Submission to the Australian Government Productivity Commission's Issues Paper "Public Safety Mobile Broadband"

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1. Introduction

This Submission provides a response to the Productivity Commission's Issues Paper titled *"Public Safety Mobile Broadband"* published in April 2015 and based upon the Terms of Reference issued to the Commission by the Federal Treasurer in March 2015 in accordance with the Productivity Commission Act 1998.

The Submission is made on behalf of the following organisations:

- The University of Melbourne Centre for Disaster Management and Public Safety (CDMPS) www.cdmps.org.au;
- The Victorian Spatial Council (VSC) www.vsc.org.au;
- The Association of Public Safety Communications Officials (APCO) Australasia www.apcoaust.com.au

These organisations welcome the opportunity to continue to build upon their previous Submissions to a range of papers released by Commonwealth Departments addressing individual components of the mission critical public safety communications ecosystem as follows:

- December 2011 – DBCDE Review of the Integrated Public Number Database;
- February 2013 - ACMA "The 803-960 MHz band – exploring options for future change"
- August 2014 – Department of Communications Triple Zero Review

2. Submission Context

Question Analysis

To provide context to the preparation of this Submission the 67 questions in the Commission's Issues Paper were examined to identify the key themes and priorities within the Paper. Using the narrative in each question this examination identified 19 key themes which were ranked according to the number of questions asked in each theme. The results of this analysis are shown in Appendix A.

As expected "cost" is the major theme for the Issues Paper closely followed by "demand, capacity and capability" and "sources of information and evidence".

While 24 of the questions related directly to "cost" a further 13 questions covered associated areas such options, opportunity cost, broadband and land mobile radio substitution, and cost benefit analysis parameters i.e. a total of 37 questions or 55% of the questions relate to the cost theme.

Of the remaining questions 24 or 36% focus on matters related to "design parameters". The remaining 6 questions or 9% address what this Submission believes are the three core issues that the Commission's Study must address *before* any consideration can be given to the cost of a Public Safety Mobile Broadband (PSMB) capability for Australia's Public Safety Agencies (PSAs), the Cost Benefit Analysis (CBA) or design parameters.

These three core issues are;

(a) The definition for *mission critical data* used in public safety communications;

(b) The use of internationally accepted *open standards* for a PSMB capability;

(c) The *spectrum* required for a PSMB capability.

In the context of these three core issues the following associated questions also need to be answered:

(d) How will the social benefits associated with PSMB capability be considered in the CBA?

(e) How valid is the use of Opportunity Cost in the pricing of spectrum for a PSMB capability?

The analysis also shows that many, if not all the questions are interrelated to varying degrees and that many will need to be considered by their extension to the following matters not specifically covered in the Issues Paper;

(f) Governance;

(g) Organisational change;

(h) Culture change;

(i) Transparency;

(j) Trust.

The provision of a PSMB capability is but one component in a mission critical public safety communications ecosystem that is rapidly changing from complicated to complex as part of the transition from analogue to digital; narrowband to broadband and hence mainstream information and communications technologies (ICT); and the transformation in service delivery capability and capacity to meet community expectations.

To illustrate these changes and provide further context to the Commission's Study a Discussion Paper has been prepared that examines the nature of mission critical public safety communications and considers how Next Generation (Web 2.0) technologies including a PSMB capability will influence future PSA operational and communications environments reliant on the ecosystem to deliver public safety outcomes. This Paper is provided at Appendix B.

For these reasons the infrastructure required by the ecosystem should be treated as critical infrastructure in a manner consistent with other critical sectors considered essential to the social wellbeing and economic prosperity of Australia's communities.

On the basis of the identification and prioritisation of the themes within the Commission's Issues Paper and our collective views on the future of the mission critical public safety communications ecosystem the following statement was developed to form the foundation for the preparation of this Submission to the Commission.

To contribute from an evidence-based perspective to discussion of available options to provide Australia's PSAs by 2020 with a resilient, sustainable, secure and interoperable mission critical PSMB capability with the capacity to meet future varying community demand for service and performance.

3. SUBMISSION OUTCOMES

Consistent with the Statement this Submission has developed a range of Outcomes for the Commission's consideration and further conversation during the course of the Commission's Study.

These Outcomes are summarised as follows:

1. The three core issues that must be addressed before any consideration can be given to the cost of a PSMB capability are; the definition for mission critical public safety data; use of internationally accepted open standards; and the quantity and frequency of broadband spectrum required;

2. PSAs need to have the opportunity to actually experience and research the potential impact of a PSMB capability on their operations, organisational structure, culture and hence resilience;

3. Mission critical Land Mobile Radio (LMR) and mission critical broadband (fixed and mobile) must be considered as compatible in the context of the mission critical public safety communications ecosystem and NOT competitive or directly substitutional, at least for many years to come;

4. At this point in time no individual organisation is in a position to accurately predict the amount of broadband spectrum that PSAs will require;

5. Given the increasing value of spectrum PSAs must be able to demonstrate the operational and service delivery benefits from the use of allocated spectrum to justify the retention of this spectrum;

6. The lack of transparency around Australia's input to the Australia Pacific Telecommunity (APT) Region 3 spectrum Plan and also the ITU 2015 World Radio Congress is of particular concern.

7. The PSMB capability is about data and NOT voice at this point in time;

8. The infrastructure required by the mission critical public safety communications ecosystem should be treated as critical infrastructure in a manner consistent with other critical sectors considered essential to the social wellbeing and economic prosperity of Australia's communities.

9. The 3GPP has acknowledged the difference between commercial LTE standards and mission critical for a PSMB capability;

10. Given the ACMA decision on PSMB spectrum allocation to PSAs is significantly different to the decisions made by Governments of other countries there is a need for research to understand the reasons for this difference.

11. The capability and capacity that the NBN may be able to provide to the PSMB capability needs to be included in the Commission's Study.

12. Arrangements need to be put in place to capture lessons learned from PSA use of commercial mobile broadband services to inform the scoping of the PSMB capability;

13. The period between 2020 and 2040 should be used as the timeframe for the CBA in the Commission's.

14. The hybrid option would seem to best fit the current environment in which both the PSAs and the PSMB capability providers may develop their understanding of each other's needs and the risks and the benefits associated with both.

4. PUBLIC SAFETY MOBILE BROADBAND

Responses to Questions

The following provides responses to the questions posed in the Productivity Commission's Issues Paper.

The Commission's Proposed Approach

Q1. What is the merit (or otherwise) of the proposed approach to undertaking first principles analysis in this study?

The Commission's proposed approach of taking a first principles analysis to its Study is supported because it will inform discussion about the public interest arising from providing Australia's PSAs with a PSMB capability matter based upon the understanding that:

> Public Interest[1]
>
> '*public interest' refers to considerations affecting the good order and functioning of the community and government affairs, and the well-being of citizens however acknowledging what is in the 'public interest' is incapable of precise definition as there is no single and immutable public interest[i]";*

and that a Cost Benefit Analysis (CBA) (as used for the National Broadband Network (NBN[2])) into providing the PSMB capability will;

> *"inform the development of Federal and State policy by systematically assessing the extent to which the social benefits of pursuing a particular government policy or project exceed the social opportunity costs, given economic and other constraints.*

While supporting the Commission's proposed approach this Submission recommends that the Commission should include in the analysis the following propositions aimed at driving the development of national policy to inform and guide complimentarily State and Territory strategies that will deliver Australia's Public Safety Agencies (PSAs) with a PSMB capability:

(a) The PSMB capability, at this point in time, is concerned with mission critical data and NOT mission critical voice;

(b) The PSMB capability must be based upon internationally accepted open standards;

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[1] *NSW Ombudsman Public Sector Agencies Fact Sheet No 16*

[2] Cost-Benefit Analysis of Public Investment in High Speed Broadband Network Infrastructure: An Analytical Framework - May 2014 - Dr Alex Robson Director, Economic Policy Analysis Program Department of Accounting, Finance and Economics Griffith University

(c) The PSMB capability will require an agreed definition for ''mission critical" data be developed;

(d) The PSMB capability will be a key component in meeting the expectations/assumptions of Australia's communities that PSAs possess the communications capability and capacity to deliver services to meet their needs;

(e) The PSMB capability will be but one component of a fully integrated mission critical public safety communications ecosystem;

(f) The PSMB capability will become a primary means of multimedia information exchange between communities and the PSAs.

(g) The PSMB capability will utilise the capability and capacity of the NBN;

(h) The PSMB capability will be developed on the basis of spectrum allocation achieving maximum harmonisation within Australia and if possible within International Telecommunications Union (ITU) Region 3; and

(i) The PSMB capability requirements will be different when operating under business as usual conditions and when responding to emergencies or extreme events.

Q2. What domestic or international developments, reports or experiences in PSMB (or related matters) are relevant to consider in this study?

A considerable body of international information and knowledge about PSMB capability already exists having been produced by industry associations, standards bodies and research organisations.

This body of knowledge has and is informing decisions being progressively made by governments, bureaucracies and regulators about the allocation and use of scarce resources i.e. spectrum and funding, to provide a PSMB capability that will allow PSAs to deliver services that meet increasing community expectations and at the same time build community resilience.

The initial consideration undertaken in the development of this body of knowledge was the amount of broadband spectrum required by the PSAs and its frequency band. Decisions about this spectrum were based upon the PSAs limited understanding of the new capabilities and benefits that a PSMB capability will provide to service delivery arrangements through changes to operational doctrine, organisational structure and cultural.

While 20 MHz of spectrum in the 700 MHz band has become the broadly accepted international benchmark for a PSMB capability no single organisation can claim to be able to accurately predict the amount of spectrum required by a PSMB capability either now or in the future. PSAs need to have the opportunity to actually experience and research the potential impact of this capability on their operations, organisational structure, resilience and culture.

The serial survey by the Royal United Services Institute (RUSI)[3] in the United Kingdom on the potential use of PSMB capability initially had PSAs identifying video capability as a "must have" but with the ability to reconsider the use of this capability the RUSI survey has identified a significant drop in video capability as a PSA "must have" which will subsequently impact spectrum allocation.

[3] https://www.rusi.org

The Productivity Commission therefore has the opportunity to collect, analyse and synthesise the findings, recommendations and outcomes from this existing body of information and knowledge to produce an Australian contribution to the international conversation about how the world's Emergency Management and Law Enforcement Sectors might best be provided with a mission critical PSMB capability.

This opportunity comes at a time when major developed countries in the world are moving to implement PSMB capability solutions using various approaches but with the common objective of closing the growing gap between the communications capabilities of their respective communities and their PSAs e.g. "For the first time in history the public has a greater communications capability then public safety does" [4].

