-the-air key updating. In addition to these system-level requirements, suitable operational procedures will also need to be developed to accomplish required levels of security for information being passed across the network.

Notwithstanding, there may also be occasions where administrations or organizations, which need special security measures, to interconnect their own equipment to meet their own unique security requirements.

**4.9 Cost implications**

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

**4.10 Performance requirements**

PPDR networks must be able to support the following performance requirements: high quality audio (quality and intelligibility), security, images, video, real-time video and ultimately provide the level of availability and data throughput to serve all of the applications enabled by a broadband PPDR capability, to the quality/resolution needed.

This will entail fast dialing and setup of calls, high throughput with adequate guarantees of quality of service, and robustness. These may be accomplished through; reallocation of both uplink and downlink rates (depending on the RAN technology), increasing spectrum efficiency, ergonomic design of terminals, very good signal coverage, high terminal radiofrequency performance, and maximum mobility.

**4.11 Electromagnetic compatibility (EMC) requirements**

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

**5 Operational requirements**

This section defines the operational and functional requirements for PPDR users.

**5.1 Radio operating environments**

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

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

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

PPDR systems and equipment capable of being deployed and set-up rapidly for large emergencies, public events and disasters (e.g. severe floods, large fires, the Olympics, peacekeeping) are extremely beneficial along with the flexibility to dynamically vary uplink and downlink bandwidth and/or assigned channel capacity.

**5.2 Interoperability**

Interoperability is an important requirement for PPDR operations. PPDR interoperability is the ability of PPDR personnel from one agency/organization to communicate by radio with personnel from another agency/organization, on demand (planned and unplanned) and in real-time. This includes the interoperability of equipment internationally and nationally for those agencies that require national and international cross-border cooperation with other PPDR agencies and organizations. Various options are available to facilitate communications interoperability between multiple agencies and networks. These include, but are not limited to:

a) adoption of a common technology, such as IMT (e.g. LTE, as in the US);

b) the use of common frequencies and standardised equipment,

c) utilising local, on-scene command vehicles/and equipment/procedures,

d) communicating via dispatch centres and/or system interconnection nodes/devices,

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

f) interconnection with (via standard interface and open system infrastructure)

* narrowband PPDR systems
* Public communication networks (fixed and mobile)
* Satellite communication network
* Other information systems

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

**5.3 Compatibility**

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

**5.4 Spectrum usage and management**

Depending on national frequency allocations, PPDR users must coexist with other terrestrial mobile users. Detailed spectrum arrangements vary from country to country. Furthermore, there may be several different types of systems supporting PPDR operating in the same geographical area. Therefore, interference to systems supporting PPDR from non-PPDR users should be minimized as much as possible. This is generally achieved through appropriate spectrum planning and frequency coordination at the national level.

**5.5 Regulatory compliance**

Systems supporting PPDR should comply with the relevant national regulations. In border areas (i.e. areas adjacent to other countries), suitable coordination of frequencies should be arranged, as appropriate. PPDR systems supporting that provide extended coverage into neighboring countries should also comply with regulatory agreements between the neighbors.

**5.6 Planning**

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

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

**6. Table of Broadband PPDR Requirements**

 Attachment 1 contains an example table of requirements indicating the degree of importance attaching to particular requirements under the three radio operating environments: “Day-to-day operations”, “Large emergency and/or public events”, and “Disasters”. The degree of importance attributed to each requirement may be different between administrations. It is up to the administrations to make a choice regarding the relative importance of these requirements. This table may require future review and updating as mobile broadband technologies evolve.

Attachment 2 provides the Generic Functional Requirements for the nationwide mission critical Broadband PPDR Wireless Communication System

**7. Spectrum Requirements**

Many countries have expressed views that determining minimum PPDR spectrum bandwidth needs is a matter for national consideration, taking account of the widely differing national policies and priorities, demographics, network investment preferences, PPDR agencies’ size and structure, operational and procedural differences, and other important factors.

In that context, this Report focuses on providing guidance to administrations in regard to their approach to determining the necessary spectrum resources to meet national PPDR requirements, rather than a particular numeric recommendation.

**7.1 Spectrum Requirement Calculation Methodology**

The PPDR bandwidth estimation models previously presented have generally relied on Recommendation ITU-R M.1390, or have otherwise adopted a bespoke estimation method of their own devising.

Recommendation ITU-R M.1390 was intended for modeling the spectrum requirements of terrestrial IMT-2000 systems, and was last updated in 1999. The IMT-2000 technology introduced *wideband* (3rd generation, or 3G) digital cellular systems offering effective peak bitrates/user of about 3 Mbps (downlink) and 500 kbps (uplink), based on a 5 MHz Code Division Multiple Access (CDMA) channel signal format. In the period prior to WRC-03, when studies on future PPDR systems were initiated (under WRC-03 Agenda Item 1.3), Recommendation ITU-R M.1390 was the only tool available for calculating IMT spectrum requirements.

Subsequently, the *broadband* version of IMT, IMT-Advanced (or Long Term Evolution, LTE) which launched end-to-end IP transport/routing and used Orthogonal Frequency-Division Multiplexing (OFDM) in channel bandwidths of 1.4, 3, 5, 10, 15, or 20 MHz, was defined and specified in the period 2003-2007. A subsequent spectrum estimation model, Recommendation ITU-R M.1768, was then developed by ITU-R to more accurately account for the technical features and performance of LTE.

It is therefore unclear whether use of the methodology of Recommendation ITU-R M.1390 remains valid for determining minimum bandwidth estimations for PPDR systems that are to be implemented using IMT-Advanced/LTE technology. Otherwise, bandwidth estimations for broadband PPDR systems should be developed with general reference to Recommendation ITU-R M.1768, and which may involve further consideration of the unique characteristics of PPDR wireless traffic.

Further details are attached at Attachment 3

**8 Examples of PPDR scenarios**

Attachment 4 provides some examples of PPDR scenarios. It is recognised that such scenarios will vary between countries whose requirements may greatly differ. It is intended that more such examples be prepared depicting studies from other countries/members which can then be further appended to the Report during its further updating and revision

**9. Summary**

This Report provides an outline of the technical requirements of mobile wireless broadband communications systems to meet mission critical broadband PPDR requirements. It presents a high-level framework and broad rationale, along with a fundamental set of recommended operational and functional requirements that might be found useful to regional administrations for a variety of purposes.

A specific objective of this Report is to encourage administrations to adopt common technology, technical features and functional capabilities, as well as harmonized spectrum arrangements as far as practicable, to maximize the potential for regional co-operation and cross-border inter-working. Further, pursuit of such harmonization is expected to lead to greater market scale to the benefit of manufacturers/vendors, government agencies, and PPDR management and operational staff.

It is anticipated that this Report will become a starting point for more detailed consideration and planning in each country by relevant administrations aiming to further develop their PPDR agencies according to contemporary operational capability and practices. This Report is not intended to be a specification (minimum or otherwise) for comparative assessment of alternative systems or commercial proposals, or for reference citation in competitive commercial tendering/acquisition documents.

