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The Strategic Case for Mission Critical Mobile Broadband

A review of the future needs of the users of critical communications

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Executive Summary

This Strategic Case Document has been developed by the TETRA and Critical Communications Association's (TCCA) Critical Communications Broadband Group (CCBG), representing a wide variety of Mission Critical mobile communications user groups. It sets out the compelling case for providing adequate resources, both spectrum and future investment, to put in place effective Mobile Broadband capabilities to assist all such Critical Communications Users in doing their vital jobs of serving our citizens and communities.

Terrorism and natural disasters are becoming increasingly prevalent in our society. The General Public assumes and expects that our Emergency Services, and those responsible for Critical National Infrastructure (Utilities – electricity, water and transportation), have the right tools to do their jobs and to respond to major and minor incidents quickly, efficiently and effectively. Governments and Regulators have a duty to ensure that those tools are in place.

The term PPDR (Public Protection and Disaster Relief) is used internationally to describe Police, Fire/Rescue, Ambulance and Civil Defence. Others use the terms Emergency Services and Public Safety & Security. They are all equivalent. They provide services which are of vital importance to our communities, and these organisations are mandated by law in almost all countries around the world to deliver the highest possible quality of service to society.

Whilst saving lives and protecting property, the PPDR staff work in very dangerous environments and situations where their employers – the Governments - have the responsibility to ensure that they have a safe working environment and the best possible tools to perform their vital but risky jobs and roles.

PPDR organisations are on one hand enterprises, and like any other enterprise wish to utilize the most modern and innovative mobile communication tools, and yet on the other hand those essential enterprises need communication solutions which are very different to those of ordinary citizens and enterprises. They perform Mission Critical Operations where human life and goods (rescue operations, law enforcement) and other core values of society are put at risk, particularly when time is a vital factor.

Mission Critical communication services are supplied by special communication solutions where reliability, availability, stability and security of the communication service are vital to ensure continuous availability of services that are critical to maintaining the wellbeing of society. Typical users of Mission Critical communications are not just the law enforcement and emergency services, but also the electricity / water / transport sectors, which all form part of the Critical National Infrastructure (CNI). Mission Critical communications include hardware, software, as well as communication facilities (including sufficient radio frequency (spectrum) capacity) to transmit and share information between users in the field and command centres, in a dependable and secure manner.

The question of how such essential services can be provided is very complex. The economics of such services interplay with technical, legal and regulatory aspects. Indeed a highly political subject; Government may build a dedicated network with the functionality required by its emergency services, or may outsource to a commercial operator, or a combination thereof. There is the political angle: Will a government want to exert full control over such essential services that may be considered part of the CNI, or is it satisfied with leaving it to the market forces? Is it politically acceptable to reduce the effectiveness of the emergency service agencies by forcing them to rely solely on the mobile communication services available from mainstream commercial mobile operators? Having control over the technology solution, and critically its underlying radio spectrum and usage, allows the emergency services to adapt their service to meet the evolving needs of society.

Therefore this document articulates the Case for Mission Critical Broadband; it provides justification for the need; it provides an appraisal of the benefits; it considers the technology roadmap; it discusses the socio-economic impacts and it provides a conclusion.

The business models for delivering Mission Critical Broadband are many and varied and are outside the scope of this document. However, the CCBG has produced an additional document that looks at the options in some detail. This document is entitled “Mobile Broadband for Critical Communications Users - A review of options for delivering Mission Critical solutions” and is available from the TCCA website at www.tandcca.com.

Index

Contents

Introduction

Every day another terrorist attack, natural disaster, conflict, major incident or other significant crisis affects citizens and communities somewhere in the world. We all assume and expect that help will come from those that provide Public Protection and Disaster Relief.

At home we expect that our Electricity supply, our Water and our Gas will be provided whenever we need it and without interruption. We expect that Trains and Metros, Ports and Airports will provide safe, reliable and on time transportation services.

It is a reasonable assumption that those that protect the health, welfare and safety of the citizens of this world on a daily basis are equipped with the best tools available to do their job. Fast, efficient and reliable communications are fundamental to the operational effectiveness of these services. This document sets out the case for ensuring that First Responders and those that look after our Critical National Infrastructure will have the benefit of modern Mobile Broadband communications over the coming 15-20 years.

This document has been developed by the TETRA and Critical Communications Association's (TCCA) Critical Communications Broadband Group (CCBG), representing a wide variety of global Mission Critical Mobile Communications user groups, operators and industry representatives. It sets out the compelling case for providing both spectrum and future investment, so as to put in place effective Mobile Broadband capabilities to assist all such Critical Communications Users in doing their vital jobs of serving our citizens and communities.

The aim of this document is to inform interested parties, including regulators, users, suppliers and operators of the justification for the delivery of dedicated Mission Critical Mobile Broadband services. In particular, this document will:

- Explain the 'Value Proposition' for Mission Critical Mobile Broadband;
- Support the case for sufficient spectrum under harmonised conditions;
- Provide justification for this new capability.

This document will not:

- Advocate a specific frequency or solution over another;
- Describe a financial business case.

We commend this Strategic Case to all stakeholders and urge that serious consideration be given to its arguments for adopting Mission Critical Mobile Broadband.

The Current Situation

The requirements of the global professional communications community for Mission Critical voice and data services are currently satisfied by a range of voice-centric Private Mobile Radio (PMR) technologies including TETRA, Tetrapol, P25, and GSM-R. These are all narrowband digital systems and offer excellent voice services but limited data capability. TEDS (TETRA Enhanced Data Service), part of TETRA Release 2, is currently being deployed in Northern Europe and will provide some wideband data services.