The following summarises the major initiatives known to be underway at the time of preparing this Submission:

Canada

The Canadian Government has recently announced decisions resulting in 20 MHz of broadband spectrum in the 700 MHz band for PSAs together with initial funding towards providing a PSMB capability and the opportunity for cross border alignment with the FirstNet Project in the United States.

United States of America

The FirstNet Project (www.firstnet.gov) continues to consult on the preparation of individual plans for each State and Territory of the USA based upon a far reaching outreach (consultation) process; issuing individual spectrum licenses to specific PSMB Long Term Evolution (LTE) Projects to test a range of operational and service delivery capabilities and capture lessons learned to progress the design of the network; and the issue of a Request For Proposal (RFP) by the end of 2015.

United Kingdom

In the United Kingdom the Home Office is continuing with the tender process for an Emergency Services Network (ESN) Project (www.gov.uk/government/publications/the-emergency-services-mobile-communications-programme) to select a commercial provider of a PSMB capability for the United Kingdom's PSAs.

Europe

Across Europe consideration continues to be given to how a public safety mobile capability can be provided to Europe's PSAs based upon 20 MHz of spectrum provided for this use and harmonised to provide pan European capability.

South Korea

In South Korea a pilot project was due to be launched in April 2015 in three cities and continue through until the end of 2015 to provide testing and validation for a planned nationwide PSMB

[4] Sherriff Jeff Johnson – Former FirstNet Board Member speaking at the PSCR Broadband Stakeholders Meeting in Westminster Colorado in June 2013

capability. Implementation of this PSMB capability will coincide with projects to provide railway and maritime mobile broadband capabilities.

World Radio Conference (WRC2015)

The International Telecommunications Union (ITU) has announced the Agenda for the World Radio Conference (WRC2015) to be held in November this year where it appears there will be a Resolution proposing more study of the impact of mobile broadband on Personal Protection and Disaster Response (PPDR) spectrum.

The more exposure given to these international initiatives through sharing and collaboration to enhance the understanding, relevance and application of information and knowledge upon which strategic decisions are being based will result in better outcomes for PSAs and the communities they serve and protect. In particular the international mission critical public safety communications community will continue to closely watch both the USA FirstNet Project and the UK ESN Project for the lessons to be learnt as a result of the different approaches being taken to delivering a PSMB capability.

It should be noted however that, with the exception of the UK and South Korea, the countries mentioned are continuing to make significant investments in mission critical land mobile radio (LMR) networks as is the case in Australia where the P25 Standard has become the defacto national standard for mission critical public safety communications LMR networks used by Australia's PSAs.

Therefore mission critical LMR and mission critical LTE must be considered as compatible in the context of the mission critical public safety communications ecosystem and NOT competitive or directly substitutional, at least for many years to come.

While the Commission's Study into providing a PSMB capability proceeds it will be one of a number of studies undertaken in recent years, unfortunately in isolation, too inform and guide strategic decisions that need to be taken about the future of public safety communications in Australia.

(a) In December 2011 the former Department of Broadband, Communications and the Digital Economy (DBCDE) sought submissions on a review of the Integrated Public Number Database (IPND). The IPND is a centralised database containing records of all Australian telephone numbers and associated customer details that in June 2014 contained 64.8 million records of connected services. The critical uses of the IPND are the PSAs, the emergency call services (ECS) the ECP and the emergency warning system (EWS) and national security and law enforcement agencies.

The outcome of this Review has just been released making nine recommendations one of which was that the current IPND should be retained for the medium term and the need for a new system should be investigated again after the completion of the Department's Review of the Triple Zero operator and the implementation of the Triple Zero contract arrangements from 2016.

(b) On 8 July 2014 the Department of Communications Triple Zero Review sought submissions on the transition and transformation from the existing Triple Zero service to a Next Generation (NG000) service providing the capability to both receive and seek information from the community using mobile broadband technologies in multimedia format. The outcome of the analysis of this information will inform the PSA response and data will be transferred using the PSMB capability to the responding PSAs (in conjunction with P25 LMR

voice), hence the PSMB capability will become a primary means of multimedia information exchange between communities and the PSAs.

The outcome from this review has not yet been released although briefings on a consultancy study commissioned by the National Emergency Communications Working Group (NECWG) have been provided at Conferences.

There has been no announcement about the outcome of this review which is intended to inform the development of tender documentation for the Emergency Call Person (ECP) service provider in 2016.

(c) The Department of Communications also sought submissions on a review of the Spectrum Management Framework Spectrum the results of which were released on 22 April 2015 and are dealt with in the response to Question 3.

The IPND, Triple Zero service, P25 LMR and proposed PSMB capability are all components of the mission critical public safety communications ecosystem which will ultimately include Australia's communities as Next Generation mobile and fixed broadband technologies enable the exchange of multimedia information. The one piece of infrastructure that has not been reviewed for use by the PSAs is the NBN and its potential to provide national backhaul capabilities for the PSAs.

The Southern Melbourne Regional Development Australia (SMRDA) Committee recently released a report titled "The Need for High Speed Broadband in South East Melbourne's Industrial Precincts"[5] highlighting the need for a change in the focus of the NBN rollout from residential to industrial to capture increase in business productivity, innovation and product development. The same benefits could be captured by PSAs if the NBN provided backhaul for the PSMB capability and their operational premises were given a high priority in the NBN roll out capturing associated social benefits from the protection of life and property.

It is recommended that the capability and capacity that the NBN may be able to provide to the PSMB capability be included in the Commission's Study.

In summary, there will be continuing developments occurring in the mission critical public safety communications ecosystem during the preparation of the Commission's Study both within Australia and the international community as it continues to move towards establishing a PSMB capability for PSAs best suited to their respective environments.

These PSMB capabilities which will be determined by a wide range of drivers and the body of information and knowledge will continue to grow from the experiences gained and shared. The investment in a PSMB capability will ensure that Australia's PSAs have at least comparable public safety communications capabilities and capacities as the international community and should also be recognised as an investment in community preparation and preparedness associated with building community resilience.

The Commission's Study could therefore be a significant contribution in a period where strategic investment decisions are being made that will impact the direction of international mission critical public safety communications for decades to come.

[5] www.rdv.vic.gov.au/smrda

Q3. What are the implications (if any) of the Australian Government's review of the spectrum policy and management framework, and ACMA's ongoing work on spectrum allocation matters, for the delivery of PSMB in Australia?

The Minster for Communications and the Parliamentary Secretary to the Minister for Communications announced the release of the *Spectrum Review Report* on 22 May 2015 during the final stages of preparing this Submission.

From a preliminary assessment of the *Spectrum Review Report* the comments and recommendations directly relevant to the Commission's Study appear to be as follows:

(a) The ACMA has estimated that mobile broadband increased Australia's economic growth rate by 0.28 per cent each year from 2007-2013. This equates to an economic contribution of $33.8 billion by mobile broadband alone over this period, primarily through productivity improvements;

(b) Spectrum used for LMR generates economic benefits of between $1.99 billion and $3.72 billion per annum[6];

(c) LMR plays a central role in the delivery of services such as mining, transport, utilities and public safety services such as police, fire and ambulance;

(d) Government users (PSAs) of spectrum provide services that offer significant benefits to society beyond a pure commercial return;

(e) Public sector agencies that hold spectrum should regularly report the value of their holdings;

(f) Public sector agencies should be permitted to either lease or sell the spectrum and retain the benefit of doing so.

The following comments were prepared for inclusion in this Submission on the importance of the Spectrum Review Report prior to the report being released and it is considered that these comments still remain relevant.

The ACMA as the Regulator has previously announced the allocation of 10 MHz of broadband spectrum (5MHz + 5 MHz) for Australia's PSAs in the 800 MHz band and stated that it believes that this amount is sufficient for both business as usual and for major events indicating that PSAs only require 6 MHz for business as usual and therefore the remaining 4 MHz is available for increased demand from major events.

As previously indicated no organisation is in a position to accurately predict the amount of broadband spectrum that PSAs will require because of the strong linkage to consumer demand for mobile broadband enabled services; the commercial industry response to this demand; and the ability of PSAs to leverage the products and services that will emerge from this response. It should be noted that the ACMA decision on PSMB spectrum allocation to PSAs is significantly different to the decisions made by Governments of other countries prompting the need for additional research to understand the reasons for this difference.

Any allocation of broadband spectrum for PSA use must incorporate a contingency amount or capability to provide for future additional capacity and hence capability however the ability of PSAs

[6] Australian Radio and Communications Industry Association (ARCA) study on the Economic Value of LMR Spectrum.

to even use allocated spectrum will be limited to the availability of funding to support investment in a PSMB capability. Given the increasing value of spectrum PSAs must be able to demonstrate the operational and service delivery benefits from the use of allocated spectrum to justify the retention of the spectrum. This requirement is an outcome from the Spectrum Review Report.

The need to be able to effectively allocate and manage spectrum makes the international exchange of information and knowledge on the innovative use of a PSMB capability by PSAs and ongoing research into its use to produce evidence to support spectrum retention imperative. This research should include technology innovation to dynamically provide additional spectrum capacity through prioritisation and pre-emption when required rather than providing a fixed allocation of spectrum.

The findings and recommendations from the Australian Government's review of the spectrum policy and management framework should be considered significant and will require further transparent consultation with all key stakeholders. The lack of transparency around Australia's input to the Asia Pacific Telecommunity (APT) Region 3 spectrum Plan and also the ITU 2015 World Radio Congress is of particular concern.

5. Public Safety Mobile Broadband in Australia

Public Safety Agencies in Australia

The Australian Federation model provides the States and Territories with operational independence for service delivery within their respective jurisdictions. The rapidly evolving mission critical public safety communications ecosystem requires PSAs to be able to respond to these changes with both flexibility and agility to be able to leverage commercial consumer oriented products and services. Current government business case and tendering processes are time consuming and complicated and do not fit this model of operation.

By international standards, the Australian PSA market is relatively small and siloed purchasing arrangements limit the potential for jurisdictions to obtain commercial benefits from streamlined and bulk purchases of equipment at a national scale.

Experience indicates that Government process can take between 3 to 5 years from proposal to implementation and within that time frame technology that was considered leading edge (not cutting edge) has been overtaken and the ability to quickly adapt to these changes has not historically been catered for within these extended time periods or contract negotiations.

PSAs must follow jurisdictional procurement requirements which may in some part contribute to the appearance that they are slow to adapt to change. This can be seen in the slow adoption of new social media based technologies being used and increasingly being accepted by the community.