**ATTACHMENT 1**

**Generic requirements for mission critical PPDR broadband communications**

|  |  |  |
| --- | --- | --- |
| Generic Requirement | Specifics | Importance[[3]](#footnote-3) |
|  |  | P1 | P2 | P3 |
| Functional | Simultaneous use of multiple applications | H | H | M |
| Integration of multiple applications* Voice, data & video
* Multicast and unicast services
* Real time instant messaging
* Scene video transmission
* Mobile office functions
* VPN services
* Telemetry
* Remote control
* Location of terminals
 | H | H | M |
| Integration of local voice, high speed data and video on high speed networks |
| Priority access | Manage levels of priority in traffic with load shedding during high traffic periods | H | H | H |
| Accommodate increased traffic loading during major operations and emergencies | H | H | H |
| Exclusive use of frequencies or equivalent high priority access to other systems | H | H | H |
| Grade of service | Suitable grades of service to support a prioritized range of services (see Annex 2 below) | H | H | H |
| Guaranteed throughput | H | H | H |
| Rapid response times for accessing network andinformation directly at the incident scene, including fast subscriber/network authentication and session set up | H | H | H |
| Coverage | PPDR system should provide complete coverage within relevant jurisdiction and/or operation | H | H | M |
| Coverage of relevant jurisdiction and/or operation of PPDR organization whether at national, provincial/state or at local level | H | H | M |
| Systems designed for peak loads and widefluctuations in use | H | H | M |
| Enhancing system capacity during PP emergency or DR by techniques such as reconfiguration of networks with intensive use of direct mode operation | H | H | H |
| Vehicular repeaters (NB, WB, BB) for coverage oflocalized areas | H | H | H |
| Very good reliable indoor/outdoor coverage | H | H | H |
| Coverage of remote areas, underground and inaccessible areas | H | H | H |
| Appropriate redundancy to continue operations, when equipment/infrastructure fails | H | H | H |
| RAN shall utilize maximum frequency reuse efficiency.  | H | H | M |
| Capabilities | Rapid dynamic reconfiguration of system | H | H | H |
| Control of communications including centralized dispatch, access control, dispatch group configuration, priority level setting and pre-emption. | H | H | H |
| Network system level management capability | M | H | H |
| Stable & easy to operate management system | H | H | H |
| Robust OAM offering status reporting and dynamic reconfiguration.  | H | H | H |
| Network to perform basic self –recovery, expediting service restoration and a return to redundant operations. | H | H | H |
| Packet data capability  | H | H | H |
| Internet Protocol compatibility (complete system or interface with) | M | M | M |
| Robust equipment (hardware, software, operational and maintenance aspects) | H | H | H |
| Portable equipment (equipment that can transmit while in motion) | H | H | H |
| Equipment requiring special features such as high audio output, unique accessories (e.g. special microphones, operation while wearing gloves, operation in hostile environments and long battery life) | H | H | H |
| Fast session set-up and instant “push-to-talk” operation | H | H | H |
| Communications to aircraft and marine equipment, control of robotic devices | M | H | L |
| One touch broadcasting/group session establishment | H | H | H |
| Terminal-to-terminal communications without infrastructure, (e.g. direct mode operation/talk-around), vehicular repeaters. | H | H | H |
| Rapid deployment capability – infrastructure & terminals | L | H | H |
| The Network shall provide seamless coverage (via handoff/handover mechanisms) and continuous connectivity within the 95th percentile coverage area at stationary and vehicular speeds up to 120 kph.  | H | H | H |
| A single common air interface (CAI) shall be utilized for the mobile broadband network.  | H | H | H |
| Mobile/portable station nominal transmit power shall be 0.25W ERP (24 dBm) and shall not exceed 3 W ERP (34.8 dBm) in rural areas for portable devices.  | L | L | L |
| Support | 24-hour and 7 days-a-week (24/7) support for fixed and user equipment | H | H | H |
| The network operations centre to operate on a 24x7x365 basis | H | H | H |
| 24/7 operations including field based support as necessary to maintain the availability of the network. In all cases, 24/7 access to call centre support for issue resolution and assistance is also required | H | H | H |
| Reliability and adaptability  | Ability to operate in accordance with national EMC regulations | H | H | H |
| Adaptable to extreme natural and electromagnetic environments. No functional network failure during climate events, operational vibration, earthquake, EMI/ESD, and supplied power events. | H | M | L |
| Support operation of PPDR communications in anyenvironment | H | H | H |
| Fixed, mobile & terminal equipment adaptable to a wide range of natural environments, with any physical facilities supporting network equipment meeting contemporary standards for electric surge suppression, grounding and EMP Protection | H | H | H |
| PPDR systems operation in accordance with national EMC regulations | H | H | H |
| Robust network and management system | H | H | H |
| Stable, resilient working platform | H | H | H |
| Self-managed network | H | H | H |
| Coordinated development of business continuity plans. | H | H | H |
| Resilient service delivery | H | H | H |
| High availability design – e.g. Diversity, redundancy, automated failover protection, backup operational processes. | H | H | H |
| Network & operational testing to ensure data/call processing functionality is restored within predetermined and guaranteed time period following an outage | H | H | H |
| The above should result in PPDR broadband networks at least matching the level of robustness displayed by the current public safety land mobile radio (i.e., P-25 or TETRA). | H | H | H |
| Availability | Service availability shall not be calculated to allow a prolonged outage even in one service area. | H | H | H |
| Power backup using battery backup and /or power generation. Redundant backhaul circuits from the RAN to the core and to the base stations. High wind loading for the cell towers (Availability 99.995% at year 10) | H | H | H |
| Highly reliable (99.999%) individual network elements. Ensuring adequate supply and easy access to spares to reduce Mean Time To Repair (MTTR). Operational readiness assured even in a maintenance window. | H | H | H |
| Redundant elements should automatically detect failure and activate to provide service upon failures of primary network components | H | H | H |
| Security  | End to end encryption. The network shall provide cryptographic controls to ensure that transmissions can only be decoded by the intended recipient. This must include data encryption over all wireless links.  | H | H | L |
| Support for domestic encryption arithmetic | H | H | L |
| The encryption should support both point‐to‐point traffic and point‐to‐multipoint traffic.  | H | H | L |
| The network shall support periodic re‐keying of devices such that traffic encryption keys may be changed without re‐authentication of the device and without interruption of service. | H | H | H |
| The network shall provide cryptographic controls to ensure that received transmissions have not been modified in transit.  | H | H | L |
| Access to public safety services and applications shall be provided only to those authenticated users and/or devices as specifically authorized by each PPDR organization. | H | H | M |
| The network shall require each device that attempts to connect to the network to prove its identity prior to granting access to network resources. Each device shall be assigned a unique identifier, and the authentication method must provide strong assurance (e.g. by public key cryptography) of the device's identity in a manner that requires no user interaction.  | H | H | M |
| The device authentication service shall utilize an open standard protocol.  | H | H | H |
| To protect against both malicious devices and malicious network stations, the authentication must be mutual, with the device proving its identity to the network and the network proving its identity to the device.  | H | H | H |
| Each PPDR organization shall be granted the option to require user authentication in addition to device authentication for certain devices assigned to that organization. When user authentication has been selected as a requirement, the network shall require each of the organization's designated devices to prove its user's identity prior to granting access to network resources. | H | H | H |
| For organizations requiring user authentication, the network must facilitate sequential authentication of multiple users from a single device.  | H | H | H |
| System authorization management. Each organization shall be granted control over authorization by means of an administrative interface. | H | H | H |
| For organizations requiring user authentication, the organization shall be granted via administrative interface (e.g. Web based) the ability to add, remove, and manage user accounts that are permitted to access the network. | H | H | H |
|  |  |  |  |
| 3rd party key management system | L | L | L |
| The network shall maintain a record of all device and user access attempts and all authentication and authorization transactions, including changes to authentication and authorization data stores.  | H | H | H |
| Over the air key update | L | L | L |
| The network shall enforce a configurable time‐out, imposing a maximum time that each device may be connected to the network. | H | H | H |
| The network shall enforce an inactivity time‐out, imposing a maximum time that each device may be connected to the network without transmitting data. | H | H | H |
| Each PPDR organization shall be granted control of the network time‐out and inactivity time‐out setting for individual devices assigned to that organization. | H | H | H |
| Each organization shall also be granted via administrative interface the means to manually and forcibly terminate access, including active sessions, to the network for any of its assigned devices individually. | H | H | H |
| The network shall be capable of attack monitoring.  | H | H | H |
| Terminal Requirements for preventing unauthorized use  | Devices shall support the network's device authentication protocol. Each device shall be assigned a unique identifier, and the authentication method must provide strong assurance (e.g. by public key cryptography) of the device's identity in a manner that requires no user interaction.  | H | H | H |
| To protect against both malicious devices and malicious network stations, the authentication must be mutual, with the device proving its identity to the network and the network proving its identity to the device. The device must not permit connectivity to the PPDR network unless the network is authenticated.  | H | H | H |
| Each PPDR organization shall have the option to require user authentication for device access. When user authentication has been selected as a requirement, the device shall require each user to prove his or her identity prior to granting access to applications or network resources.  | H | H | H |
| Devices may support a means of erasing (via best practice multiple pass overwriting of data storage media) all data stored on the device.  | H | H | H |
| Devices may support a means of encrypting data stored on the device such that user authentication is required for decryption.  | H | H | H |
| Cost | Scalable system | L | H | M |
| Open standards | H | H | H |
| Open system architecture | H | H | H |
| Cost effective solution & applications | H | H | H |
| Competitive marketplace for supply of equipment and terminals | H | H | H |
| Reduction in deployment of permanent network infrastructure due to availability and commonality of equipment | H | H | L |
| Implementable by public and/or private operator for PPDR applications | H | H | M |
| Rapid deployment of systems and equipment for large emergencies, public events and disasters (e.g. large fires, Olympics, peacekeeping) | H | H | H |
| Information to flow to/from units in the field to the operational control centre and specialist knowledge centers | H | -H | -H |
| Operational issues | Greater safety of personnel through improved communications | H | H | H |
| Intra-system: Facilitate the use of common network channels and/or “talk groups” | H | H | H |
| Inter-system: Promote and facilitate the options common between systems | H | H | H |
| Coordinate tactical communications between on-scene or incident commanders of multiple PPDR agencies | H | H | H |
| Share with other terrestrial mobile users | L | L | M |
| Interoperability | Interoperable/Interconnection with narrowband trunked systems. Interconnection required with:* Inter RF subsystem Interface Voice service and Supplementary services
* Console supplementary Interface Voice service and Supplementary services
 | M | H | H |
| Interoperable/ Interconnection with other broadband systems | H | H | H |
| Interoperable/ Interconnection with satellite systems | H | H | H |
| Interconnection with other information systems | H | H | H |
| Interfaces that interconnect to esoteric systems | H | H | H |
| API compatible with standard interfaces | H | H | H |
| Appropriate levels of interconnection to public telecommunication network(s) – fixed and mobile | M | M | M |
| Spectrum usage & management | Suitable spectrum availability (BB channels) | H | H | H |
| Minimize interference to PPDR systems | H | H | H |
| Increased efficiency in use of spectrum | M | M | M |
| Appropriate channel spacing between mobile and base station frequencies | M | M | M |
| Dynamic spectrum allocation | H | H | H |
| Comply with relevant national regulations | H | H | H |
| Reallocation of upstream and downstream rates | H | H | H |
| Regulatory compliance | Coordination of frequencies in border areas | H | H | M |
| Provide capability of PPDR system to support extended coverage into neighboring countries (subject to agreements) | M | M | M |
| Ensure flexibility to use various types of systems in other Services (e.g. HF, satellites, amateur) at the scene of large emergency | M | H | H |
| Adherence to principles of the Tampere Convention | L | L | H |
| Planning  | Reduce reliance on dependencies (e.g. power supply, batteries, fuel, antennas, etc.) | H | H | H |
| As required, have readily available equipment (inventoried or through facilitation of greater quantities of equipment) | H | H | H |
| Provision to have national, state/provincial and local (e.g. municipal) systems | H | H | M |
| Pre-coordination and pre-planning activities (e.g. specific channels identified for use during disaster relief operation, not on a permanent, exclusive basis, but on a priority basis during periods of need) | H | H | H |
| Maintain accurate and detailed information so that PPDR users can access this information at the scene | M | M | M |