Mission Critical Users are characterised by those that work in groups and therefore need to communicate in groups using specific and unique functionality. The communications systems that they use have been specifically designed and optimised to meet this fundamental means of working. Cellular phone technology has been developed for person to person communications and, as such, is unsuitable for Mission Critical Communications. Imagine, for example, a football stadium with a lost child. Communicating a description to several hundred staff by phoning each one would be a hugely inefficient process. Sending a single voice message to all staff simultaneously and efficiently using a PMR system could be accomplished in seconds.

PMR technologies in use in Mission Critical Networks are designed to be highly resilient, deliver high availability, be secure and provide the broad range of functionality that is required by the Critical Communications Users.

The growing demand around the world for access to increasingly bandwidth-hungry data applications in order to be more efficient has resulted in individual user organisations adopting or considering 2.5G/3G/4G consumer devices for data communications. With no other available alternative, they are relying on commercial mobile networks for delivery of those services. Many governmental and other critical communications organisations are seeking to address this issue through new initiatives. Organisations that are considering Mobile Broadband services include:

Mission Critical Users:

- Public Protection & Disaster Relief (PPDR) including Public Safety (Police, Fire and Ambulance);
- Government agencies;
- Military users.

Critical Infrastructure Operators:

- Utilities including Gas, Electricity and Water;
- Power generation;
- Petrochemical ;
- Transport.

The Critical Communications sector has enjoyed the benefit of inter-agency interoperability for their Mission Critical voice services by building one network per country - shared by many agencies. Using harmonised spectrum allocations and common technology standards have provided competition, innovation, more efficient solutions and choice.

The user community has an expectation that, as the use of Mobile Broadband data services increases, these services will soon become intrinsically Mission Critical as well. This has on-going implications for public safety and other such Mission Critical Users of Mobile Broadband services.

The Case for Mission Critical Mobile Broadband

Mission Critical Definition

'Mission Critical' is defined as a function whose failure leads to catastrophic degradation of service that places public order or public safety and security at immediate risk. These systems are paramount to the operation of a nation's public safety and critical infrastructure services and are therefore required to have particular and adequate inbuilt functionality, availability, security and interoperability.

In simple terms, Mission Critical users are those that are responsible for the health, safety, security and welfare of our citizens. Police, Fire, Ambulance, rescue services and specifically the Military would be classed as Mission Critical. Those that ensure the availability of Electricity, Oil and Gas, Water and Core Transport services, without which modern life would quickly degenerate, are also classed as Mission Critical .

What the User wants

Consumer access to Internet Services, Social Media, Video, Image and Text Messaging is already widespread and many of our citizens are becoming reliant on such technologies. Instances of children needing urgent assistance and using social media to call for help are already known. Strategies for the future delivery of emergency call answering services that include interaction with social media, receiving video and images from members of the public are well developed. Today, our Mission Critical users are typically not equipped with such technology and consequently are unable to interact with the population at large. This leads to First Responders using their own personal devices to fulfil their communications requirements.

Some Public Safety organisations have equipped officers with Internet enabled 'Smartphones' and these are providing some mobile data capability. However, coverage is limited to that which the cellular operator considers economically viable, resilience is limited and there is substantial evidence of network outages causing loss of service for hours or days at a time. Such capability demonstrates the benefit of data to the officer on the street but, until service can be provided to the required areas of coverage and at an acceptable availability level, it cannot be widely relied upon for Mission Critical use.

Today, the need for specialist applications is putting pressure on the existing narrowband technologies, meaning that in order to make the most of the next generation of broadband services in support of more efficient Mission Critical operations, these narrowband technologies have to be augmented with a Mission Critical Mobile Broadband capability. The urgent need for delivery of such a capability means that there is a significant 'capability gap' that needs to be filled.

Over the past 12 months user and industry groups across the Mission Critical and business critical sector have held workshops, written papers and collated their respective views on their future requirements.[1] What is clear from this work is that users require more wireless data capabilities in order to make use of advanced applications that can offer efficiencies, help streamline operations, provide quicker response times and ultimately provide the potential to better safeguard the security, wellbeing and prosperity of communities.

In a recent survey[2] eight categories were identified in which professional users have said that they require more data-centric access in the field. Specific applications or uses include:

1. Situational Awareness to/from mobile devices including video, picture, GPS location, mapping;
2. Streaming of live video to Control Rooms and back to groups of mobile users;
3. Facial recognition and instant access to back office databases;
4. Patient record access;
5. Data collection and sharing (From Machine-to-Machine Sensors) and telemetry;
6. Instant gathering and group distribution of picture information;
7. Administrative procedures automation (e.g. forms completed in the field, avoiding further manual transcription, also remote management capability of field equipment);
8. Data exchange between automatic control systems (e.g. signalling between train and ground during high speed running).

In addition to these core areas where users require a Mobile Broadband capability, it has been highlighted that they require a Mobile Broadband service that provides:

- **Point to Point Communications:** to provide access from individuals to other users, to network resources such as back office databases, to Internet sources etc.
- **Group Communications:** Communications across groups of users and multiple groups of users is an important aspect of any Mission Critical communications systems.
- **Prioritization:** A Mission Critical Service will provide prioritisation of communications, based upon a number of parameters including User profile, Incident and Service.
- **Resilience:** Mission Critical Services need to provide a high level of resilience and availability, typically the underlying networks will self-heal and autonomously reconfigure around network failures through Self-Organizing Network (SON) type design.
- **Scalability:** Users will require the availability of different broadband speeds at different times. During a major operation or incident, availability of the service at specific speeds has to be guaranteed.