The transition to PSMB represents a unique opportunity for the establishment of an integrated national capability and new streamlined supply arrangements for PSAs in all jurisdictions provided that these new arrangements also drive innovative solutions generated by collaboration between research organisations, industry and PSAs. The Commonwealth Scientific and Industrial Research Organisation's (CSIRO) work on Face-Book analysis to identify disasters and the emerging work at the University of Melbourne's CDMPS on Twitter analysis to geo-locate major events or incidents are good examples of collaborative innovation. The CSIRO research has progressed and provided a demonstrator whilst the CDMPS is currently undertaking research on open sources in relation to geo-location of Twitter feeds.

The development of innovative technologies to provide a PSMB capability to dynamically allocate spectrum to match PSA demand will require a definition of what is mission critical in relation to both voice and data to improve both Situational Awareness and Common Operating Picture capability coupled with jurisdictional interoperability at national, State and Territory level.

Q4. Are there any other PSAs that should be considered within scope in this study? To what extent are communications between PSAs and the community relevant to this study?

Users of the PSMB Capability

This question has the potential to create as many questions as answers because it will raise strategic jurisdictional, organisational and cultural (turf) issues traditionally associated with PSAs both in Australia and internationally.

The use of the term PSA has only recently been used in Australia and has probably been driven by the general use of this terminology internationally in consideration of the provision of a PSMB capability. Prior to this the term Emergency Service Organisation or ESO was used in Australia and may or may not have included Police or Law Enforcement Agencies at State, Territory or national level. Likewise the term Emergency Management Sector is a more recent development.

The former Federal Government, when offering the PSAs broadband spectrum, required access be provided to the PSMB capability for Federal Agencies e.g. the Australian Federal Police. The role of the State Emergency Service (SES) needs to be considered as it is not currently considered a PSA as well as the Volunteer Coast Guard and Surf Life Saving Association. Individual law enforcement agencies in each State and Territory should also be considered e.g. the Sherriff's Office in Victoria.

In the United States the importance of the role performed by Utilities in emergency and disaster management is progressively being recognised i.e. First Responders (PSAs) rely on the "Second Community" (Utilities) for the provision of services to support the response role of PSAs.

Extension of PSMB capability to Utilities could be a possibility although there may be some reluctance by Utilities to accept this invitation from a risk management perspective to keep critical networks separate for resilience purposes and well as matters related to trust and culture.

While consideration is given as to which agencies might be given access to the PSMB capability it would also be appropriate if the network infrastructure currently in place for PSA LMR and required for the future PSMB capability was classified as "critical Infrastructure". This classification would then be consistent with the manner infrastructure used by other critical sectors addressed by the Commonwealth Government's Critical Infrastructure Resilience (CIR) Strategy and its linkage to the National Disaster Resilience Strategy (NDRS).

Communications between Communities and PSAs

Information and communications play a fundamental role in establishing context and meaning regarding the location and extent of an emergency event as it supports decision making and establishing priorities for both the community and the PSAs. The use of social media during an emergency is driven by and centred on people rather than conforming to traditional approaches towards public safety communications which are controlled by PSAs. This trend is challenging established concepts, systems and norms within the public safety industry and it suggests 'a fundamental shift in power from capitals and headquarters to the people agencies aim to assist' (OCHA 2013:2).

As previously mentioned the PSMB capability needs to be seen as one component of the mission critical communications ecosystem in which Next Generation Triple Zero will provide a multimedia gateway between information received from the public and transmitted to PSAs using the PSMB capability. The different ways in which the public will access PSA services through Next Generation Triple Zero and the way this access is provided by State and Territories also need to be considered.

Public Safety Answering Points (PSAPs) will be a key component of multimedia gateway; however to a significant extent Australian PSAPs are designed and operated on systems and processes to respond to telephony-based requests for assistance. The introduction of multimedia into PSAPs represents a fundamental change in business processes yet there is a minimal level of research on the potential impact within the PSAP. In the absence of a thorough Business Impact Assessment (BIA) and change management strategy for jurisdictional PSAPs it is unlikely if the full potential benefits of PSMB will be realised.

The Department of Communications released its final report on the Integrated Public Number Data Base (IPND) in April 2015 which suggested, in recognition of the interdependencies, that the current system be retained until at least the completion of the Department's review of the Triple Zero Operator and the letting of the tender for the Triple Zero operator in 2016 and recommended investigating the need for a new system after the completion of these arrangements.

The IPND, Triple Zero service, LMR, the commercial mobile broadband services and the future PSMB capability are all integrated components of the mission critical public safety communications ecosystem facilitating communication between communities and PSAs. By doing so the ecosystem is contributing to building community confidence in PSAs ability to protect the social wellbeing, economic prosperity and resilience of Australian communities.

Q5. How do the organisational and institutional arrangements for PSAs vary between the Australian jurisdictions? What implications (if any) does this have for the way in which PSAs procure, operate and use communications services?

This information should be sought from the PSAs because differences do exist and these differences may impact the way in a PSMB capability may be designed, procured, operated and maintained assuming that the PSMB capability will be delivered on a "network of network" architecture.

In general terms existing jurisdictional communications networks range from fully owned and operated systems to fully outsourced networks. Existing communications infrastructure e.g. radio towers, exists across Australia to support legacy analogue and new digital radio communications networks. The ownership of this infrastructure varies; however there is a potential for some of this infrastructure to be incorporated into the future PSMB capability network infrastructure. This approach may reduce the overall cost of the PSMB capability and provide a funding stream for jurisdictions.

These organisational and institutional arrangements may inhibit the development of national policy to inform and guide State and Territory strategies that deliver PSAs with a PSMB capability.

PSA current use of communications services and spectrum in Australia

Q6. What is an appropriate definition of 'mission critical' communication systems and capability for the purposes of this study? What metrics should be used to assess whether capability is being delivered to adequate levels during mission critical circumstances? What evidence is there that existing capabilities are satisfactory or unsatisfactory?

The ability of PSAs to deliver services to meet community expectations must be supported by a *mission critical* public safety communications ecosystem defined by and built upon the following characteristics;

- Open technology standards;
- Public Safety Grade infrastructure;
- Interoperability;
- Cyber security;
- Spatial enablement; and
- Sustainable commercial competiveness driving innovation.

The better understanding of these characteristics and the definition of a core set of common *mission critical* characteristics will facilitate the possible incorporation of existing or planned critical infrastructure into the "network of networks" architecture.

Mission Critical Voice

In the case of LMR the term "mission critical communications" refers to the characteristics required in the narrow band communication networks and devices used by PSAs to be able to reliably communicate with each other as part of both business as usual and major events.

To ensure that the mission critical and interoperability requirements are met Industry Associations and Standards Development Organisations (SDOs) have developed open standards known as P25 and TETRA for products produced by industry which have to meet compliance testing requirements.

P25 originated in the United States and uses the Telecommunications Industry Association (TIA) as its SDO and TETRA originated in Europe and uses the European Telecommunications Standards Institute (ETSI) as its SDO.

The United States National Public Safety Telecommunications Council (NPTSC) www.npstc.org) defines the key elements of *mission critical* voice to include the following:

- Direct or Talk Around: This mode of communications provides public safety with the ability to communicate unit-to-unit when out of range of a wireless network OR when working in a confined area where direct unit-to-unit communications is required.

- Push to Talk (PTT): This is the standard form of public safety voice communications today - the speaker pushes a button on the radio and transmits the voice message to other units. When they are finished speaking they release the Push-to-Talk switch and return to the listen mode of operation.

- Full Duplex Voice Systems: This form of voice communications mimics that in use today on cellular or commercial wireless networks where the networks are interconnected to the Public Switched Telephone Network (PSTN).

- Group Call: This method of voice communications provides communications from one-to-many members of a group and is of vital importance to the public safety community.

- Talker Identification: Provides the ability for a user to identify who is speaking at any given time and could be equated to caller ID available on most commercial cellular systems today.

- Emergency Alerting: Indicates that a user has encountered a life-threatening condition and requires access to the system immediately and is, therefore, given the highest level or priority.

- Audio Quality: This is a vital ingredient for *mission critical* voice. The listener MUST be able to understand without repetition, and can identify the speaker, can detect stress in a speaker's voice, and be able to hear background sounds as well without interfering with the prime voice communications.

In Australia the P25 Standard is the defacto national standard for new narrowband mission critical public safety communications with the majority of PSAs continuing to invest in the upgrade and/or expansion of the use of this technology as they transition from legacy analogue networks to the new digital P25 networks.

The established characteristics of mission critical LMR have formed the initial base for the development of the mission critical LTE Push To Talk (PTT) Standard and its associated capabilities.

In the case of the PSMB capability the 3GPP (www.3gpp.org/about-3gpp/partners) is currently developing mission critical standards for a PSMB capability using LTE technology on the basis of Use Cases provided by SDOs. The 3GPP has acknowledged the difference between commercial LTE standards and mission critical standards for a PSMB capability through the establishment of the SA6 Working Group to specifically meet the need for mission critical public safety communications standards.

Expectations are that the first products based upon these LTE mission critical standards will be released to the market by 2018 – 2020.

Mission Critical Data

APCO Australasia's response dated 22 February 2013 to the ACMA Discussion Paper "*The 803-960 MHz band – exploring options for future change"* at Section 6(c) discussed public safety mission critical data and recommended that *"the characteristics of mission critical data be identified to assist in developing a better understanding of the manner in which PSAs will use broadband technologies".*

The PSMB capability is about data and NOT voice at this point in time therefore the characteristics of a PSMB capability and its design parameters have to be considered in the context of "Big Data" and the management challenges associated with this technology driven phenomenon and consumer demand for products and services.

These characteristics have to be based upon understanding the data behind this demand which is changing the way in the way the communities of the world function now and more importantly will function in the future with consequential impact upon PSAs.

In the same way PSAs need to be able to specify their demand for a PSMB capability upon the data that this capability will need to be able to carry and support. This will influence design parameters and the amount of spectrum required to support this capability from the perspective of being able to carry "mission critical" data for PSAs.

The technical and operational requirements for data capture and transmission will be critical components of these design parameters and subtle differences will be present in similar data formats for different organisations. For example video required by a fire service to establish Situational Awareness will have a lower impact on the PSMB capability when compared to video required (or potentially required) for evidentiary or forensic purposes of police agencies. This also means that mission critical data needs to be categorised for operational/tactical and business/strategic purposes.