**Attachment 2**

**Generic Functional Requirements for the nationwide mission critical Broadband PPDR Wireless Communication System**

The functional requirements for broadband PPDR applications should be satisfied with:

1. Survivability and Resiliency
2. Capability to respond disaster
3. Security
4. Interoperability
5. Operational Efficiency

Detailed attributes are described in the below:

|  |  |  |
| --- | --- | --- |
| **Functional Requirements** | **Specifics** | **Importance**[[4]](#footnote-4) |
| **PP** | **PP** | **DR** |
| **-1** | **-2** |
| **1. Survivability and Resilience**  |
| Direct mode operation | Function for Direct mode operation between mobile terminals/repeater and gateway functions in order to achieve survivability of mobile terminal in any unexpected circumstances | H | H | H |
|
|
| Mobility support  | Function that enables mobile terminal to sustain established bearer path in order to sustain service continuity thus to maintain stable service status in any system coverage area | H | H | H |
|
| Capability to respond to burst call attempt | Function that provides capability to respond to burst call attempt in order to support stable system operation thus ultimately to prepare the unexpected highest demand of call situation, i.e., disaster  | H | H | H |
|
| Standalone mode operation of base station | Function that provides base station with stand-alone operation mode in which base station provides communication bearer path in case of any possible failure in mobile backhaul and switching centre in order to support group communication function in corresponding area | M | M | M |
|
|
| Duplication/transport media management | Function that provides automatic switch-over of transport network media (microwave, satellite and other IP networks) for switching centre, base station and access network in case of any failure and stable provision of seamless communication service | M | ,M | M |
|
|
| Communication service quality | Function that satisfies voice, video and data service provided by domestic professional technical group under the stable provision of seamless communication service | M | M | M |
|
|
| Backup restoration | Function that provides automatic back-ups and restoration of important data in management system (group management information, call attempt history and failure logs ) in order to support remote situation recognition around mobile terminal e.g., hijacking by system management node (Dispatcher) | M | M | M |
|
|
| **2. Capability to respond disaster**  |
| Individual call | Function that provides one-to-one communication by using of callee ID in order to give a call to a specific person | H | H | H |
|
|
| Group call | Function that provides one-to-many communication. This function provides effective communication capability that enable group based communication in order to provide effective communication service in specific circumstances e.g. mutual cooperation or assessing situation | H | H | H |
|
| Area selection | Function that all mobile terminals registered in specific area (single or multiple base stations) shall be selected and called by use of system management interface in order to respond fast in specific regional catastrophe | H | H | H |
|
| Dynamic Group Number Assignment | Function that creates new communication group, delete communication group and re-program existing communication group remotely according to situational change | H | H | H |
|
| Call Interruption | Function that suspend on-going group call to join the conversation in order to enable high priority intervention call by dispatcher  | H | H | H |
|
| Emergency call | Function that provides prioritized network access by use of special UI on mobile terminal e.g. pushing emergency button in order to provide immediate communication service without waiting time | H | H | H |
|
| Identification of mobile terminal location | Function that provides location of mobile terminal by use of satellite or base station location measurement technology in order to identify the location of mobile terminal in any situation | H | H | H |
|
| Video call | Function that provides one-to-one or one-to-many video call for the rapid situation recognition and response | M | M | M |
|
| Ambient Listening  | Function that provides remote listening of mobile terminals whose transmitter was turned on by remote system manager (or dispatcher) in order to support remote situation recognition around mobile terminal e.g. hijacking by system management node (or dispatcher) | M | M | M |
|   |
| Multiple group communication reception by single mobile terminal | Function that provides single mobile terminal with reception of multiple group communication in order to support situation monitoring function for multiple group communications | M | M | M |
|
| **3. Security**  |
| Validation or barring the use of mobile terminal | Function that authenticates or invalidates the use of mobile terminal in order to sustain security in case of stolen/missing terminals | H | H | H |
|
| Encryption | Function that eavesdrops or wiretaps by encrypting the bearer path in order to achieve communication security in case of specific events and talks between major commanders | H | H | H |
|
|
| Authentication | Function that provides valid communication service to authenticated users with registration of mobile terminal/users | H | H | H |
|
|
| Provision of security enforcement interface | Function that provides standardized interface to inter-work with external security equipment in order to conform the security standard of law and institution  | H | H | H |
|
|
| Integrated Security Control | Function that provides integrated security control e.g. intrusion detection, prevention against security attack in order to protect from possible hacking attack in order to provide integrated security monitoring system to respond to any security issues | H | H | H |
|
| **4. Interoperability** |
| Openness/conformity of standards | Function that provides inter-working interface specification and conform domestic/international standards to achieve interoperability between different vendor’s system  | M | M | M |
|
| Call establishment | Function that provides minimal call establishment and delay time to support interoperability between different vendor’s systems  | M | M | M |
|
| Network  | Function that provides interoperability with legacy PPDR network (UHF/VHF/TRS…) and public network (PSTN, PSDN and Internet) in order to support information sharing  | M | M | M |
| interconnectivity |
| 　 |
| **5. Operational efficiency** |
| Rapid propagation of situation messages | Function that provides message ( included data) broadcasting by system management (dispatcher) or mobile terminal for rapid propagation of situation status  | H | H | H |
|
| Security of communication capacity | Function that provides security of subscriber capacity required for stable PPDR operation of telecommunication network in various situations | H | H | H |
|
| Full duplex multi group communication | Function that provides simultaneous calls with different multiple mobile terminals in order to support conference call in any situation | M | M | M |
|
| Data service  | Function that supports data communication service while in single/multiple calls in order to support seamless communication capability | M | M | M |
| Recording of voice/video call | Function that provides recording of specific voice/video call in order to secure the evidence in any cases of incident/accident | M | M | M |
| Caller ID representation | Function that provides caller identification by use of ID appearing on any display unit in order to identify any communication-protocol-related offense case by use of caller ID | M | M | M |
|
| Remote network management  | Function that provides remote management function to authenticate/register mobile terminal as well as network O&M in order to provide efficient network management function e.g. remote programming of mobile terminal | M | M | M |
| Network Management system  | Function that provides centralized network management systems which give the overall information of network operation in order to provide the management functions e.g. system control, securing of account and security, resolve of obstacle and performance | M | M | M |
|
| Reporting function | Function that provides automatic report generation function about subscriber information, traffic statistics and alarm history in order to provide systematic response to any cases | M | M | M |
|
| Call capacity enhancement  | Function that provides the enhancement communication capacity in the system and base stations when insufficient communication capacity issue arises in a specific area in a disaster situation | M | M | M |
|
| Broadband/Network coverage | Function that provides enhanced throughput speed and nationwide network coverage in order to establish mobile broadband and secure nationwide network coverage | M | M | M |
|
|
| Frequency Multiplexing | Function that provides high communication capacity in a single frequency band in order to support efficient management of limited radio frequency resource | M | M | M |
|  |  |  |  |  |