[1] LEWP Requirements Document (2011)
UIC Requirements(2012)
TCCA Rail Requirements (2012)
JRC Smart Grid Briefing Paper May 2013
EUTC Spectrum Positioning Paper 9th April 2013
EUTC Spectrum White Paper March 2013
[2] TCCA CCBG March 2013 User Needs Questionnaire

- **Secure:** Mission Critical Users, due to the nature of their work, are likely to be passing sensitive and often personal information. They therefore require a Mobile Broadband capability that is secure and cannot be intercepted or 'attacked' by outside parties.
- **Interoperable:** The need for interoperability is of vital importance, both for cross-border operations, information sharing and multi-agency responses to major incidents.
- **Coverage:** On-net, off-net access needs to be provided, regardless of terrain. Incidents may occur outside of network coverage. Availability has to be guaranteed or solutions deployed to enable the Mobile Broadband capability to be delivered from any location.

Mission Critical Users have realised the benefit of inter-agency interoperability for their Mission Critical voice services through access to common spectrum allocation and common technology standards. This is a key requirement for the future provision of Mission Critical data services, especially considering disaster relief activities such as : floods (annually in the Czech Republic, Germany, Austria and others), earthquakes (as in Pakistan, Turkey, Haiti, Japan,…), terrorist attacks (Boston, London, Madrid, 9/11, etc.) and many more.

What is clear from the user needs identified above is that they require the availability of a Mission Critical grade Mobile Broadband capability that can enable the delivery of advanced applications for a variety of different user groups.

Can Mission Critical Broadband be delivered today?

For Mission Critical use, mobile communications need to be available on a nationwide basis, wherever incidents occur and with a guaranteed level of availability.

Cellular network operators are commercial businesses that typically provide infrastructure and coverage only where there is an economic case, such as cities, roads and popular tourist locations. Redundant infrastructure and resilient power supplies are not a generally accepted necessity for most commercial operators.

Major traffic incidents, be it by car, train or even inland shipping can occur away from urban areas, and this is where reliable communications are essential. The risk from terrorism is most apparent in highly populated areas, which are precisely the same areas as those with the highest consumer demand for Mobile Broadband communications. Disasters such as airplane crashes, avalanches, floods or industrial incidents may happen in the most rural areas, outside of any commercial network's coverage. Having the ability to send high definition images and video from the units in the field to a command centre would be highly beneficial to the emergency services. Providing patient telemetry to a hospital from a climbing accident on a hillside could be life-saving. Fast remote switching of electricity can avoid widespread outages occurring with all of the knock-on effects that loss of power can have, including further risk to safety.

There is a real need for Mission Critical Mobile Broadband services to increase the efficiency of these and many other organisations. The question is therefore, how to provide these services?

As part of this analysis, a related document[3] has been prepared by the TCCA looking at the various delivery options that might be utilised to provide Mobile Broadband services. These include:

- Taking service from standard commercial networks;
- Operating as a Mobile Virtual Network Operator (MVNO);
- Taking service from a Commercially Owned Dedicated Network;
- Build Own and Operate a Dedicated Network;
- A Combination Approach;
- Using Satellite Services.

Regardless of which of the above options is best suited to a particular situation there are some fundamental requirements that have to be satisfied.

Funding

With the exception of simply taking consumer services from a standard commercial network, there will be costs associated with setting up a Mission Critical Mobile Broadband service. Funding would be needed either from Government for the Build, Own and Operate model or from third parties for any privately-owned networks. Where a MVNO approach is preferred, there will still be some capital

[3] CCBG Implementation Options Paper

funding required to provide the front end systems that are required to interface into one or more commercial networks.

If a user wishes to go down the consumer services route, but requires a Mission Critical grade of service then it will be necessary to invest in improving the resilience and coverage of the respective commercial network(s). Standby power systems in commercial networks today tend to be limited and network resilience may also need to be improved. If there is an expectation that voice services will be carried over the network then these items take on an even greater level of importance. For users, total costs will need to be well understood.

Spectrum

No mobile radio system can function without appropriate spectrum in which to operate. Mobile Broadband services are no exception. In the case of LTE, blocks of spectrum are required rather than narrowband channels. Current versions of the technology require a minimum of 2 x 1.4MHz of spectrum, although 2 x 10MHz is widely accepted for commercial networks as a minimum for reasons of efficiency, effectiveness and capacity reasons.

Studies conducted both within ETSI and CEPT have concluded that the required bandwidth for Broadband PPDR would be a minimum of 2 x 10MHz and this does not include capacity for Ground to Air services, Direct Mode (set to set) or any additional capacity that is required for voice services.. Clearly that 20MHz of spectrum is not immediately available in Europe (unlike North America), especially in the sub 1GHz area which is necessary for wide area and even nationwide networks. At the same time, we must remember that PPDR is not the only Mission Critical user segment that needs broadband, but the same is true for power utilities and some transport operators.

If service is taken from an existing commercial operator - spectrum would already have been licensed to the cellular operator for a significant sum. The operator will want to maximise their Return on Investment, so if the PPDR users' needs to have priority access to capacity it will be at a premium. Additional spectrum could be made available to a chosen operator enabling him to provide the capacity when and where needed. When not needed by PPDR, the operator could be allowed to use the spectrum for his own profit making purpose. Spectrum would not be un-utilised. Even with additional spectrum, the operator would have to meet additional needs such as a very high degree of availability, special implementation requirements and will result in very stringent contractual commitments in order to deliver some type of guaranteed service. A question remains if mainstream operators would be willing to enter into such stringent contractual commitments.