The European Commission Report *"Is Commercial Cellular Suitable for Mission Critical Broadband?"*suggests that *"a mission is "critical" when its failure would jeopardise one or more human lives or put at risk some other asset whose impairment or loss would significantly harm society or the economy"*[7]

Research on what constitutes "mission critical" data appears to be very limited and there is no agreed definition for public safety "mission critical data" in the current conversation about PSMB capability.

The Department of Homeland Security Acting Under Secretary for Security and Technology, Mr Robert Griffiths, in a keynote address at the International Wireless Congress and Exhibition (IWCE) in March 2015 stated that he was no longer concerned about Big Data rather it was "little data" that now concerned him (note: this comment was interpreted to mean mission critical data), and that the operationalisation of data had to be linked to how spectrum was used; and that the sharing of data will be inhibited by cultural, market forces and operational issues; and not technology.

The University of Melbourne's CDMPS has been considering mission critical data in the context of Spatial Data Infrastructure (SDI) (www.csdila.unimelb.edu.au/research/spatial-data) and its role in Safer Cities of the Future.

To date this work has proposed a series of filters to test Big Data and hence identify public safety communications mission critical data. These filters are:

Location; - spatial enablement of data

Imagery; - video, pictures, visualisation

Sensory; - data collection, analysis and evaluation

Temporal; - real time

Standards; open non proprietary

[7] European Commission Report *"Is Commercial Cellular Suitable for Mission Critical Broadband?" - Chapter 6.1 Towards a definition of "mission critical"*

The use of these filters is anticipated to inform development of a model based upon the following:

Patterns; - identification

Predictions; - future events

Presentation; - informing decisions

Personalisation; - influencing behavioural change

Further information on this research can be made available to the Commission upon request.

Metrics

PSAs will specify network performance in Request For Proposals (RFP) which should provide the level of performance to meet the demand upon which the network design was based. This highlights the importance of the demand estimation.

Q7. What applications do PSAs currently use on their LMR networks that are provided for mission critical purposes? Does this differ by jurisdiction?

This information needs to be requested from each of the PSAs in each of the States and Territories using LMR networks.

Detailed information about P25 Standard LMR networks can be found at the (PTIG) website at www.projectP25.org. The P25 Standards suite allows PSAs to prepare RFPs for their networks that provide applications to meet their specific needs.

Q8. How often are PSA narrowband networks (such as LMR networks) renewed or upgraded, and to what extent are different jurisdictions at different points in this process? What are the costs involved in maintaining these networks?

This information should be sought from the PSAs however major multimillion dollar investments in P25 mission critical narrowband networks have recently been made in Victoria, Queensland and South Australia and across the reminder of Australia. As stated in the response to question 6 the total capital and operating expenditure associated with establishing and operating Australia's public safety communications ecosystem is unknown.

Whilst the full cost of investment in P25 networks is unknown it is estimated that approximately $1.5 - $2 billion has been spent by jurisdictions across Australia. There are also a significant number of standalone legacy analogue networks used for public safety communications still in operation around Australia and the cost of operating these networks is unknown. Without a full understanding of the capital and operational expenditure associated with Australia's public safety communications ecosystem any study on the potential benefits of a PSMB capability will be of limited value.

To give an indication of some of the costs, available open source information indicates that:
Victoria implemented a multi-agency Metropolitan Mobile Radio P25 network used in the Melbourne metropolitan area by Victoria Police, Ambulance Victoria and the Metropolitan Fire Brigade at the cost of $261 million. The Victorian Mobile Data Network was implemented in Ambulance Victoria and metropolitan Victoria Police vehicle at a cost of $187 million.

In 1999 the South Australia Government radio network consisted of approximately 40,000-45,000 users operating on 28 separate networks across 17 Government agencies, utilising 1200 communication sites, 12,000 radios and 8,000 pagers. A project was initiated by the South Australian government to establish a new, single integrated State owned Government Radio Network (GRN) for South Australia at an estimated cost of $247.7 million (PoSA 1999:4-5).

In Queensland the Government Wireless Network was established to provide an integrated and secure radio communications network for Queensland's PSAs especially for major events like the G20 and the 2018 Commonwealth Games. This network cost approximately $457 million (QG 2015).

In New South Wales (NSW) the Government Radio Network provides a common platform for NSW government agencies and authorities who use mobile radio communications (NSWGTA 2015). The cost of this network is estimated to be between $250- $450 million.

In 2006 the Northern Territory Government allocated approximately $13 million to implement a digital radio network to link Darwin, Katherine and Alice Springs for the police, fire and emergency services (The Drum 2010:4).

The Tasmanian Government has invested $29 million in upgrading the Trunk Mobile Radio Network (TMRN) which is mainly used by Tasmania Police and the Tasmanian Electricity Supply Industry (TESI). It is envisaged that the TMRN will form the basis for a whole of government public safety radio network (TAO 2014).

These investments should be considered as indicative only as they may not include further enhancements or upgrades to the networks which may have occurred after the initial public announcements.

Q9. How do the different types of events that PSAs deal with affect their demand for communications capabilities? Can you provide examples or evidence to illustrate this?

PSA demand for communications capabilities will vary from business as usual through to major events in natural and built environments or human intervention requiring single or multi agency response over varying time frames.

P25 Network Management Systems (NMS) are capable of providing detailed performance analysis of PSAs demand for communications during both business as usual operation and during responses to extreme events. PSAs should be engaged to provide this information. Similarly PSA Computer Aided Dispatch (CAD) systems should be able to provide detailed analysis of the changes in demand from the community for assistance.

Various public inquiries in relation to natural disasters, Black Saturday, Queensland Floods, Victorian Flood, Tasmanian Fires, South Australian Fires and the Warrnambool Telephone Exchange Fire have produced reports that may include reference to the performance of mission critical public safety communications and commercial communications.

7. What Is Mobile Broadband?

Q10. How, and to what extent, are PSAs using mobile broadband capability provided over commercial networks, and related products and applications, to support their operational activities? Are there any lessons or insights from these experiences, including the benefits that are being realised?

This information should be sought from the PSAs however Telstra has been providing trials of its LANES product in both Western Australia and Queensland.

It is understood that PSAs are using existing commercial networks to access legacy agency record management systems, agency email accounts and incident management systems. To the best of our knowledge there is no formal co-ordinated process to capture and share the lessons or insights from these experiences, including the benefits that are being realised? This type of analysis is critical to understand the potential benefits of a PSMB network within the Australian context.

Q11. How do other large organisations (such as government and corporate organisations with certain requirements which may be similar to those of PSAs) currently use mobile broadband services provided on commercial networks?

This information should be sought from the Trusted Information Sharing Network (TISN – (www.tisn.gov.au/Pages/default.aspx) through the Commonwealth Attorney Generals Department.

The TISN covers major critical private sectors such as finance and banking, utilities, transport, energy, food and communications and conducts annual workshops to test scenarios relevant to the whole of TISN and the individual TISN Sub Groups.

Q12. What lessons or insights can be taken from the previous trials of Telstra's LANES model, including during the G20 summit in November 2014?

This information should be requested from the PSAs who have been involved in the LANES trial.

It should be noted that the G20 summit was also supported by the new Queensland Government P25 LMR network.

Q13. Can commercial network solutions that involve dedicated spectrum for PSAs (and prioritised capacity in other spectrum bands during emergency incidents) allow for interoperability between networks operated by other mobile carriers and/or for end user to roam across multiple networks? Are there any technical, institutional or commercial barriers that would prevent this outcome?

This information should be requested from the commercial network providers. However two key software-led initiatives like the Software Defined Networking (SDN) movement created by the Open Network Foundation and the related carrier oriented Network Functions Virtualisation (NFV) standards being developed by the ETSI may provide this capability at some point in the future.

Alternatively independent advice on this matter could be requested from the Public Safety Communications Research laboratories (PSCR) located in Boulder Colorado USA (www.pscr.gov) on research being undertaken on PSA ability for PSMB prioritisation and pre-emption. The PSCR is an agency of the National Institute of Standards and Technologies (NIST).

8. Potential Opportunities for PSAs to use mobile broadband

Q14. What applications could PSAs use if they had access to PSMB capability? How could this be expected to vary across PSAs?

The application that is normally most referred to in reference to the PSMB capability is video. However with the gradually maturing knowledge of the use of PSMB capability video is moving from a "must have" to determining where video fit in operational doctrine.

Through research a greater appreciation of the importance of the quality of video is being gained and that the ability to dynamically vary quality depending on how this capability is being applied at any point in time will likely emerge as a mandatory characteristic of the use of video in public safety communications.

The American Public Transport Association (APTA) Standards Development Program has published a number of video related standards for a range of applications including CCTV systems (APTA IT-CCTV-RP-001-11) and Body Worn Camera Systems (APTA-RP-004-14-01). These standards provide a detail regarding the different attributes of these systems for example image resolution and frame rates for a range of applications.

It is anticipated that a range of body worn devices with potential public safety applications will emerge over the near to midterm. For example health monitoring sensors and augmented reality systems like Microsoft's HoloLens and Google Glass has been identified as displaying promising attributes for PSAs. Globally there is interest in the rapid development of sensor systems in what has been described as the Internet of Things (IoT). A subset of these sensor systems termed the Internet of Public Safety Things (IoPST) will become more relevant for PSAs; however at this stage it is unclear if this subset of sensors will operate on commercial or dedicated public safety networks but it will be supported by the development of 5G.

Advancements in telemedicine applications will have an increasing role to play in developing new capabilities with emergency medical services to improve patient treatment and monitoring procedures. The spectrum requirements of a PSMB capability to support these innovations, especially when responding to a mass casualty event are unclear.

The technical design and implementation of these systems will have a large influence of the capacity of the PSMB capability. Historically PSAs have installed multiple isolated systems within their vehicles and this has created a number of complex power management and system prioritisation issues for PSAs. With the development of mobile broadband technologies it appears that PSAs are using a range of Commercial Off The Shelf (COTS) solutions to create a Virtual Private Network (VPN) to support a range of devices used by their personnel. The VPN provides the communications link between these devices and the communications network rather than having multiple devices and applications competing for network connectivity and capacity.

The ability to receive and transmit spatially enabled information across the mission critical public safety communications ecosystem will be another characteristic of PSMB capability. This characteristic will be driven by the implementation of Next Generation 3 digit call systems (NG000) internationally where Public Safety Answering Points (PSAPs) will be the cross roads between the use of mobile broadband capability by the public and the PSMB capacity used by the PSAs.