**ATTACHMENT 3**

**Use of Recommendation ITU-R M.1390 for estimating PPDR Spectrum Requirements**

If Recommendation ITU-R M.1390 is retained as an option for determining PPDR spectrum requirements, a careful review of the text reveals that the values of several parameters must be selected with considerable care to avoid misleading results:

*Activity\_Factores*

As described clearly in Recommendation ITU-R M.1390, this factor represents the actual channel resource occupancy and, in contrast to previous *circuit-switched* modes of GSM and IMT-2000, in the case of *packet-oriented* IMT-Advanced channels the value will always be significantly less than unity.

More specifically, while narrowband systems traditionally assigned an *entire* channel to each user for the duration of a communication session (activity factor = 1), today’s high-speed digital packet-oriented systems simultaneously accommodate multiple independent communications sessions within the broadband channel.

In particular, using Adaptive Multi-Rate Wide Band (AMR-WB) in normal mobile environments results in an effective bit rate of about 12.65 kbps for superior audio quality speech and music (ie. quality better than a 56 kbps Rec. ITU-T G.722 signal) – and can range up to 23.85 kbps in adverse background noise environments. For a 5 MHz LTE wireless broadband channel that offers an average aggregate bit-rate of around 20 Mbps (downlink) and 4 Mbps (uplink), each continuing AMR-WB speech signal will exhibit an effective channel occupancy of about 0.0006325 to 0.005963.

This effective channel occupancy value for packet-oriented voice traffic represents the *Activity Factor* applicable to speech communications carried by LTE services. For comparison, where later 3G systems began to carry speech in a (non-IP) digitized form, the effective channel occupancy (*Activity\_Factores*) was around 0.00074 to 0.0074.

In the case of other applications, good quality video encoding similarly results in effective channel occupancy values of less than unity (eg. not more than 0.5 for a continuous 2Mbps video uplink, or 0.1 for downlink), while file transfer and database access also share the LTE channels with other packet streams, with effective occupancy significantly less than unity. Thus, the value for *Activity\_Factores* for encoded uplink video streams should typically be not more than 0.5 and for downlink video streams not more 0.1.

*Group\_Sizees*

This factor accounts for traffic inflow, outflow and sharing/offloading between a *cluster* of cells/sectors, and reflects the trunking efficiency benefits of neighbouring cells/sectors. As described in Recommendation ITU-R M.1390, the *Group\_Sizees* is applied in the form of a pre-scaling factor to the determination of estimated offered traffic. For modern LTE networks, where 1:1 frequency re-use is implemented, the value for *Group\_Sizees* should be at least 3 to reflect the minimum number of neighboring cells/sectors, but (depending on deployment configuration) could range up to 9 where ‘clover-leaf’ cell configurations are routinely used in public networks to achieve greater coverage reliability (‘depth’).

*Net\_System\_Capabilityes*

As described in Recommendation ITU-R M.1390, this factor is not the same as modulation spectral efficiency, but is comprised of a number of QoS effects that are combined in a complex manner – and includes *spectral efficiency*, effective *Eb/No*, target *C/I*, and several other elements.

For LTE systems, the effective (link) *spectral efficiency* (bits/s/Hz/cell) will vary depending on the separation distance between UE and host base-station, since the technology uses different coding rates and modulation methods to maximize channel resource utilisation depending on prevailing propagation conditions. From measurements of actual networks in operation, a conservative average value for link *spectral efficiency* (Ses) is in the range 1.8-2.

Taking account of other QOS objectives, this then leads to a conservative average value for *Net\_System\_Capabilityes* for typical LTE deployments of around 3500-4000 kbit/s/MHz/cell for downlinks, and 1000-1500 kbit/s/MHz/cell for uplinks.

**ATTACHMENT 4**

**EXAMPLES OF BROADBAND PPDR REQUIREMENTSSTUDIED IN SOME APT COUNTRIES**

**Example 1 Broadband PPDR spectrum requirements in Korea**

**Example 2 LTE PPDR Broadband requirements contributed by Motorola Solutions India**

**Example 3 LTE based technology for PPDR broadband provided by China**

**Example 4 PPDR specifications developed in Australia for augmentation support by IMT technologies**

**Attachment 4**

**Example 1 Example from Korea**

**broadband ppdr Spectrum requirements in korea**

1. **Introduction**

The Government of Korea recently decided to use Public Safety LTE technologies with 2x10 MHz frequency in the 700MHz band (718-728 MHz for uplink and 773-783 MHz for downlink according to APT 700 MHz Band Plan) to build nationwide Public Protection and Disaster Relief (PPDR) Broadband network for sharing among Korean PPDR agencies. According to this decision, the Ministry of Public Safety and Security of Korea (MPSS; http://www. mpss.go.kr/main/main.html) has lead the related project to build PPDR Broadband network since 2014. This broadband network is considered to be not only used for PPDR agencies (police, fire brigade, etc) but also carry out public broadband services for express railway[[5]](#footnote-5) and inshore vessel[[6]](#footnote-6). The PPDR network is supposed to be built as a nationwide dedicated network basically but the use of commercial network to cover area where PPDR network coverage does not reach is also being considered.

The spectrum requirements have been studied and they are based on traffic scenarios of PPDR agencies (e.g. police, fire brigade, coast guard) in PP1 (day-to-day operation), PP2 (large emergency and public event), DR (disaster) scenarios respectively. Spectrum requirements when multiple PPDR agencies jointly carry out operation are considered. Korea government is considering integrated public broadband services for PPDR, railway, and inshore vessels in a single nationwide LTE network. Thus, spectrum requirements for the integrated public broadband service are also analyzed.

In Section 2, spectrum requirement calculation methodology is explained and traffic parameters of each scenario are presented. Section 4 shows spectrum requirement calculation results and conclusions are drawn in section 5.

1. **Spectrum Requirements Calculation Methodology**

The spectrum requirement calculation methodology adopted in this study is based on Recommendation ITU-R M.1390 which is used for the calculation of IMT-2000 terrestrial spectrum requirements and its use to calculate spectrum requirements for PPDR is shown in PPDR in Report ITU-R M.2033. The spectrum requirement calculation procedure consists of 4 stages as in figure 1.

A. Geographic Consideration

B. Market and

Traffic

Consideration

C. Technical and System

Consideration

D. Spectrum

 Results

Consideration

Figure 1: Spectrum requirements calculation procedure in Rec. ITU-R M.1390

In this study, the Recommendation ITU-R 1390 methodology is considered but modified to reflect broadband PPDR service characteristics as explained below.

1. Geographic Considerations

In this stage, environment type, cell area and geometry etc are considered. Environment types are usually selected most significant contributors. In this study, dense urban and urban are considered as density and in-building and pedestrian are considered as mobility. Circular cell geometry and at least 1 km cell diameter is assumed. In general, cell diameter is used to calculate the number of user in a cell, but in this study cell diameter is irrelevant to the number of user since it is assumed that most of users are concentrated on one cell. When operation being carried out over wide area (e.g. police PP2 scenario in Section 3-1), we assume cell diameter is 1 km.