The TCCA has two fundamental objectives: (a) driving common technology standards for Mission Critical Mobile Broadband systems globally, and (b) targeting harmonised spectrum in which to operate such systems. These objectives increase competition, reduce equipment prices and encourage innovation. Whilst the objective of global standards is possible to achieve, the harmonisation of spectrum internationally is more difficult. It is also recognised that individual countries may make some spectrum available for critical communications users on a national basis.

This need is well documented. The 27 European Union Ministers of Justice and Home Affairs recommended in 2009 that dedicated spectrum for future Mobile Broadband solutions should be

found. European Law[i4] was passed in 2012 which stated that "The Commission shall, in cooperation with the Member States seek to ensure that sufficient spectrum is made available under harmonised conditions to support the development of safety services and the free circulation of related devices as well as the development of innovative interoperable solutions for public safety and protection, civil protection and disaster relief" and in 2013 the CEPT/ECC report (Report 199) was agreed amongst all 48 member states, documenting an analysis that substantiates a minimum of 2 x 10MHz is required.

The next World Radio Conference in 2015 represents a rare opportunity to have sufficient spectrum under harmonised conditions for Mission Critical users in Europe, the Middle East and Africa allocated.

[4] DECISION No 243/2012/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 March 2012

Justifying the need

What the users want and why they need it is very important when justifying the provision of any capability, and in particular the gap that exists between what users have today and what they need in the future. The following table has been developed following analysis of significant amounts of research that has been conducted from a wide user base, including CEPT FM PT49, Law Enforcement Working Party, International Railways and the UTC. The high level objectives and comparison in achieving these objectives between the narrowband capability available today compared with the broadband capability available in the future is shown in Table 1 below:

Objective	Can additional benefit be deliver with current technology?	Note	Can additional benefit be delivered with future technology?	Note
Personal safety of operatives with immediate status and emergency alarming facilities	+++	Small amounts of prioritised data can provide an immediate service, even on narrowband systems	+++	Broadband networks can provide the same service
Improved operational effiency - efficient resource allocation	++	Low speed data, limits the ability to provide enhanced applications that can provide these efficiencies	+++	Use of vehice, person location services, mapping applications and smart real time routing. Use of smart reporting means staff do not need to return to base so often
Providing ability to interact directly with the public	++	Interaction with the public only available through voice, text messaging and low definition pictures	+++	Enhanced provision of interaction with social media and picture imaging applications will enable better informed and more reliable decision making, especially in the field
Allow automated train-control/signalling systems (ERTMS and beyond)	++	Narrowband technology provides limited services	+++	Enhanced in-cab signalling with live video streaming can be provided
Improved operational effiency - Improved response times for Mission Critical Users	++	Low speed data, limits the ability to provide enhanced applications that can provide improved response times	+++	Providing better information to mobile resources incuding routing instructions
Improved operational effiency - Provide cost savings	+	Low speed data, limits the ability to provide enhanced applications and cannot provide the added awareness that video gives which can provide savings.	+++	Provision of smarter applications using broadband data capability and better command and control awareness with video will deliver more efficient operations thus saving time and money.
Increased officer safety through availability of live video	+	Benefits of Video cannot be delivered so informed decisions cannot be made	+++	Sending video from incident scenes enables supervisory staff to make informed decisions
Enhanced safety of the public	+	Narrowband technology cannot deliver the services required	+++	Improved repsonse times, improved surveillance and security checking, potential for use of facial recognition, augemented reality and other advanced techniques all add to increased public safety
Contributes to saving more lives	+	Narrowband technology cannot deliver the services required	+++	Enhanced telemedicine, remote diagnostics, machine-to-machine sensors and remote threat analysis applications will save lives

Key: + Limited Additional Benefit, ++ Some Additional Benefit, +++Significant Benefit

Table 1: Gap Analysis between Narrowband Technologies today and future Mobile Broadband

The findings from this analysis clearly identify that a major gap in capability exists and that the future provision of Mobile Broadband will enable this gap to be filled.

Furthermore, a recent UK research study (LSE, 2013)[5] involving senior frontline police officers has identified that a number of mobile data applications in use today support safety-critical decisions being made by frontline officers where lives are saved or serious injury avoided. However the vast majority of these data applications are not Mission Critical in the sense that, if they fail, then officers can revert to using Mission Critical voice provided by the nationwide TETRA operator (LSE, 2013).

This same study also highlights that in the next 5-10 years there are likely to be many more data applications that are safety-critical together with emerging mobile video applications that will enhance situational awareness and collaboration. The majority of these applications are expected to be Mission Critical given the amount, complexity and richness of information that they will convey to field officers. This information cannot be substituted, in an operational sense, by voice communications. In light of this, the absence of a suitable Mission Critical Mobile Broadband service that can convey PPDR data and video applications will place at risk the safety of the public and frontline officers.

In order to enable users to make the best use of new modern day applications that can help the public remain safe, operations to be more effective, response times to be more efficient, and officials to be better informed, advanced information capture and exchange enabled through a Mobile Broadband capability is required.

While voice will remain an essential application, most users of existing technologies need a seamless migration to improved Mobile Broadband capacity and are seeing that, the benefit of multi-media applications to the General Public, clearly influences the aspirations of Mission Critical organisations. Delivering a Mission Critical broadband capability to the users is important for the following reasons:

- **Growing Mobile Data Requirement:** All operations can make use of the growing amount of data that is available for greater situational awareness and more efficient use of resources.
- **Informed Decision Making:** A wide variety of advanced applications will enable decision making to be more efficient, helping to save lives and protecting critical national infrastructure. Decision making, especially under pressure, requires data and information to be evaluated, interpreted and acted upon. Therefore, informed decision-making requires information that must be **relevant**, **timely** and **accurate** (the right data at the right time at the right place).
- **Data will be Critical:** As the utilisation of data services and advanced applications becomes engrained in daily operation, data will no longer be a useful add-on but, instead, become a Mission Critical service; as important as voice and requiring the same level of service.
- **Quality Information:** Information quality is not only required during emergency situations. For example, corrupted, missing or late information can be the cause of the derailment of a train, a wrong decision made by our utilities or energy companies switching off the wrong power transformer or a Mission Critical user making the wrong decision that ultimately leads to loss of life. Accurate and reliable information has to be available all of the time regardless of the scenario.