The PSMB capability will allow the development of applications difficult to even imagine at this point in time. APCO international has developed an AppCom website (www.appcomm.org) to allow developers to publish proposed public safety apps for comment. The site currently has over 300 proposed public safety apps and has allowed the development of a list of key attributes of public safety apps with APCO now working with the U.S. Department of Commerce and the PSCR to identify and categorize data types for public safety mobile apps (http://appcomm.org/wp-

content/themes/directorypress/thumbs/AppComm_Key_Attributes.pdf). It is expected that this work will inform the establishment of a public safety Apps Store as part of the FirstNet Project.

In the United Kingdom British APCO has worked with British Telecom (BT) to establish a process to certify public safety apps as "fit for purpose' on the BT mobile phone network.

It can therefore be expected that Australia's PSAs will have a wide range of choice in public safety apps to choose from when the PSMB capability is in place.

Q15. To what extent could these applications replace or supplement the capability and systems currently used by PSAs on their narrowband networks?

It should be expected that PSMB applications will supplement the applications already available on narrowband networks and in some cases drive innovation with narrowband applications to provide capabilities expected to be provided though PSMB e.g. TETRA research in Norway regarding video streaming.

The definition of mission critical data will also identify data currently being carried on narrowband networks e.g. status and location, which can be enhanced through use of spatially enabled information in conjunction with a PSMB capability.

It is anticipated that radio voice applications on jurisdiction LMR networks will have a long-term role to play in the Australian public safety communications ecosystem.

Q16. How important are communications between PSAs and the community during emergency incidents?

As indicated in the response to Question 4, information and communications play a fundamental role in establishing context and meaning regarding the location and extent of an emergency event as it supports decision making and establishing priorities for both the community and the responders.

More recently the role of social media usage by the community, especially on mobile devices, is becoming more prominent during an emergency event. The use of social media during an emergency is driven by and centred on people rather than conforming to traditional approaches towards public safety communications which are controlled by PSAs.

Social media has become ubiquitous in our society and its use is capable of generating significant amounts of data during emergencies and mass disruption events. Some social media platforms like Twitter have increasingly become an important tool for people affected by these types of events as they share or try to report on what has occurred, is occurring or to seek help or assistance from others. PSAs have recognised that this type of information and interaction on social media could potentially enhance their level of situational awareness and support their decision making process.

The successful integration of social media into public safety communications and emergency management is a complicated and challenging process. The integration of any social media initiative will need to fit into a broader multi-channel communications ecosystem and operational environment.

Critically, the integration of social media into public safety communications and operations during emergency management activities represents a new way of operating using direct two-way communications and engagement with the community and this will challenge the operational culture of a number of agencies.

During an emergency traditional communication techniques for example radio and television broadcasts will still be a key method of communication with the community, however mobile broadband enables a higher level of interaction with PSAs. It is anticipated that future community communications will be based on a multichannel strategy involving both traditional and public safety communications platforms.

9. Developing Options for Evaluation

The Commission's Issues Paper proposes the following three options for evaluation in providing the PSMB capability:

- A dedicated PSMB network;
- A commercial network(s) solution;
- A combination (or hybrids) of approaches.

The following comments are offered on these options.

Option One: Establishing a Dedicated PSMB Network

This option is consistent with PSAs traditional ability to use dedicated narrowband (LMR) networks and, subject to the provision of spectrum and funding, would most likely be the option favoured by the PSAs on the basis of being able to control access to and use of a dedicated network.

The key issues associated with this option are:

(a) The identification and assessment of existing State and Territory network infrastructure in terms of its ability to contribute to the establishment of a PSMB capability i.e. suitability, and availability;

(b) The willingness of the States and Territories to contribute this infrastructure to the establishment of a PSMB capability; i.e. governance, cultural and organisational willingness particularly where the existing infrastructure is part of a Government Radio Network (GRN) with many government users;

(c) The development and agreement of a Framework under which this contribution would be made i.e. the operational, technical, financial, performance and resource components and the agreed value of the contribution of each State and Territory to the establishment of a PSMB capability.

Consideration of this option would however further add to understanding the national mission critical public safety communications LMR capability.

Option Two: Relying fully on commercial networks

The key issues associated with this option are:

(a) The financial capability of PSAs to purchase the "service" required i.e. not all States and Territories may have sufficient funding to purchase PSMB services which may cause interoperability issues without the agreement on a core set of common service requirements that will provide a truly national PSMB capability.

(b) This option would also depend on agreement by PSAs to what data is mission critical which in turn would be linked to the quantum of spectrum required to allow the PSAs to deliver their services to the community.

(c) This option would be the quickest to implement subject to satisfactory commercial arrangements being reached.

(d) The commercial attractiveness of this option to potential service providers would more than likely depend on the amount of spectrum allocated to PSAs. The decision to provide a PSMB service to PSAs will be driven by a decision about Return On Investment (ROI) for their shareholders arising from the combination of cost to provide the service verses the price agreed with PSAs to provide the service; the degree of risk associated with the provision of the service (commercial and reputational); in return for the value of the spectrum to which access would be gained for commercial use when not required by the PSAs.

(e) As with Option One the willingness of the States and Territories to work collaboratively to purchase a service that provided the core capabilities of a PSMB capability i.e. governance, cultural and organisational willingness would need to be overcome with the additional hurdle of placing trust in the commercial service provider to be able to deliver the service as and when required particularly in times of major emergencies when the commercial networks would be under stress through increased consumer use.

(f) The cost of commercial providers augmenting (or 'hardening') parts of their networks to meet Public Safety Grade infrastructure for resilience purposes and to meet agreed service levels would be factored into the ROI calculation previously mentioned.

(g) This option would also rely on a satisfactory level of trust being established between the PSAs and the commercial service provider(s).

Option Three - Some Combination (hybrid) of Options One and Two.

A hybrid solution developed from a part government and part commercial model probably offers more benefit than either of the two previous models on the basis of the following:

(a) Risk mitigation through the ability to allocate identified risk components to the party best positioned to manage/mitigated the specific risk;

(b) Develop collaboration between PSAs and potential commercial providers of a PSMB capability as a service;

(c) Allow PSAs to specify their core needs based upon the ability to improve their knowledge of what benefits a PSMB capability can offer and the degree of cultural and organisational change that may be required to capture these benefits;

(d) Allow PSAs to demonstrate the benefits of the PSMB capability in terms of improved service delivery to communities and the building of community resilience;

(e) Provide flexibility in service contract arrangements to take into account developments in mobile broadband technologies and products that will continue to become available;

(f) Allow commercial service providers to develop an understanding of the ROI for providing a PSMB capability to PSAs and make a corporate decision as to whether this decision is in the best of interests of its shareholders or that it needs to be considered in the category of a potential community service with which the organisation wishes to be recognised as providing to the PSAs.

The hybrid model would also allow the trialling of a Multi-Vendor Network Operator (MVNO) approach in conjunction with a dedicated PSA broadband network built to utilise the existing PSA/GRN network infrastructure i.e. Option One. The balance between the two may be that the dedicated PSA broadband network carries mission critical data while the MVNO carries non mission critical data with the capability of dynamically providing additional capacity as required by PSAs for defined events or periods of time.

The hybrid option would seem to best fit the current environment in which both the PSAs and the PSMB capability providers may develop their understanding of each other's needs and the risks and the benefits associated with both. This hybrid option also reinforces the need to take a compatible rather than competitive approach to providing the PSMB capability.

The hybrid model would however require the establishment of a national governing body to provide oversight to the development and operation of the model.

Characteristics of a PSMB capability

Q17. What PSMB capability characteristics should be considered in this study?

Refer to the response to Q6.

The determination of the characteristics of an appropriate PSA PSMB capability should commence by setting, as a minimum, the characteristics of mission critical narrowband voice as developed over decades of use by PSAs.

These narrowband voice characteristics have been specified in the engineering standards produced and published by SDOs and used in the design and manufacture of the equipment used in the construction, operation and maintenance of narrowband networks.

These characteristics have arisen from PSAs progressively refining their needs from their communications networks and associated equipment to meet the changing requirements of their operating environments and from their technical knowledge of their communications networks. The same process is now being applied to the development of PSA requirements for PSMB where SDOs and public safety communications associations have provided Use Cases to the 3GPP for development of mission critical standards for PSMB.

It is anticipated that the current PSMB research and development occurring in North America and Europe will be a key influence in developing new global standards for PSMB capability characteristics. As a result it is important that Australia engages with key international agencies and advocacy groups in these research and development initiatives to ensure that any new global standard is fit for purpose for the context of Australian PSA requirements.

Q18. How should 'national interoperability' be interpreted in this study? Does it include interoperability between networks, devices and applications used by PSA in different jurisdictions? Does it extend to integrating communications services between different local PSAs (for example, police, fire, ambulance and other responders)?

Interoperability is a critical design parameter for both narrowband and broadband. National interoperability should be interpreted to be just that i.e. *national interoperability* allowing information to be easily shared in a timely manner between PSAs and across borders.

In the case of the PSMB capability the focus will be on "data" and network interoperability with the potential use of the NBN for national backhaul. The PSCR and SDOs are currently developing interface standards that will provide interoperability between mission critical LMR and LTE communications.

As previously mentioned P25 is the defacto national mission critical narrowband standard for PSAs in Australia therefore the CDMPS and APCO Australasia have made a submission to the National Emergency Management Grants Program seeking funding to conduct an assessment of the degree of interoperability between P25 networks however at the time of preparing this Submission no advice on the Submission has been received.

Equally important will be interoperability between PSAs *within* State and Territory borders.

Australia has the unique opportunity to establish a fully interoperable national PSMB capability. It is believed that such a capability is a critical requirement to support national efforts against serious organised crime groups and terrorist activities. Similarly, a fully interoperable national PSMB capability will significantly enhance cross jurisdictional support during major emergencies and natural disasters.

Q19. Does delivering a PSMB capability raise any new opportunities for achieving national interoperability?

Many jurisdictions currently have interoperability arrangements with the majority of these catering for cross border communications. Many jurisdictions provide radios to border areas to enable collaboration on a small scale. Given the increasing incidence of large scale disasters many weather or fire related, the recent trend has seen multi-jurisdictional deployment of personnel and equipment that has been in many cases not interoperable. There are many examples of this type of deployment. The most recent being multi-jurisdictional deployments of fire fighters to assist South Australia over the recent large scale fire events in that state.

There are an increasing number of field deployable solutions that are multi-modal and that can be vendor agnostic however jurisdictions are limited in their capability and capacity to influence or adapt to these innovative systems for a great many reasons (political, financial and expertise).