1. Market and Traffic Considerations

In this stage, the number of user per cell is calculated from service type, population density and penetration rate. Traffic parameters (busy hour call attempt, average call duration, activity factor) for each service (e.g. voice, data, and video) are also considered and traffic per cell in Erlang unit is calculated from the traffic parameters. To calculate required channels from traffic per cell, QoS parameters (e.g. call blocking probability for circuit switched network, packet delay for packet switched network) is also considered. In this study, traffic parameters are collected from major PPDR agencies (police, fire brigade, coast guard) as given in Section 3. Stages B and C to calculate traffic in kbps unit are integrated as explained in stage C.

1. Technical and System Considerations

The number of channel required for each application is obtained from traffic per cell and QoS parameters through Erlang B or C formula. The obtained number of channel for each application is multiplied by required bit rate of the corresponding applications. Finally, spectral efficiency parameter is considered to transform traffic into spectrum requirements.

In above stage B and C, traffic in Erlang unit are calculated into the required number of channel and transformed into traffic in kbps. In this study, for simplicity of calculation, traffic in kbps is calculated directly as follows referring to ECC Report 199 or Recommendation ITU-R M.1651.

For real time application, traffic [kbps] = number of user x call (transaction) attempt per hour x required bit rate [kbps] x call (transaction) duration per hour [min] / 60. For non real time application [kbps] = 8 x number of user x call (transaction) attempt per hour x data [Byte] / (3600 x 1000).

The result of traffic in kbps obtained from this calculation method may be smaller than the result from M.1390 which takes into account QoS parameters. However, it is anticipated that the difference would not be significant because HD quality video transmission services which account for the most of spectrum is assumed to be ensued for their channel.

As a radio interface technology, LTE Release 8 is assumed and its spectral efficiency is given as follows.

Table 1: Spectral Efficiencies Assumption

|  |  |  |
| --- | --- | --- |
| Spectral Efficiency [bps/Hz] | Uplink (1x2 MIMO) | Downlink (2x2 MIMO) |
| Average | 0.735 | 1.69 |
| Cell edge | 0.024 | 0.05 |

The values of spectral efficiency differ depending on location of mobile station in a cell or transmission modes (e.g. Multicast-broadcast single frequency network (MBSFN)) for a specific application (e.g. group call)[[7]](#footnote-7). In this study, average spectral efficiency is assumed for simplicity. We also assume a cell is spitted into 3 sectors and due to the cell split total cell capacity is increased by 2.5 times considering inter-sector interference.

1. Spectrum Results Considerations

Traffic in kbps for each application is divided by spectral efficiency to obtain spectrum requirements. Weighting factor and adjustment factor are assumes as 1 in this study.

1. **Traffic Parameters**

Traffic parameters for broadband PPDR network in PP1 (day-to-day operation), PP2 (large emergency and public event), DR (disaster) scenarios are considered. Applications are categorized into voice, data, and video though there are some differences for each agency. The definitions of traffic parameters are defined as follows.

Table 2: Definitions of traffic parameter[[8]](#footnote-8)

|  |  |  |
| --- | --- | --- |
| Parameters | Definition | Unit |
| Session attempt per hour | The average number of attempts during busy hour; | - |
| Number of user | The number of user or group | - |
| Session duration per hour | The mean actual duration of the session during the busy hour | min |
| Activity factor | The fraction of time a user is active during session | - |

**3-1. Individual PPDR Agency Operation**

Traffic parameters for major individual PPDR agencies of police, fire brigade and coast guard are considered. Each parameter of each scenario is assumed as an average value. Traffic parameter values for PP2 and DR scenarios are presented as below to save pages.

1. **Police**

In PP1 scenario, commitment of 500 police officers in a cell for daily works such as traffic enforcement, 112 call incident responses, and special facility security are assumed.

 In PP2 scenario, it is assumed that a special event occurs over diameter 4-5 km in Seoul metropolitan area and 20-30 thousand police officers are committed to the guard operation. In general, base stations are built densely in metropolitan area to avoid traffic overload in a cell. Thus, it can be assumed that cell diameter is reduced to 1 km and about 2,500 police officers are crowded within a cell[[9]](#footnote-9).

Table 3: Traffic parameters of police in PP2 scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.5 | 2500 | 45.3 | 0.5 | 0.5 | 2500 | 45.3 | 0.5 | 0.5 |
| Group Call | 1 | 250 | 45.3 | 60 | 0.05 | 250 | 45.3 | 60 | 0.05 |
| Data | Message | 10 | 250 | 1 | 0.02 | 1 | 250 | 1 | 0.02 | 1 |
| Mobile inquiry | 20 | 250 | 64 | 0.02 | 1 | 250 | 64 | 0.02 | 1 |
| 112 mobile | 5 | 25 | 64 | 0.02 | 1 | 25 | 64 | 0.02 | 1 |
| Navigation | 10 | 25 | 64 | 0.02 | 1 | 25 | 64 | 0.02 | 1 |
| GPS | 30 | 25 | 64 | 0.02 | 1 | 25 | 64 | 0.02 | 0.1 |
| ANPR | 500 | 5 | 1 | 0.02 | 1 | 5 | 1 | 0.02 | 1 |
| Video | Video Transmission | 1 | 3 | 2,000 | 60 | 1 | 3 | 2,000 | 60 | 1 |
| Video Call | 1 | 3 | 512 | 2 | 0.5 | 3 | 512 | 2 | 0.5 |
| Image Transmission | 4 | 150 | 512 | 0.02 | 1 | 150 | 512 | 0.02 | 1 |

In DR scenario, a special event in Seoul metropolitan area as PP2 scenario along with a disaster is assumed.

Table 4: Traffic parameters of police in DR scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.05 | 3,000 | 45.3 | 0.5 | 0.5 | 3,000 | 45.3 | 0.5 | 0.5 |
| Group Call | 1 | 300 | 45.3 | 60 | 0.05 | 300 | 45.3 | 60 | 0.05 |
| Data | Message | 10 | 300 | 1 | 0.02 | 1 | 300 | 1 | 0.02 | 1 |
| Mobile inquiry | 30 | 300 | 64 | 0.02 | 1 | 300 | 64 | 0.02 | 1 |
| 112 mobile | 10 | 30 | 64 | 0.02 | 1 | 20 | 64 | 0.02 | 1 |
| Navigation | 10 | 30 | 64 | 0.02 | 1 | 30 | 64 | 0.02 | 1 |
| GPS | 30 | 30 | 64 | 0.02 | 1 | 30 | 64 | 0.02 | 0.1 |
| ANPR | 500 | 5 | 1 | 0.02 | 1 | 5 | 1 | 0.02 | 1 |
| Video | Video Transmission | 1 | 3 | 2,000 | 60 | 1 | 3 | 2,000 | 60 | 1 |
| Video Call | 2 | 30 | 512 | 3 | 0.5 | 30 | 512 | 3 | 0.5 |
| Image Transmission | 5 | 30 | 512 | 0.02 | 1 | 30 | 512 | 0.02 | 1 |

1. **Fire Brigade**

In PP1 scenario, commitment of 1 fire station of average 86 fire fighters is assumed.

In PP2 scenario, it is assumed that regional fire department of 171 fire fighters carry out emergency operation in a cell.

Table 5: Traffic parameters of fire brigade in PP2 scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.2 | 171 | 45.3 | 0.39 | 0.5 | 171 | 45.3 | 0.39 | 0.5 |
| Group Call | 1 | 19 | 45.3 | 60.00 | 0.075 | 19 | 45.3 | 60.00 | 0.075 |
| Data | SMS | 1.5 | 19 | 1 | 0.02 | 1 | 19 | 1 | 0.02 | 1 |
| MMS | 1.5 | 19 | 520 | 0.02 | 1 | 19 | 520 | 0.02 | 1 |
| Internet Access | 2 | 22 | 384 | 0.21 | 1 | 22 | 384 | 1.05 | 1 |
| Sensor | 360 | 18 | 76 | 0.02 | 1 | 22 | 76 | 0.02 | 1 |
| GPS | 360 | 34 | 76 | 0.02 | 1 | 22 | 76 | 0.02 | 1 |
| Video | Image(SD) | 0.2 | 171 | 512 | 0.03 | 1 | 171 | 512 | 0.03 | 1 |
| Video(HD) | 1 | 1 | 2,000 | 60 | 1 | 1 | 2,000 | 60 | 1 |
| Individual Call | 0.2 | 171 | 512 | 0.39 | 0.5 | 171 | 512 | 0.39 | 0.5 |
| Group Call | 1 | 9.5 | 512 | 60 | 0.075 | 9.5 | 512 | 60 | 0.075 |

In DR scenario, multiple regional fire departments of 685 fire fighters come together to carry out emergency operation in a cell.