[5] Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the EU
Dr Alexander Grous, Centre for Economic Performance, London School of Economics and Political Science

The key benefits from the success of delivering and operating a Mission Critical Mobile Broadband capability can be summarised as:

- Improved Efficiency for Resources.
- Improved situational awareness including improved Information and Intelligence Gathering and Sharing.
- Improved decision making.
- Cost Effective operations.
- Improved safety, saving lives, protecting property.

The Availability of Technology and the Timeline

LTE and LTE-A (4G mobile communications) are the next generation technologies widely expected to address bandwidth limitations on all mobile networks. For Mission Critical communications, it provides high bandwidth data and offers a common technology platform on which to implement required features such as group communications.

Although first-phase consumer LTE networks are already being rolled out in some regions, LTE-based data services for Mission Critical communications which fully meet users' requirements and allow for interoperation with, and an evolution path from, existing technologies in different regions as well as a wide range of cost effective manufacturers terminals and equipment are not expected to be practically available until about 2018 at the earliest. Further information on this and related topics is published in a white paper: ***'Mission Critical Mobile Broadband: Practical standardisation & roadmap considerations'***.[6]

The delay in suitable equipment coming to market is not a reason for complacency or delay in decision making on the topic of Mission Critical Mobile Broadband. In the interim, considerable work has to be completed on defining, standardising and implementing the technology, plus a harmonised and dedicated spectrum in which to operate has to be found and assigned globally.

[6]The full text of the white paper can be found here

The Socio-Economic Benefits of Mission Critical Mobile Broadband

Whilst socio-economics are primarily utilised by governments and regulators to understand which strategic options under consideration are likely to deliver the greatest benefits to society and the wider economy, it is also valuable for PPDR users and other key stakeholders such as the public at large to gain an appreciation of the benefits that the PPDR community (through their interventions) could provide with the use of this new technology.

Determining the socio-economic benefits regarding any future technology are inherently complex and challenging, as evidenced historically by the lack of studies in this area. However, a number of recent studies by the London School of Economics (2013;2013a) and WIK Consult have generated findings that assess these benefits in both qualitative and quantitative terms that can be readily digested and appreciated by key stakeholders[7]. Prior to introducing the findings from these recent socio-economic studies, it is prudent to provide a brief background context to the opportunity that confronts us with regards to spectrum.

Given that:

- Some European governments have plans to replace existing voice networks with solutions based upon LTE;
- the existing harmonised spectrum allocated to TETRA is currently utilised and, for the majority of deployed networks, will continue to be so until such time as a suitable migration path to Mission Critical Mobile Broadband technology can be supported;
- the future Mission Critical Mobile Broadband technology will include voice, data and video capabilities in order to eventually substitute TETRA functionality, and will therefore require a minimum of 2x10MHz (ETSI, 2013; ECC Report 199, 2013);
- the continual technological advancements in consumer mobile devices, software and applications are generating a wealth of benefits to society but at the same time inevitably raising the capabilities of rogue elements to create havoc, disruption, damage and risk to life (Riots, Communities and Victims Panel, 2012);
- the growing threats and impacts to the national economies and society from cyber-attacks, such as those identified by the UK Government (Cabinet Office, 2011), associated with the Internet, and by implication the Mobile Internet, including but not limited to, potential large-scale denial of service;
- the threat of European natural disaster loss (WIK, 2013), such as but not limited to, the large numbers of people impacted by a natural disaster, the considerable potential for property damage, and the risk to social cohesion in the aftermath of a disaster. It is clear that even small improvements in the effectiveness of PPDR could have significant benefits. Furthermore, it is clear that there is ample room for improved ability to coordinate and interoperate during such incidents;

[7] For the LSE and WIK reports see http://www.tandcca.com/assoc/page/13043

Then the socio-economic benefits of allocating Mobile Broadband spectrum to PPDR and Mission Critical Users for the purposes stated above would be:

- to avoid the increased risk to the safety of Emergency Services' personnel, and also the public at large, associated with the inadequate provision of Mission Critical Mobile Broadband voice, data and video services that would be required by the Emergency Services to continue to safeguard the public in the current and future threat environment. This socio-economic cost is potentially in excess of £5bn per annum (LSE, 2013) and could equate to thousands of lives and over 100,000 serious injuries;
- to support the continued growth, adoption and innovation in the use mobile technology by the Emergency Services that could drive greater levels of organisational efficiency and effectiveness across Criminal Justice Systems; citing the UK as an example, today the Criminal Justice System costs circa £12bn annually to manage crime that currently costs the UK economy circa £36bn (Home Office, 2000; 2005; 2011) – these expected improvements to efficiency and effectiveness are estimated to provide socio-economic benefit of between £4bn to £12bn per annum in the UK alone (LSE, 2013);
- to enable the possibility of a globally harmonised 700 MHz frequency range for PPDR products and services that could deliver the greatest economies of scale, encourage new competition and innovation in the industry, whilst at the same time providing Emergency Service Users with the future capabilities they will need and minimising the burden on the taxpayer (LSE, 2013). Additionally, interoperability of equipment for incidents that involve multiple countries (either because they occur at a border, or because they cover a large geographical area) and the ability to seamlessly loan PPDR teams from one country, or region, to another in times of need (WIK, 2013).