The PSMB capability therefore will provide opportunities for national interoperability if agreement can be reached between the States and Territories to the standards to be adopted, the design of their respective networks, and the method of network operation assuming that the PSMB capability will be provided on a network of networks basis. These factors will vary according to the option selected to deliver the PSMB capability.

The opportunity cost will be dependent upon the availability of funding to invest in the new PSMB capability. Community benefit will be enhanced if revenue gained from the potential release of spectrum, as suggested in the Spectrum Review Report, to commercial interests is used (at least in part) to fund the investment in the new PSMB capability.

The Australian Government has a responsibility for creating national capabilities in a manner which is sympathetic to jurisdictional independence. The development of a PSMB capability will provide the opportunity, or create the necessity, to establish new governance arrangements to achieve national interoperability through national co-ordination of the development of the PSMB capability in a manner recognising that the States and Territories are individually responsible for emergency management and law enforcement within their jurisdictional boundaries.

These governance arrangements should include national policy, strategy, design, procurement, implementation, operation, security and performance monitoring functions. In a similar manner the FirstNet Agency in the USA has been established to provide the national PSMB capability across all States and Territories of the United States based upon a common architecture.

To further understand the complexity of such an arrangement the Commission should examine the level of national interoperability between mission critical LMR networks as mentioned in the response to Q18.

Q20. Would the benefits, costs and risks of achieving national interoperability vary under different deployment options? If so, how?

The benefits, costs and risks will be directly related to the deployment and operational components of the options available and be dependent on the variation in design parameters e.g. coverage related to whether the PSMB capability is being provided in urban, rural or remote environments and the method of deploying the infrastructure to provide the PSMB capability at any point in time and for specific events in these environments e.g. bushfire in rural environments.

Q21. What progress has been made in putting in place arrangements to better coordinate emergency communications within and across PSAs and jurisdictions?

This information should be requested from individual States and Territories and reference should be made to the response provided to Q 19.
The use of technology roadmaps is one method to illustrate the development of mission critical public safety communications technologies, their position in the ecosystem, their expected lifespan and potential convergence.

Emergency Management Victoria (EMV) has produced a Long Term Communications Plan (LTCP) that illustrates a proposed technology roadmap and time frame for the convergence of the mission critical public safety communications technologies either currently in use or expected to be used in that State (www.emv.vic.gov.au/plans/long-term-communications-plan-ltcp).

The PSCR is also producing a series of technology roadmaps to guide investment in research projects that will benefit the PSAs. The first of these has been completed for Location Based Services and the second for Data Analytics is currently in production.

It is envisioned that new PSMB capability will be able to provide significant digital productivity gains within PSAs; however it is unclear PSAs have fully considered the potential opportunity to revolutionise legacy record management systems and business processes as part of the transformation process in the transition to broadband technologies.

Operation in Metropolitan and Regional Australia

Q22. What level of network coverage do the existing networks used by PSAs (for narrowband voice and low-speed data capability) currently provide? How does this vary across jurisdictions?

At this stage the national mission critical public safety communications capability is unknown. This information should be requested from the respective States and Territories as each has differing levels of maturity.

Q23. What level of mobile broadband network coverage do PSAs require across metropolitan and regional Australia? Does this vary for different PSAs?

Cornick & Gathercole (2012) found that network coverage requirements for PSAs will vary for day-to-day activities as well as for extreme events that may impact on large numbers of people. Network coverage requirements will be a mixture of permanent requirements for major population centres, temporary arrangements for incidents at major venues and rapidly deployable networks for random and unpredictable events.

As indicated in the RUSI study, perceived network and application requirements change as PSAs become more familiar with PSMB capabilities. Similarly, technological advancements will provide new opportunities that will have to be integrated into PSMB networks.

The extent of coverage required by PSAs from their PSMB capability will depend on the data requirements (mission critical and non mission critical) associated with their respective functions and their operational requirements for access to and use of this data. Similarly, the connectivity requirements of devices used by PSAs will influence their coverage requirements.

Coverage is a critical design parameter and will determine the type of infrastructure required to provide this coverage. It is assumed that the States and Territories have previously provided this information as input to the previously announced National Implementation Plan (NIP) but it should be should be requested again to provide the opportunity for the States and Territories to review the information provided.

Australia's topography is diverse and as such network coverage varies extensively. Any future PSMB capability coverage will be influenced by available funding and the technical design of the network. The backhaul mechanism will be a key factor that needs to be considered in any discussion on a PSMB capability. As previously mentioned the ability of the NBN network to provide the most economical backhaul mechanism for the PSMB network needs to be assessed.

Q24. What is the most appropriate measure of network coverage for use in this study?

While qualified current industry measures for commercial mobile network coverage could be used for the purpose of the Commission's Study they may not be truly representative of a mission critical PSMB capability suitably "hardened" to meet public safety communications grade requirements as explained in the response to Q 39.

Q25. What options are there for extending the mobile coverage of commercial networks?

Mobile infrastructure is available for deployment to provide additional network coverage for specific events or periods of time e.g. COW - Cells On Wheels, COLT - Cells on Light Trucks etc and it should be expected that new aerial infrastructure will emerge to provide extended coverage for specific events for responses to rural or remote locations or random and unpredictable events.

Q26. Would the benefits, costs and risks associated with achieving an acceptable level of network coverage for PSAs vary under different deployment options? If so, how? And with what operational consequences?

See the response to Question 20.

<u>The Ability to Integrate Voice Communications</u>

Q27. How could voice services — traditionally carried on narrowband networks — be integrated into a mobile broadband network capability? What challenges and risks need to be accounted for? Are the challenges at the local level (due to legacy factors) greater than those at the national level?

The 3GPP is developing mission critical standards for voice within the PSMB capability. The PSCR and SDOs are already considering the interface standards required between mission critical LMR and mission critical LTE. However from a resilience and return on investment perspective it is expected that investment in LMR mission critical voice will continue for the foreseeable future.

The issues of the integration of voice communication as previously mentioned have not been clearly articulated. It is know that there are latency issues when voice and data are integrated and within the public safety arena, the loss of data packets as a result of the inability to initiate quickly or from interference has the ability to be life threatening at key times. In times of emergency, the ability to provide key voice communications during peak demand must remain a priority. With current heightened 'threat' levels the ability to encrypt both voice a data have become increasingly important. Encryption also places a further strain on latency and data throughput placing further strain on any communications system. Within any integrated communication and data network dynamic prioritised partitioning should contribute to network integrity and provide flexibility.

Care therefore needs to be exercised when considering the integration of both voice and data considering the considerable investment by the jurisdictions in voice networks. The limitations of LTE or even 5G networks are still not understood and the limitations of these networks is not publicised by commercial carriers. What is acceptable to the general public from a commercial point of view is not and cannot be suitable for public safety applications. This point has been highlighted many times by various inquiries.

Q28. What challenges or opportunities arise (from a technical, institutional and/or commercial perspective) from such integration, and would the benefits, costs and risks vary under different options for PSMB? If so, how?

The open standards interfaces referred to in Q 27 will present the opportunity to develop a fully integrated mission critical public safety communications ecosystem enabling PSAs to interface with and leverage the Internet of Things in an agile manner. This will allow PSAs to keep pace with community expectations of service delivery particular with the evolution of Future Smart Cities in urban environments.

Q29. The Commission understands that there is currently work underway to develop voice applications for 4G/LTE networks for use in mission critical circumstances. When are these applications likely to become available?

The 3GPP is developing standards for mission critical public safety communications based upon LTE technologies. The 3GPP is using the processes it uses for developing and maintaining standards for commercial mobile phone networks but has recognised that there are differences between commercial and mission critical public safety standards. These standards are progressively published through a sequence of Releases (currently 12, 13).

Release 12 was due in to be completed in December 2014 but has slipped into 2015. This Release will include Proximity Services (direct mode and group communications) emulating mission critical LMR. Requirements definition and architecture for mission critical push to talk (MCPTT) which emulates functions provided by mission critical LMR is on-going in Release 13.

The timetable for the completion of these Releases is very fluid and it is suggested that further information on the timetable be obtained directly from the 3GPP website at www.3gpp.org.

Maintain The Integrity and Security of Communications

Q30. What factors are important in ensuring the integrity and security of communications for PSAs? To what extent does this differ for different types of PSAs?

PSAs have maintained that secure voice communications remain the ultimate fall back in any dynamic emergency situation. This is as relevant today as it was five years ago. Secure, accurate and available voice communications remain the primary means of ensuring the safety of the public safety community when responding to incidents (large or small).

Mission critical LMR security is principally related to the use of encryption whereas mission critical LTE security arrangements will need to be targeted at cyber security and these arrangements are included in the development of the LTE Standard by 3GPP.

It would be expected that these cyber security arrangements for the LTE Standard will be further reviewed in the development of mission critical public safety LTE standards. It is anticipated that security arrangements will operate at the network level, at the device level and the PSA level.

The Australian Signals Directorate (ASD) produces the Australian Government Information Security Manual (ISM). The manual is the standard which governs the security of government ICT systems and complements the Protective Security Policy Framework. The ISM and PSPF will key factors in determining the PSMB capability security requirements.

Q31. Would the costs and risks associated with ensuring the integrity and security of communications differ depending on how a PSMB capability is delivered? If so, how?

The type of data being carried by the PSMB capability will determine the level of security required in accordance to the response to Q 30.

Security would be expected to be a differentiating factor between the choices of the options for providing the PSMB capability.

Q32. What methods or metrics could be used to define and/or measure the level of security provided over a network that delivers mobile broadband capability?

See the response to Q 24. The methods and metrics should be expected to be developed as part of the standard referred to in the response to Q30 and to the type of data being carried as referred to in Q 31.

Q33. What additional security needs do PSAs have compared to other sectors with high security requirements for their communications?

See the response to Q 30.

Accessibility, priority and sufficient capacity for PSAs

Q34. How should PSA demand for mobile broadband capability be estimated in this study, including their expected demand requirements into the future?

The higher community expectations relevant to service delivery provided by PSAs will drive the demand of PSAs for PSMB capability and capacity. The previous work done for the PSMB Steering Committee could be reconsidered but as this work was essentially discounted or not accepted by the ACMA, and is probably now dated by the continuing development of information, knowledge and technology, new work should be commissioned as part of the Commission's Study.

This new work should include the submissions to the Department of Communications Triple Zero Review and be able to demonstrate the flow through effect from the public demand for access to PSA services to the PSMB capability in the context of the previously mentioned mission critical public safety communications ecosystem.

Consideration should be given to the demand drivers behind decisions being progressively taken by other governments about the quantum and location of spectrum and studies undertaken by the ITU for the WRC2015.