Table 6: Traffic parameters of fire brigade in DR scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.2 | 685 | 45.3 | 0.39 | 0.5 | 685 | 45.3 | 0.39 | 0.5 |
| Group Call | 1 | 76 | 45.3 | 60.00 | 0.075 | 76 | 45.3 | 60.00 | 0.075 |
| Data | SMS | 3 | 76 | 1 | 0.02 | 1 | 76 | 1 | 0.02 | 1 |
| MMS | 3 | 76 | 520 | 0.02 | 1 | 76 | 520 | 0.02 | 1 |
| Internet Access | 2 | 30 | 512 | 0.39 | 1 | 30 | 512 | 1.95 | 1 |
| Sensor | 360 | 70 | 76 | 0.02 | 1 | 30 | 76 | 0.02 | 1 |
| GPS | 360 | 137 | 76 | 0.02 | 1 | 30 | 76 | 0.02 | 1 |
| Video | Image(SD) | 0.2 | 685 | 512 | 0.03 | 1 | 685 | 512 | 0.03 | 1 |
| Video(HD) | 1 | 2 | 2,000 | 60 | 1 | 2 | 2,000 | 60 | 1 |
| Individual Call | 0.2 | 685 | 512 | 0.39 | 0.5 | 685 | 512 | 0.39 | 0.5 |
| Group Call | 1 | 38 | 512 | 60.00 | 0.075 | 38 | 512 | 60.00 | 0.075 |

1. **Coast Guard**

In PP1 scenario, 1 coast guard vessels are committed to respond vessel failure or to transport emergency patient of island area.

In PP2 scenario, 10 coast guard vessels are committed to carry out searching operation, to respond to marine oil spill, ship fire and flood.

Table 7: Traffic parameters of coast guard in PP2 scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.5 | 300 | 45.3 | 0.5 | 0.5 | 300 | 45.3 | 0.5 | 0.5 |
| Group Call | 1 | 10 | 45.3 | 60 | 0.05 | 10 | 45.3 | 60 | 0.05 |
| Data | Message | 2 | 10 | 520 | 0.02 | 1 | 10 | 520 | 0.02 | 1 |
| Paging | 1 | 300 | 1 | 0.02 | 1 | 300 | 1 | 0.02 | 1 |
| Location data | 120 | 300 | 56 | 0.01 | 1 |  |  |  |  |
| Video | Video(HD) | 2 | 10 | 512 | 0.2 | 0.5 | 10 | 512 | 0.2 | 0.5 |
| Group Call | 1 | 2 | 2,000 | 60 | 1 |  |  |  |  |

In DR scenario, 50 coast guard vessels are committed to carry out searching operation or to respond to large scale marine oil spill, ship fire and sinking accident.

Table 8: Traffic parameters of coast guard in DR scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.5 | 1,500 | 45.3 | 0.5 | 0.5 | 1,500 | 45.3 | 0.5 | 0.5 |
| Group Call | 1 | 50 | 45.3 | 60 | 0.05 | 50 | 45.3 | 60 | 0.05 |
| Data | Message | 3 | 50 | 520 | 0.02 | 1 | 50 | 520 | 0.02 | 1 |
| Paging | 1 | 1,500 | 1 | 0.02 | 1 | 1,500 | 1 | 0.02 | 1 |
| Location data | 120 | 1,500 | 56 | 0.01 | 1 | 1,500 | 56 |  |  |
| Video | Video(HD) | 2 | 50 | 512 | 0.3 | 0.5 | 50 | 512 | 0.3 | 0.5 |
| Group Call | 1 | 3 | 2,000 | 60 | 1 |  |  |  |  |

**3-2. Multiple PPDR Agencies Operation**

In case of large emergency, there would be a case that multiple PPDR agencies carry out joint operation to respond emergency. In this study, a gym collapse incident occurred at Gyeongju, Korea in Feb. 2014 is considered. Total number of committed responder is 1,448 which consist of 788 fire fighters, 500 police officers, 80 local government officials and 80 soldiers.

Table 9: Traffic parameters of multiple agencies operation scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traffic | Application | Session attempt per hour | Uplink | Downlink |
| Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor | Number of user (or group) | Bit Rate [kbps] | Session duration per hour [min] | Activity factor |
| Voice | Individual Call | 0.1 | 1,448 | 45.3 | 0.39 | 0.5 | 1,448 | 45.3 | 0.39 | 0.5 |
| Group Call | 1 | 145 | 45.3 | 60 | 0.075 | 145 | 45.3 | 60 | 0.075 |
| Data | SMS | 3 | 145 | 1 | 0.02 | 1 | 145 | 1 | 0.02 | 1 |
| MMS | 3 | 145 | 520 | 0.02 | 1 | 145 | 520 | 0.02 | 1 |
| Internet Access | 2 | 30 | 512 | 1 | 1 | 30 | 512 | 20 | 1 |
| Sensor | 360 | 70 | 76 | 0.02 | 1 | 70 | 76 | 0.02 | 0.1 |
| GPS | 360 | 145 | 76 | 0.02 | 1 | 145 | 76 | 0.02 | 0.1 |
| Video | Image(SD) | 1 | 64 | 512 | 0.02 | 1 | 64 | 512 | 0.02 | 1 |
| Video(HD) | 1 | 3 | 2,000 | 60 | 1 | 3 | 2,000 | 60 | 1 |
| Video(SD) | 1 | 3 | 1,000 | 60 | 1 | 3 | 1,000 | 60 | 1 |
| Individual Call | 0.2 | 788 | 512 | 0.39 | 0.5 | 788 | 512 | 0.39 | 0.5 |
| Group Call | 1 | 39 | 512 | 60 | 0.075 | 39 | 512 | 60 | 0.075 |

**3-3. PPDR operation with other public broadband services**

Traffic scenario of integrated public broadband service where not only PPDR but also other public broadband services (e.g. for railway or inshore vessels) is provided. To calculate spectrum requirement of integrated service, traffic scenarios can be considered separated by geographical service area of land and sea. For land area, PPDR and railway broadband services, for sea area, PPDR and inshore vessel broadband services are used simultaneously. Spectrum requirement are determined so as to meet spectrum requirements of all service areas.

In this study, an incident near Seoul station is assumed for land area scenario and traffic parameters of multiple PPDR agencies as given in section 3-2 is adopted. For sea area scenario, ship sinking near Busan harbor is considered. In this scenario, PPDR agency officers in harbor area and cost guard vessels in sea are assumed and broadband service for in shore vessel is also provided simultaneously.

1. **Spectrum Requirements**

Table 10 and 11 show that for individual PPDR agency operation 2x5 MHz would be sufficient for PP1, PP2, DR scenarios.

Table 10: Uplink spectrum requirements for individual PPDR agency operation [MHz]

|  |  |  |  |
| --- | --- | --- | --- |
| Agency | Police | Fire Brigade | Coast Guard |
| Scenario | PP1 | PP2 | DR | PP1 | PP2 | DR | PP1 | PP2 | DR |
| Voice | 0.087  | 0.437  | 0.524  | 0.038  | 0.211  | 0.152  | 0.003  | 0.028  | 0.139  |
| Data | 0.036  | 0.060  | 0.102  | 0.250  | 0.322  | 0.983  | 0.035  | 0.165  | 0.843  |
| Video | 0.007  | 3.326  | 3.695  | 1.323  | 1.460  | 4.206  | 1.089  | 2.186  | 3.335  |
| Total | 0.131  | 3.822  | 4.321  | 1.611  | 1.992  | 5.340  | 1.127  | 2.379  | 4.316  |

Table 11: Downlink spectrum requirements for individual PPDR agency operation [MHz]

|  |  |  |  |
| --- | --- | --- | --- |
| Agency | Police | Fire Brigade | Coast Guard |
| Scenario | PP1 | PP2 | DR | PP1 | PP2 | DR | PP1 | PP2 | DR |
| Voice | 0.038 | 0.190 | 0.228 | 0.016 | 0.092 | 0.066 | 0.001 | 0.012 | 0.060 |
| Data | 0.015 | 0.023 | 0.003 | 0.150 | 0.548 | 0.352 | 0.000 | 0.001 | 0.011 |
| Video | 0.008 | 1.446 | 1.607 | 0.575 | 0.635 | 1.829 | 0.000 | 0.004 | 0.030 |
| Total | 0.061 | 1.660 | 1.838 | 0.742 | 1.274 | 2.247 | 0.001 | 0.017 | 0.102 |

In case of multiple PPDR agencies operation, 7.4 MHz and 5.2 MHz are required for uplink and downlink respectively thus 2x10 MHz should be provided for this case.