Furthermore, the findings of the LSE report on the EU PPDR context (LSE, 2013a) indicate that the benefits of Mission Critical mobile broadband to society that constitute the EU28 region could total in the region of €34 billion on an annual basis which is likely to far exceed the opportunity cost of the corresponding spectrum (that enables the technology and service) being auctioned off to commercial operators. Considering these figures alone, the case for spectrum being provided to PPDR organisations to deploy Mission Critical mobile broadband services might appear to be a fait accompli. However, the reality is far from this and interested stakeholders are strongly encouraged to publicise and debate these benefits such that hearts as well as minds can be won over given the overwhelming benefits that this new technology is likely to afford.

Conclusion

Terrorism and natural disasters are becoming increasingly prevalent in our society. The general public assumes and expects that our Emergency Services, and those responsible for Critical National Infrastructure, have the right tools to do their jobs and respond to major and minor incidents quickly, efficiently and effectively. Governments and Regulators have a duty to ensure that those tools are in place.

The availability of Mobile Broadband services has created a new world in communications whether it is for Internet access, social media or information exchange. The general public regularly shares images and videos, thoughts and experiences using smartphones, tablets and laptop computers. Now is the time to provide our Critical Communications Users with the same capability that is already widely in use by the public - including our school children.

A Mobile Broadband capability will not only improve our Emergency Services' response times and capability but also save lives, avoid serious injury, increase efficiency and reduce costs for many agencies. Surveys have been undertaken that confirm the needs and identify the most important applications for future Mission Critical Mobile Broadband services. The European Law Enforcement Working Party has undertaken a detailed analysis of needs for their user groups and similar studies have been undertaken by other Critical Infrastructure organisations.

If the need for Mission Critical Mobile Broadband is proven, then the question is: how should it be delivered? Commercial Cellular Operators may well have a role to play in the provision of Mobile Broadband data, especially in the short term. However, current Mobile Broadband standards have significant limitations in providing adequate capability for Critical Communications Users. The TETRA and Critical Communications Association is working internationally with like-minded organisations to assist Standards Development Organisations in adding the necessary functionality to the LTE (4G) standard.

It must also be recognised that, with the exponential growth in traffic that cellular operators are experiencing, it will become increasingly difficult for commercial cellular network operators to reserve capacity for Critical Communications use. Coverage is also likely to remain limited in rural areas.

A variety of options exist for delivering Mission Critical Mobile Broadband services and some of these include working with Cellular network operators, but all of these options will require both spectrum and investments. This paper argues that Mission Critical service cannot be sourced from a mainstream operator and identifies the rationale for why spectrum and investments are required to protect our citizens and maintain our critical services.

In closing, it is important to note that, for the existing Mission Critical narrowband users, a smooth migration path towards mobile broadband and the related service continuity is an absolute necessity. There needs to be a delivery roadmap which enables organizations to continue with their existing operational models, control rooms and narrowband solutions at the same time as new Mission Critical mobile broadband solutions and services are being introduced.

Definitions and abbreviations

2G	2nd Generation Cellular radio technology
3G	3rd Generation Cellular radio technology
3GPP	3rd generation Partnership Project – the organisation responsible for the LTE standard
4G	4th Generation cellular radio technology
CCBG	Critical Communications Broadband Group. A working group of the TETRA and Critical Communications Association
CEPT	European Conference of Postal and Telecommunications Administrations – a coordinating body for European state telecommunications
CNI	Critical National Infrastructure typically includes the Utilities (Gas, Electricity and Water) , Transportation (Rail and Metro, Buses and Trams, Ports and Airports) and other critical industries without whom society would quickly break down
EC	European Commission
ETSI	European Telecommunications Standards Institute
EUTC	Utilities Telecom Council –an Association of Utility organisations in Europe
FCC	Federal Communications Commission – the US regulator
FirstNet	First Responder Network Authority (FirstNet)is an independent authority whose task is to provide emergency responders with the first high-speed, nationwide network dedicated to public safety in the USA
GSM-R	Global System for Mobile Communications - Railways
ITU	International Telecommunications Union – coordinates the shared global use of the radio spectrum
LEWP	Law Enforcement Working Party
LTE	Long Term Evolution – the latest standard for cellular communications. LTE provides higher data rates than 3G UMTS but is not quite a 4G technology
MCMBB	Mission Critical Mobile Broadband
MNO	Mobile Network Operator – A commercial cellular network Operator
MVNO	Mobile Virtual Network Operator
PMR	Private Mobile Radio technology provides group based radio communications for business and professional users
PPDR	Public Protection and Disaster Relief is a term that encompasses the traditional Public Safety organisations and also major incident rescue services
SON	Self-Organising Network
TCCA	TETRA and Critical Communications Association (see www.tandcca.com)
TEDS	TETRA Enhanced Data Service
TETRA	Terrestrial Trunked Radio - a digital trunked mobile radio technology
Tetrapol	A technology developed for the French Gendarmerie and in use by a number of Public Safety agencies in various parts of the world
UIC	Union Internationale des Chemins de fer' - the French-language acronym for the International Union of Railways

Annex A

Spectrum

In the world of mobile communications, spectrum is a fundamental resource without which mobile communications cannot take place. In Public Safety and other Critical Communications sectors spectrum is already limited and barely sufficient to provide the core voice services required by these users. If Mission Critical users are to take advantage of Mobile Broadband data services then additional spectrum is required.