Consideration should also be given to having the outcome from the Australian demand study being modelled by the PSCR using their design tools for PSMB capability.

One key issue overlooked by the Commission's Issues Paper is that of the capacity of PSA's to make calls and transmit data. The human aspect of PSA's and the limiting factors in staffing, rostering and award entitlements provides a limiting capability in times of peak demand. This was clearly evidenced during the Black Saturday fires when thousands of E-000 Victorian calls went unanswered.

A further clear example is the flood of calls experienced during extreme weather event to answer points for the SES and the resulting backlog of responses for assistance. A questioned to be

answered remains centred on capacity and an assessment of what are the 'must haves', 'should haves' and the 'nice to haves' and are these applicable to business as usual or time of extreme peak demand.

In considering any commercial solution of a broadband solution the previously mentioned issues would potentially overly complicate contractual requirements and hinder the provider's ability to understand what can and cannot be done in time critical situations.

Q35. What methods or metrics could be used to define and/or measure the level of service capacity provided to PSAs?

See the response to Q 24.

Q36. What level of capacity will PSAs need for a PSMB capability, and how will this differ between business as usual activities and large scale emergency incidents?

The level of PSMB capacity will be will be directly related to the level of demand imposed by PSAs through the full range of events from business as usual to large scale emergency incidents and determined by the response capability specified by PSAs, either individually or on a multi-agency basis, and the decision making processes that will come into place as events escalate.

Therefore this capacity has to be highly scalable to be able to meet increasing demand from PSAs and needs to be treated as a key design parameter for the PSMB capability.

Q37. How might the demand for PSMB capability differ between types of PSAs? How could competing demands amongst PSAs be managed? Should particular uses be prioritised?

The question relates to the definition of mission critical data discussed in Q6. Once these core elements are determined they can be further defined by the attributes required to meet the specific requirements of individual PSAs.

The management of competing demand between PSAS needs to be addressed through the governance arrangements suggested in the response to Q 19.

Q38. How would the benefits, costs and risks of ensuring sufficient capacity vary under different deployment options?

In simple terms the variation will occur in the way each of the options meet the requirements of the PSAs from the PSMB capability based upon coverage, performance and resilience related to the ability to provide a scalable response to varying levels of demand to meet community expectations while at the same time building community resilience.

<u>Resilience and Continuity of Services</u>

Q39. What level of resilience do PSA narrowband networks usually provide and how does this differ from commercial mobile broadband networks?

The term "mission critical" has been traditionally used to differentiate PSA narrowband networks from commercial narrowband networks e.g. the P25 logo is used to indicate the suite of narrowband engineering standards produced by the Telecommunications Industry Association (TIA) that specifically meet the needs of PSAs as identified by the P25 Steering Committee.

The term "resilience" has come into vogue in all aspects of emergency management policy and planning; however within the public safety communications community the term "public safety grade" is used to describe a similar concept of resilience. NPSTC in its report titled "Defining Public Safety Grade Systems and Facilities" dated 22 May 2014 describes public safety grade as:

> *"a conceptual term that refers to the expectation of emergency response providers and practioners that their equipment and systems will remain operational during and immediately following a major natural or manmade disaster on a local, regional, and nationwide basis"*.

The 3GPP Partnership through the process of developing standards for broadband LTE mobile technologies has also acknowledged the specific needs of mission critical public safety communications and in December 2014 announced the formation of a new Working Group SA6 to address these needs.

There are many general definitions of resilience and a number that pertain specifically to network resilience. In this case the definition provided by European Union Agency for Network and Information Security (ENISA) is limited to maintaining an acceptable level of service. In the case of a PSMB capability resilience should also include the ability to restore the network using self healing, portable and deployable infrastructure (example COW's and MEOW's). Battery back up in terms of hours is not acceptable and this should be measured in days.

Specifications for critical infrastructure should be risk based on the frequency of major events (example fires and storms) hence fire resistant, wind resistant and water resistant. A key question in relation to sustainability and resilience should be whether it is acceptable to cater to the 1/100 year event considering that Australia's east coast jurisdictions have endured a number of these (by contractual definition) over the last decade.

The bottom line is that when all other communications networks fail the expectation is that PSA communications will still be functioning in whole or part allowing PSAs to provide key services to communities in need.

Q40. What methods or metrics could be used to define and/or measure the level of resilience provided by the networks used to deliver PSMB?

See the response to Q 24. The methods or metrics relating to the level of resilience should be expected to be developed as part of the standard referred to in the response to Q30; to the type of data being carried as referred to in Q31 and to similar mission critical sectors as referred to in the response to Q35.

Q41. What priority should be given to the capacity to stand up a replacement service within a specified timeframe in the event of a physical or network based disruption?

See the response to Q 39 and Q 40.

Q42. Are there any barriers (for example, institutional, informational and/or technological) to, or challenges associated with, delivering a resilient PSMB capability? How might this differ between different deployment options?

The resilience of the PSMB capability under any deployment option should be at least equivalent to that of a mission critical LMR network.

Sustainability of Arrangements

Q43. How could future developments in technology, or growth in demand for mobile broadband services and capacity, affect the sustainability of PSMB capability under different deployment options?

The ability to cater to future developments should include engagement of the academic community. Many of these entities are currently researching the next generation of developments and these will be the key to any future proofing of both LMR and PSMB networks.

Developments in 3D modelling, spatial information and quantum computing have the potential to impact on any network. One clear example is research currently underway in Australia in relation to 3D building and location at Melbourne University. A further example is research being conducted in the USA in relation wireless data transmission at rates approaching 1G per second from deployable equipments (ground mobile and remote air based). At this time it would be difficult to define acceptable methods of service level requirement given the potential data capacities required.

A previous example cited the Warrnambool telephone exchange example where by a large area of Victoria (including PSAs lost nearly all data, communications and telephony capabilities for a number of days. This should not be seen as an isolated incident as there have been similar incidents that did not last as long or impact such a large area. The regional reliance on single points of failure should clearly be taken into account in relation to any proposed network or contractual obligations.

The unknown element is the growth in PSA data required to be carried by the PSMB capability to provide the ability to meet the demand for service from the public. Under all options the ability to provide a contingency to be able to meet this demand needs to be provided. This increase in demand will be related to the manner in which the future Triple Zero service is designed to allow data to be received from the public and any future technology adoption.

Q44. How will the convergence of voice and data services affect the sustainability of PSMB capability under different deployment options?

To provide an assurance of on-going continuity of service It should not be assumed that voice and data services will necessarily converge onto a PSMB capability, even though the capability to carry mission critical voice on a PSMB capability will eventually become available.

The continued separation of mission critical LMR and LTE will more than likely be required for resilience and also to allow for growth in data on the PSBM capability.

Q45. What challenges are involved with delivering a mobile broadband capability to PSAs by 2020? Do these differ under alternative deployment options?

The 2020 target seems to be an artificial target related to the completion of the Interoperability Framework by the National Co-ordinating Committee for Government Radio (NCCGR) when in fact the PSMB capability will be determined by; the outcome from the Commission's Study; Government

decisions about the recommendations arising from the Study; the publishing of mission critical LTE standards; the products and services in the market based upon these LTE standards; and the funding available at State and Territory to provide the PSMB capability.

Once these hurdles have been overcome PSAs will have to progress through their respective governmental procurement processes before a PSMB can be implemented. Given these variables, it is unlikely that a PSMB network will be available by 2020 unless new governance arrangements as previously mentioned have been put in place. However, PSAs currently have access to commercial broadband networks providing the opportunity to test options and assumptions to inform the development of a PSMB capability.

Any decision regarding spectrum allocation for a PSMB network will have a long-term impact on the community and PSAs. Australia has the opportunity to learn from international research and development on PSMB networks and it is essential that these decisions are not made in haste to achieve an artificial time line or short term perceived benefit.
It is noted that the NCCGR is due to provide a Review of progress towards achieving the National Interoperability Framework in mid-2015 which could inform these likely hood of meeting the 2020 target date.

Compatibility With A Range of End User Devices

Q46. What potential obstacles exist to a mobile broadband network being fully compatible with a range of end-user devices? Does this depend on the network deployment option?

There are currently a number of available technical solutions to device interoperability. Some of these solutions include the ability to be network interoperable. It is envisaged that the issue of compatibility could be addressed contractually and by negotiation with the jurisdictions.

A further consideration is the size of the current Australian volunteer base within the Emergency Management Sector and the costs of providing end user devices. There have been suggestions that the ultimate consideration will be Bring Your Own device (BYOD) provided this option can be catered for within network security capabilities.

The ability to detail key principals around End User Devices and their interoperability with the PSMB capability should be determined in consultation with the jurisdictional post evaluation of the responses to the Commissions Issues Paper. These key principals should be inclusive of key PSMB capo ability backbone infrastructure, flexibility to be adapted for or by end users, and scalable to cater for the nature of the event and future proofed to deal with over the horizon developments.

The development by the 3GPP of mission critical public safety LTE standards as open standards and the adoption by PSAs of these standards should remove these obstacles. Any decision to adopt a particular vendor-based network solution may result in the selection of a proprietary configuration that locks PSAs into a limited choice of vendor approved products and devices. A decision on spectrum allocation for PSMB capability before the 3GPP mission critical public safety LTE standards are released would be high risk.

Q47. How does the method of ensuring interoperability impact on the cost of the system to PSAs?

The use of mission critical public safety LTE standards should ensure interoperability is achieved with minimal cost increase. This cost increase should be the examined by a CBA to identify the operational benefits achieved from providing this interoperability.

Developing Specific Options for Evaluation

Q48. What detailed options should be evaluated in this study? What underlying assumptions and key parameters would be associated with each option?

The ability to utilise the NBN for backhaul for the PSMB capability should be evaluated as part of the Commission's Study.

The level and cost of initial and on-going training in the use of the PSMB capability to ensure the capability is being fully utilised in the most efficient and cost effective manner at all times and in all situations.

Q49. What (if any) assumptions or parameters should be 'common' across all options?

Common parameters across all options would be Interoperability, roaming, prioritisation, pre-emption, capacity, security, scalability and public safety grade infrastructure.

9.0 Identifying and Estimating Costs

Q50. What are the sources of costs relevant to this study?

To effectively comment of networks costs a further evaluation of responses to the Commission's Issues Paper should be conducted. It is envisaged that there would be a large disparity between a dedicated build, commercial provision and a hybrid evolution type solution. It is considered that the hybrid type solution would be the most cost effective with development and implementation costs amortised over a number of years to complement existing end of service agreements. Regardless of the direct costs a methodology of measuring the indirect costs should also be incorporated that provides an indication of the costs/benefits to regional, state and national communities. This will ensure an appropriate baseline model for any future works or system upgrades should they become necessary.