Table 12: Spectrum requirements for multiple PPDR agencies operation [MHz]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Services | Voice | Data | Video | Total |
| Uplink | 0.28 | 1.202 | 5.869 | 7.351 |
| Downlink | 0.122 | 2.477 | 2.552 | 5.151 |

When PPDR service is integrated with other public broadband service, spectrum should be provided to cover all areas (both land and sea). From Table 12, it is shown that broadband services in each service area can be supported by using 2x10 MHz spectrum.

Table 13: Spectrum requirements for PPDR operation with other public broadband services [MHz]

|  |  |  |  |
| --- | --- | --- | --- |
| Service Area | Service | Uplink | Downlink |
| Land Area | PPDR  | 7.35 | 5.15 |
| Railway Broadband\* | 2.05 | 1.85 |
| Sub Total | 9.4 | 7 |
| Sea Area | Coast Guard | 4.32 | 0.1 |
| Inshore Vessel Broadband\* | 4.89 | 4.21 |
| PPDR | 0.35 | 0.62 |
| Sub Total | 9.56 | 4.93 |

**Attachment 4/**

**Example 2: Scenario of LTE PPDR Broadband contributed by Motorola Solutions India (based on a conceptual scenario in USA)**

Given the unique mission critical requirements of public safety, it is essential that first responders have unilateral control over sufficient broadband capacity to serve current and future needs. To this end, Motorola Solutions developed a model to evaluate public safety’s broadband wireless requirements by drawing upon existing policies and recent incident feedback. For purposes of this research, Level 1 through Level 3 Hazardous Materials Incident was considered: Level 1 being a Tanker Spill, Level 2, a Clandestine (Drug) Lab, and Level 3, a Petrochemical Refinery incident. Table 1 below summarizes an example of a public safety equipment and personnel response needed to manage such an incident based on consultation with PPDR agencies in USA.



**Table 1** – Typical Response Scope for Level 1-3 Hazardous Materials Incidents

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

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

1. **Individual (Person/Vehicle) CAD overhead functions**: The classification includes incident data, GPS information, biosensors and other status, messaging, and queries. Each station individually consumes relatively low down/uplink bandwidth but in aggregate usage can be significant across many users.
2. **Incident Scene database lookups/downloads and information searches**: The classification includes the download of manuals, incident scene images, maps and topography information, building plans, etc. This use case has the unique requirement that, in general, the information is needed quickly as incident commanders initially assess the scene and develop a strategy. The model assumes that all expected initial data is downloaded and available with the first 10 minutes of the incident. The demands are scaled with the incident size and complexity.
3. **Video**: This classification of usage is comprised of personal video cameras for workers operating in the hot-zone, incident scene (car) video positioned around the perimeter, and cameras deployed within the scene. The video is uplinked via the network and a subset of the streams (switchable on command) is down-linked to the on-scene command center. Rates of 400kbps (QVGA 320x240 @ 30fps) and 1.2 Mbps (1280x960 @ 30fps) are used and the number of each type of video stream is scaled with the size and complexity of the incident.

Figure 2 below summarizes the results of the analysis, for worst-case assumption that all PPDR assets and personnel listed above transmissions are simultaneously transmitting, and where the bandwidth demands for both uplink and downlink are compared with the expected *average* capacity of a single LTE serving sector (*cell edge* performance, especially on the uplink, would be considerably less and obviously under optimistic conditions peak data rates can be much higher). Further, an additional “background” load of 20% is added to the total demand on the assumption that this would be a minimum “base load” for other non-incident related, nominal activities across the same single sector coverage area.



**Figure 2** – Broadband Wireless Capacity Implications

On these worst-case single-sector assumptions, 10MHz (5+5) of capacity is insufficient to service the uplink demands for even a Level 1 incident. On the other hand, although 10+10 is still deficient for the ideal Level 3 workload, it services the Level 1 and Level 2 incident demands and comes much closer to providing reasonable capability for the Level 3 case.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Attachment 4**

**Example 3: LTE based technology for PPDR broadband provided by China**

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

Process to handle the incident:

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

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

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

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

**Table 1 Analysis of Bandwidth Requirements during the Strike**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Emergency Team | Personnel and Equipment | Service(s)  | Source Coding Rate | Uplink Bandwidth | Downlink Bandwidth |
| Command Center | 15 | compressed video broadcast |  |  | 7MHz |
| Ordinary Police Officers | 20 | identity authentication and query |  |  |  |
| Medical Team | 5 | 1 channel D1 video upload and download | 1Mbps | 2MHz | 2MHz |
| Fire Fighters | 5 | 1 channel D1 video upload and download | 1Mbps | 2MHz | 2MHz |
| Negotiation Experts | 3 | high definition video download |  |  | 4MHz |
| Strike Team | 10 | 2 channels CIF video upload and download | 0.5Mbps | 2MHz | 4MHz |
| Police Helicopter | 1 | 1 channel 1080P video upload and download | 3Mbps | 5MHz | 1MHz |
| Reconnaissance Robot | 10 | 1 channel 720P, 1 channel CIF video upload | 3.5Mbps | 6MHz |  |

The above analysis shows that to fulfill the task, uplink needs at least 17 MHz bandwidth and broadcast downlink at least 7MHz (frequency spectrum utilization about 50%). Consider the routine work; extra 10% background spectrum width is needed. The total spectrum width is about 27MHz. It is asserted that the more complex the incident case, the more spectrum is needed.

The bandwidth needed by broadband PPDR would be tremendously different in different scenarios. However, the typical case above shows that allocating about 30 MHz bandwidth for PPDR agencies may fulfill the requirements of PPDR general scenarios, except in disaster relief situations that require more spectrum.

**Attachment 4**

**Example 4 PPDR specifications developed in Australia for augmentation support by IMT technologies**

**Purpose**

The purpose of this table is to broadly outline the baseline requirements for augmentation or ‘overflow’ of a nationally interoperable public safety mobile broadband (PSMB) network proposed for deployment in Australia using IMT technologies.

**Approach**

A value has been attributed to each requirement based on the criticality of operational service need. These being:

|  |  |
| --- | --- |
| **MUST** | Indicates a capability that is mission-critical to emergency response and management. Unavailability of this requirement will impact on management of a life and death situation, and therefore is absolutely required for satisfactory implementation of the PSMB capability. |
| **SHOULD** | Indicates a capability that is business-critical for performing operational tasks but not essential to management of a life and death situation. The requirement is therefore highly desirable but could be modified for satisfactory implementation of the PSMB capability. |
| **MAY** | Indicates a capability that may enhance operational tasks, but its use is not part of anticipated PSMB capability operational models. The requirement may therefore be useful but is not needed for satisfactory implementation of the PSMB capability. |
| **SHOULD NOT** | Indicates a capability that is not called for within the anticipated PSMB capability operational models. The requirement is unnecessary for implementation of the PSMB capability. |
| **MUST NOT** | Indicates a factor that would present risks for successful implementation of the PSMB capability. Presence of this factor may negatively impact on management of a life and death situation. |