In the USA, Congress has allocated 2 x10MHz of 700MHz spectrum to Public Safety users for Mobile Broadband in addition to the spectrum already set aside for voice services. Recent reports including the ETSI SRDoc[8] suggest that this amount of spectrum is the minimum required by Public Safety agencies in Europe for conventional services. An independent report for the German Government[9] concluded that 10MHz in the downlink and 15MHz in the uplink was the minimum for German requirements. None of these stated minima include air to ground operations, direct mode (device to device) operation or any allocation for non-public safety use.

It is clear that there are a number of options for providing Mobile Broadband services for critical communications users. These include taking service from commercial cellular operators, operating as an MVNO, building and operating a dedicated network, and other solutions. These options are described in a separate document produced by the TCCA entitled “Mobile Broadband for Critical Communications Users - A review of options for delivering Mission Critical solutions”

Regardless of the implementation option chosen for any particular circumstance, there are many reasons for ensuring that Critical Communications users have access to dedicated spectrum in the long term, even if that spectrum is temporarily leased to a commercial operator. Only in this way can critical communications users be secure in the knowledge that, should the commercial operator go out of business, have ownership transferred, or simply be unable to provide the required level of service, that they have spectrum rights in which to implement alternative solutions.

The need for harmonised spectrum

Whilst, in principle, it may seem plausible for each national administration to allocate such spectrum as it feels appropriate and from within its own allocations, there are several reasons why a coordinated (or harmonised) approach should be achieved as widely as possible, ideally globally.

Experience of the past with relief activities in the aftermath of disasters in Haiti, Turkey, Pakistan, etc. have shown, that more and more international coordination is undertaken and First Responders and PPDR organisations from all continents are working together on scene. Such collaboration

[8] Title: Electromagnetic compatibility and Radio spectrum Matters (ERM);System reference document; Land Mobile Service; Additional spectrum requirements for future Public Safety and Security (PSS) wireless communication systems in the UHF frequency range.
This document is downloadable from ETSI - http://pda.etsi.org/pda/queryform.asp Search for TR102628 LEWP 2012

[9] PPDR Spectrum Harmonisation in Germany, Europe and Globally, WIK 2010

requires a high degree of interoperability between organisations (example Haiti: 2500 different satellite images, photos, maps etc. had to be shared between the organisations acting there).

Modern communication systems and devices require an ever increasing investment in time and money and the historical practice to produce country specific equipment variants simply is no longer feasible with broadband technologies for Critical Communications use. This is why the Mission Critical user community and industry have chosen to adopt the LTE standards to take benefit from the mass market software protocols and semiconductor chip sets as key enablers of Mission Critical Broadband equipment. The same is also true for frequency variants of the equipment, especially with the lower market volumes required for Critical Communications use. The required market size is much bigger than a typical European country.

Public Safety and PPDR[10] services in many countries need to respond to situations that may span international borders and/or involve multiple critical communications organisations. In some parts of the EU/Schengen area this is common and almost daily practice. Harmonised spectrum enables responders to roam seamlessly across borders and intercommunicate with ease in order to respond effectively where lives are at risk.

Recognizing that harmonized spectrum is a limited resource, we consider that it will be almost impossible for the various critical communications organisations that are mentioned throughout this document, to each have their own dedicated spectrum made available. However, we take the view that a single government controlled multi-organisational network based on harmonised spectrum and using open standards will be the most cost effective solution. Given this, national governments should therefore motivate all essential critical infrastructure services to use this highly resilient wireless government intranet.

Spectrum Options

As already noted, spectrum is managed and controlled on a national basis. However, the World Radio Conference of the ITU sets the overall framework by updates to Radio Regulation, where frequencies are allocated to broadcasting, fixed, mobile, fixed satellite or mobile satellite services on a regional basis. The ITU splits the world geography into three regions. Broadly speaking these can be defined as:

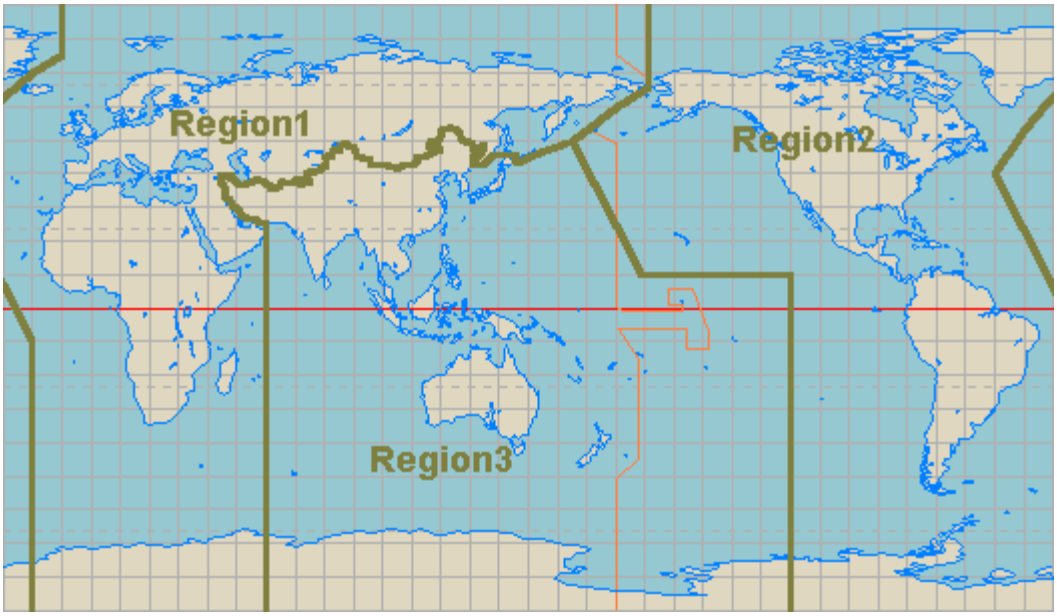
Region 1 - Europe, Russia, Middle East and Africa

Region 2 - Asia Pacific

Region 3 - North and South America

The countries inside each Region have further established regional regulatory organisations, such as the ECC/CEPT in Europe, to prepare and agree more detailed level spectrum decisions and recommendations.