TABLE 1

**Australia Example of PPDR requirements for augmentation support by IMT technologies**

|  |  |
| --- | --- |
| **No.** | **Requirement and relevant service value** |
| 1. | Any commercial augmentation service **MUST** ensure interoperability with the full features and functionality of thePSMB capability in all environments. |
| Any commercial augmentation service **MUST** allow all applicable components of the network to be tested for compliance with any PSMB Interoperability Certification Requirements. |
| 2. | Commercial augmentation services **MUST** provide a broadband data capability. |
| Commercial augmentation services **SHOULD** support high levels of video upload. |

|  |  |
| --- | --- |
| 3. | Commercial augmentation services MUST provide preferential services including:* + **MUST** incorporate prioritisation features.
	+ **MUST** incorporate Quality of Service features.
	+ **MUST** incorporate Grade of Service.
	+ **MAY** incorporate other features that enhance reliability and performance.
 |
| Commercial augmentation services **MUST** meet Agreed Service Levels to provide for continued operation of the PSMB capability during emergencies. |
| 4. | Commercial augmentation services **MUST** provide overflow for Mission Critical and Operational/Business applications. |
| Commercial augmentation services **MUST** provide for continued operation of the PSMB capability priority service levels, including during emergency events or where network service may be degraded. |
| Commercial augmentation services **SHOULD** offer at least three service levels with clear service boundary SLAs. |
| 5. | Commercial augmentation services **MUST** provide an IP data transfer capability. |
| 6. | Commercial augmentation services **MUST** provide access to PSAs’ networks that provide the applications and services that support their operational requirements (e.g. by Virtual Private Networks). |
| Commercial augmentation services **MAY** provide public internet access if requested by PSAs. |
| Commercial augmentation services **SHOULD** allow for network access to be specified on a per-user basis. |
| 7. | Commercial augmentation services **MUST** ensure delivery of mission and operation critical information. |
| Commercial augmentation services **MUST** ensure that network reliability is not compromised. |
| 8. | Commercial augmentation services **MUST** provide seamless coverage and support transfer of users with capable devices to/from other networks, triggered by **coverage** loss (e.g. dedicated PSMB and Wi-Fi networks). |
| Commercial augmentation services **MUST** support the capability of Cells-On-Wheels to provide additional seamless coverage for major events and incidents outside dedicated coverage areas. |
| 9. | Commercial augmentation services **MAY** support transfer of users with capable devices to/from other networks when capacity improvement is available (e.g. dedicated PSMB, Wi‑Fi, and satellite networks). |
| Commercial augmentation services **SHOULD** support the insertion of service provider Cells-On-Wheels into existing networks to provide additional capacity for major events and incidents. |
| Commercial augmentation services **MAY** provide alternate broadband radio communication technologies (such as Wi-Fi networks) that can be added to existing networks to provide additional capacity for major events and incidents. |
| 10. | Commercial augmentation services **SHOULD** take best efforts to improve the resilience of their networks. |
| 11. | Commercial augmentation services **MAY** offer PSAs access to additional backhaul services where available to support other PSMB capability e.g. Cells-On-Wheels, ad-hoc Wi-Fi access networks. |
| 12. | The PSMB capability user base **MUST** include State and Territory law enforcement agencies and emergency services agencies. |
| The PSMB capability user base **MAY** include Commonwealth law enforcement agencies and emergency services agencies. |
| Commercial augmentation services **MUST** provide for management of a national PSMB user base expected to number in excess of approximately 100,000 terminals. |
| 13. | Commercial augmentation services **SHOULD** support sharing of devices between authorised users. |
| Commercial augmentation services **MUST** allow PSMB to have ownership and control over device SIMs. |
| 14. | Commercial augmentation services **MUST** support the ability for a user to sign into any device and use all applications the user is authorised to use (this requirement does not apply to devices without the input capabilities to support sign-on e.g. modems). |
| Commercial augmentation services **SHOULD** support user addressing for operator-provided services. |
| 15. | Commercial augmentation providers **SHOULD** permit rapid provisioning of services for additional users/terminals where required (e.g. for significant events and operations). |
| Commercial augmentation providers **SHOULD** provide PSAs with management and configuration capability to support adding, updating and removing user equipment access in a time critical manner. |
| 16. | Commercial augmentation services **MUST** provide an IP-compatible data transfer service. |
| 17. | Commercial augmentation services **SHOULD** provide best endeavours voice capability. |
| Commercial augmentation services **SHOULD** allow for later addition of mission-critical voice once standardised in a 3GPP LTE release. |
| 18. | Commercial augmentation services **SHOULD** provide for appropriate PSMB users to receive and display Emergency Alerts. |
| 19. | Commercial augmentation services **MAY** consider deploying capabilities to reduce the impact of the video demand of PSAs on their networks. |
| 20. | Commercial augmentation services **SHOULD** provide for M2M. |
| Commercial augmentation services **MUST** provide for location services. |
| 21. | Commercial augmentation services **SHOULD** have capability for pre-emption features that guarantee PSMB users access to their network. |
| 22. | Commercial augmentation services **MUST** permit PSAs to define the default priorities of all PSMB users and classes using the augmentation service. |
| Commercial augmentation services **SHOULD** provide a mechanism for PSAs to change the prioritisation of PSMB users on the augmentation service within agreed service level constraints so as to optimise resource use for effective management during an incident. |
| Commercial augmentation services **SHOULD** permit PSAs to control default access restrictions of all PSMB users and classes using the augmentation service. |
| 23. | Commercial augmentation services **MUST** permit PSMBs/ a user under duress to immediately gain maximum network prioritisation and QoS attributes for their IP streams. |
| 24. | Commercial augmentation service providers **MUST** ensure that only appropriately security cleared personnel are able to manage, access or in any way influence the operation of the PSMB capability. |
| Commercial augmentation service providers **SHOULD** establish training programs for all personnel who manage PSMB communications resources. |
| Commercial augmentation service providers **SHOULD** participate as required in any training and exercises for the PSMB. |
| 25. | Commercial augmentation services **SHOULD** make best efforts to offer each jurisdiction some local control over the PSMB capability. |
| 26. | Commercial providers **SHOULD** provide PSAs with prompt trouble reports, restoration reports and information to help facilitate operations using contingency communications. |
| Commercial providers **MAY** develop mechanisms for PSAs to monitor network availability. |
| Commercial augmentation services **MAY** develop mechanisms for PSAs to obtain insight into overall system performance metrics including congestion and coverage. |
| 27. | Commercial augmentation services **SHOULD** maintain backwards compatibility with deployed user equipment. |
|  | Commercial augmentation services **MAY** provide PSA with the opportunity to submit feature requests and comment on network feature priorities. |
| 28. | Commercial augmentation services **MAY** provide PSA with the opportunity to comment on areas of the network that they see as coverage and capacity priorities. |
| 29. | Commercial augmentation services **SHOULD** make best efforts to maximise network availability. |
| Commercial augmentation services **SHOULD** implement an upgrade coordination and notification process with all appropriate PSA partners. |
| Commercial augmentation services **SHOULD** implement a maintenance coordination and notification process with all appropriate PSA partners for all scheduled maintenance that may impact the user experience on the PSMB capability. |
| Commercial augmentation services **SHOULD** perform infrastructure maintenance in such a way as to minimise outage areas. |
| 30. | Commercial augmentation services **SHOULD** offer billing that can provide breakdowns at the device, agency and jurisdiction level of usage. |
| Commercial augmentation services **MAY** offer billing breakdowns at the user level of usage. |

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\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*END OF REPORT\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

1. APCO Project 16B has defined instant push to talk as <= 500ms for voice call setup [↑](#footnote-ref-1)
2. A description of an international emergency preference scheme (IEPS) is described in ITU T Recommendation E.106. [↑](#footnote-ref-2)
3. The importance of that particular requirement to PPDR is indicated as high (H), medium (M) or low (L). This importance factor is listed for the three radio operating environments:

“Day-to-day operations”, “Large emergency and/or public events”, and “Disasters”, represented by P1, P2 and P3, respectively. [↑](#footnote-ref-3)
4. The importance of that particular requirement to PPDR is indicated as high (H), medium (M) or low (L). This importance factor is listed for the three radio operating environments:

“Day-to-day operations”, “Large emergency and/or public events”, and “Disasters”, represented by P1, P2 and P3, respectively. The importance levels contained in this column have been based on table included in Report ITU-R M.2033 and have been updated based on input contributions. [↑](#footnote-ref-4)
5. Ministry of Land, Infrastructure and Transport of Korea has been planning a railway broadband service known as Intelligent Railway Integrated System (IRIS) which provides train safety applications including train control and monitoring. [↑](#footnote-ref-5)
6. Ministry of Oceans and Fisheries of Korea has been planning to provide ship safety broadband services primarily to inshore small vessels which are not equipped with Global Maritime Distress and Safety System (GMDSS). [↑](#footnote-ref-6)
7. The effect on spectrum requirement due to communication at cell edge area and the use of different transmission mode is discussed in other literatures such as ECC Report 199. [↑](#footnote-ref-7)
8. For detail explanation, refer to Recommendation ITU-R M.1651. [↑](#footnote-ref-8)
9. In LTE system, cell diameter for 700 MHz band is in the range of 2 - 3 km. [↑](#footnote-ref-9)