[10] PPDR - Public Protection and Disaster Relief



Region 1 - EMEA

European administrations are in the middle of making preparations for WRC-15 on implementation of a co-primary mobile allocation between 694 and 790MHz for Region 1 as decided in WRC-12. Alignment with the lower part of the Asia-Pacific 703 – 803MHz band with 2 x 30MHz capacity seems currently the strongest candidate. If this approach is confirmed in WRC-15, there is a possibility that the same single band LTE device would be usable everywhere outside North America.

At the same time the ECC/CEPT is working on Broadband PPDR reports with Report 199 concluding the BB PPDR spectrum need to be "in the range 2 x 10MHz" while noting that some cases may need more. Currently the identified candidate BB PPDR bands are 410 – 470MHz and 700MHz but this discussion is not yet complete. Currently CEPT member administrations are emphasizing the national sovereignty of the member states to make BB PPDR spectrum decisions on national basis. It should be noted that the 400MHz bands are heavily used in some countries making harmonisation in that band extremely problematic.

The 700MHz mobile use represents a rare opportunity to grant harmonised spectrum for the users of critical communications in multiple Regions, including Europe. Whilst Public Safety has already identified 2x10MHz as a minimum requirement, it is not unreasonable to assume that 2 x 15MHz would be sufficient to cover the needs of all Critical Communications users including the Utilities, Transportation and others.

Region 2 - Americas

As already stated, USA and Canada have already allocated 2 x 10MHz for Public Safety Broadband in 758 – 768 and 788 – 798MHz. South American countries seem to consider a different 700MHz mobile band plan in line with the Asia- Pacific mobile band between 703 and 803MHz. It is too early to estimate how possible Broadband PPDR frequencies would be arranged in Latin America.

Region 3 – Asia Pacific

Asia-Pacific Tele-community is writing recommendations on use of part of the 703 – 803MHz for Public Safety. So far Australia has identified 2 x 5MHz for Broadband Public Safety in the 800MHz LMR band. China is planning to use TDD LTE for Broadband Public Safety in 1.4GHz.

Spectrum Requirements

We conclude that the highest priority should be to support the preparatory activities for WRC-15 agenda to maximise the chance of having PPDR taken into account and to ensure early release of harmonised spectrum for PPDR broadband after WRC-15.

In the short to medium term, we recommend:

- Governments should work together to reserve enough harmonised spectrum for dedicated Mobile Broadband networks serving PPDR as well as energy, transport and other essential sectors.
- Governments should start planning for such a network now.
- Government agencies should start now to build organizational capability.

Annex B All referring documents.

Cabinet Office (2011)	The UK Cyber Security Strategy. Protecting and promoting the UK in a digital world. Cabinet Office. www.gov.uk/government/uploads/system/uploads/attachment_data/file/60961/uk-cyber-security-strategy-final.pdf
ETSI (2013)	FM49 (13)004 – LEWP-ETSI Matrix with spectrum results.xlsx. ETSI. Published 28 January 2013.
ECC Report 199 (2013)	User requirements and spectrum needs for future European broadband PPDR systems (Wide Area Networks)
Home Office (2000)	The economic and social costs of crime. Home Office Research Study 217. Brand, S & Price, R. London: Home Office. webarchive.nationalarchives.gov.uk/20110218135832/rds.homeoffice.gov.uk/rds/pdfs/hors217.pdf
Home Office (2005)	The economic and social costs of crime against individuals and households 2003/4. Home Office Online Report 30/05. Home Office. webarchive.nationalarchives.gov.uk/20110218135832/rds.homeoffice.gov.uk/rds/pdfs05/rdsolr3005.pdf
Home Office (2011)	Revisions made to the multipliers and unit costs of crime used in the Integrated Offender Management Value for Money Toolkit. September 2011. Home Office. www.gov.uk/government/uploads/system/uploads/attachment_data/file/118042/IOM-phase2-costs-multipliers.pdf
LEWP	Law Enforcement Working Group – RCEG Requirements Matrix 2011
LSE (2013)	The Socio Economic Value of Mission Critical Mobile Applications for Public Safety in the UK: 2x10MHz in 700MHz. Grous, A. London School of Economics.
LSE (2013a)	Socioeconomic value of Mission Critical Mobile Applications for Public Safety in the EU: 2x10 MHz in 700 MHz in 10 European countries. Grous, A. London School of Economics.
RCVP (2012)	After the riots: The final report of the Riots Communities and Victims Panel. webarchive.nationalarchives.gov.uk/20121003195935/http:/riotspanel.independent.gov.uk/wp-content/uploads/2012/03/Riots-Panel-Final-Report1.pdf
TCCA Rail Requirements	TCCA Rail Requirements 2012 www.tandcca.com
TCCA Implementation Options (2013)	Mobile Broadband for Critical Communications Users A review of options for delivering Mission Critical solutions www.tandcca.com
WIK (2010)	PPDR Spectrum Harmonisation in Germany, Europe and Globally
WIK (2013)	The Need for PPDR Broadband Spectrum in the bands below 1GHz

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[i] Article 8.3 of the Radio Spectrum Policy Program