Costs associated with existing PSA communications systems should be provided by the States and Territories to enable a national picture to be built of current expenditure (capital and recurrent) on mission critical public safety communications.

Q51. In what ways could delivering a PSMB capability affect non PSA users? How would these effects differ across deployment options? What methods could be used to estimate these effects?

Non PSA users could be affected by both being denied access to the spectrum allocated to the PSMB capability or by being offered access to capability that is not being used at a point in time on the basis of a fee for this non priority access. Non PSA users would also be positively affected by the potential enhancement of service delivery and efficiency gains by PSAs provided with a PSMB capability. Alternatively non PSA users would be negatively affected by the loss of opportunity of

these potential enhancements. This approach would be consistent with the recommendation from the Spectrum Review.

Q52. Is it appropriate to consider option values as part of the cost benefit analysis in this study? If so, how? What information or data is relevant?

Any delay in making investment decisions to provide a PSMB capability to Australia's PSAs through any of the options being considered would place Australia even further behind the rest of the developed world in implementing this capability. If considered the Commission's Study should detail the estimated social and economic cost of this delay.

Network Costs

Q53 Are the network cost elements identified in box 4 relevant for this study? What specific cost items would fall within these categories? What other network costs should be considered? What is the nature and materiality of these (and other relevant) costs under alternative PSMB options?

The contents of Box 4 are considered actable for the Commission's Study.

The ability to use the NBN for backhaul for mission critical public safety communications should be specifically examined in the Commission's Study.

The ability to share existing government infrastructure and to use this infrastructure to augment commercial networks to provide the PSMB capability should also be explored.

Q54. What method(s) should be used to estimate the network costs of different deployment options for delivering PSMB? What studies should inform the Commission's thinking in this area?

The body of information and knowledge regarding PSMB capability should be examined together with the research being undertaken by the PSCR into PSMB capability and studies associated with the FirstNet Project should be considered.

Q55. What network cost components are interdependent with other costs, or other parameters (such as assumptions about the amount of spectrum allocated)? What is the nature of these interdependencies?

All the network design parameters and their costs should be assumed to be interdependent on the basis of being able to provide a highly interoperable and resilient PSMB capability. This assumption can be tested and modified through the process of design for delivery of the PSMB capability.

Q56. What data sources could be used to estimate expected PSMB traffic requirements, and the network infrastructure elements required to deliver PSMB capability under different deployment options?

This question has to be based on the demand for access to and service from the PSAs generated by community expectations. This demand will vary directly with the type and scale of event; the continuing development of technologies to meet consumer demand; and the ability of PSAs to be able to leverage these technologies in the most agile manner possible.

The PSCR models would be of use in evaluating traffic estimates for possible deployment options.

Q57. What data sources could be used to estimate the cost of the infrastructure, equipment and operation in delivering PSMB capability under different deployment options?

The commercial carriers should be able to provide the cost of providing the PSMB capability using their infrastructure with the addition of the cost of hardening their networks to meet the requirements of public safety grade mission critical communications. However this information should be expected to be commercially sensitive and probably not available.

It is unlikely that PSAs would be in a position to be able to provide a cost estimate for a PSA PSMB capability given their inexperience with the capability at this point in time. However the PSAs should be able to provide information about infrastructure that they own that could contribute to establishment of a PSMB capability on a PSA owned network.

State and Territory Governments should be able to provide cost estimates that could be used to estimate the cost of a dedicated PSA narrow band network designed, constructed, operated and maintained to public safety grade mission critical communications standards.

These cost estimates should also identify the differences between a PSA narrowband and broadband capabilities for consideration.

Opportunity Costs of Spectrum

Q58. What is the appropriate approach (or approaches) to model the opportunity costs of spectrum under different deployment options? What issues does 'spectrum sharing' raise for estimating these opportunity costs, and how might they be addressed?

The response to this question assumes that agreements can be reached to a definition for mission critical data; the allocation of an amount of spectrum; and its frequency allocation.

The question of the validity of the use of opportunity cost to the allocation of spectrum for PSA use has not been tested or evaluated against the social benefit derived from the use of spectrum. This question needs to be answered first and then further tested and validated against the different methods of deployment.

The ACMA has begun using opportunity cost for the allocation of spectrum and the outcomes to date may be of use in considering this question. The ARCIA study of the economic value of narrowband spectrum for PSAs may also provide some guidance.

Both APCO Australasia and ARCIA provided comment on the use of opportunity cost in the Submissions made to the Department of Communications 900 MHz Review.

The concept of spectrum sharing needs to be considered in three ways consistent with the options to be tested in the Commission's Study:

(a) Sharing between PSAs within a mission critical public safety communications ecosystem;

In this case the opportunity cost relates to which PSA will achieve better outcomes from being able to access spectrum for a specific event i.e. law enforcement agencies versus emergency service agencies which becomes even more complicated because of the multi-agency approach to responding to and management of public safety events. The responsibility for management decisions and accountability for the allocation of the PSMB capability based around the allocation of spectrum becomes a further complicating issue.

(b) Sharing of spectrum between PSAs and commercial carriers where the commercial carrier's networks have been "hardened" to meet public safety grade requirements;

In this case the both the opportunity cost of providing the PSMB capability through use of commercial carriers infrastructure which has been "hardened" by the carrier to met the resilience requirements of mission critical public safety grade communications and the commercial contract arrangements agreed to provide this capability.

The opportunity cost then needs to focus on the cost to commercial carriers of having to provide immediate scalable access to spectrum to meet demand by PSAs versus the commercial value of having access to spectrum allocated to PSAs to meet estimated demand.

(c) Sharing of spectrum between PSAs and commercial carriers where the commercial carrier's networks have not been "hardened" to meet public safety grade requirements;

In this case the opportunity cost would need to take into account the risk of providing the PSMB capability over a non hardened carrier infrastructure versus the commercial value of having access to spectrum allocated to PSAs to meet estimated demand.

In summary the use of opportunity cost applied to the allocation of spectrum both generally and specifically to a PSA PSMB capability is an exercise in risk management which has to take into account both economic and social benefits.

Q59. What data sources could be used to estimate the opportunity costs of spectrum under different deployment options for PSMB?

This question relates to the definition of mission critical data for PSAs which in turn will determine the amount of spectrum required to be able to deliver this data for any particular scenario i.e. business as usual through to major event of disaster.

The absence of PSAs experience the capabilities of PSMB and specifically mission critical data over a PSMB capability will make the estimation of opportunity cost difficult.

The study commissioned in 2014 by ARCIA into the value of LMR spectrum found that the 400 MHz LMR spectrum used in Australia had a value within a range of $1.99billion and $3.72billion and that the that the social benefit was in the order of ten times the economic benefit derived from spectrum use.

As previously mentioned the validity of the use of opportunity cost pricing in relation to PSA spectrum and not allowing for the associated social benefits arising from the use of this spectrum has to be determined.

Other considerations in a Cost Benefit Analysis

Q60. What is the appropriate discount rate, or range of discount rates, to use in this study?

Advice should be sought from the individual State and Territories Departments of Treasury and Finance on this matter.

Q61. How far into the future should costs and benefits be measured?

The time frame will be driven as much by the degree to which PSAs need to leverage consumer technologies to continue to support their capability and capacity to deliver services to meet community demand and build the level of community resilience in existence at any point in time.

Input from specialist researchers or executive training courses in futures thinking and strategy development (https://mteliza.mbs.edu/Strategy-Short-Intensives/Strategy/futures-thinking-and-strategy-development) should be sought together with a review of all PSA corporate planning documentation to determine the degree to which this question had been addressed in PSA planning processes.

State and Territory Government documentation relating to future Land Use Planning should also be reviewed as the demand for PSA services is driven by land use.

The Emergency Management Victoria (EMV) Long term Communications Plan (LTCP) extends to 2025 while the PSCR Location Based Services Study extended to 2040.

It is suggested that for the purpose of the CBA the year 2040 should be used as this will take into account the release to market of the 3GPP mission critical public safety communications standards based products by 2020 and provide a 20 year period in which temporal changes in technologies and consumer demand can be reasonably assessed.

Within this timeframe the cost of refreshing both infrastructure and devices will vary with advances and technologies that PSAs will need to access to keep pace with the matching increase in community expectations e.g. devices will become even more multipurpose and be disposable.

10. Identifying and Estimating Benefits

Q62. What are the sources of benefits relevant to this study?

Identifying and estimating the benefits of a PSMB capability should be the subject of qualitative and quantitative academic research to develop an agreed set of specific measures and benefits with clear definitions of what is being evaluated and how this is being measured.

What is clear is that improved outcomes from PSA use of the PSMB capability directly contributing to improved community resilience should be assessed to enable on-going and future evaluation.

These measures and benefits should be carried forward into the community recovery phase to enable measurement of effectiveness and efficiency to assist in the development of a base line from which to compare improvements. There is potential to utilise a number of previous studies of disasters that have been conducted and a number of higher educational institutions have experience within this field and should be engaged to assist in determining key measurable benefits.

The external measure would be the potential level and quality of service being delivered to the community and its contribution towards building community resilience.

The internal measure would be the potential level of improvement in the efficiency and effectiveness in the PSAs delivering services to the community.

Q63. How can the potential benefits of PSMB capability (in terms of PSA outcomes) be estimated? Is scenario analysis useful? How should scenarios be constructed to reflect an appropriate range of situations faced by PSAs?

PSAs routinely use scenarios for training which rely on the use of mission critical narrowband capabilities. These scenarios could be used as a control sample against which the use of PSMB

capability could be tested and evaluated. Current exercise methodologies have matured sufficiently to be able to test this and this could be explored as an alternate testing mechanism.

PSAs would need to lead the design and manage the conduct of the scenarios and be involved in the evaluation of the results and the documentation of the outcomes in order to have the required level of ownership of both the process and the outcomes.

However this process needs to also include representation from government, industry and academia so that learning's from use of the scenarios are distributed across sectors.

Q64. Can you identify any trials or pilot programs of PSMB capability? Are there any insights to draw from these experiences about potential benefits (or costs)?

The PSCR is conducting research in to the use of PSMB capability by PSAs in the USA. The outcomes from this research are being provided to the FirstNet Project for use in the design of the FirstNet architecture.

The FirstNet Project is running a series of PSMB Projects designed to assess specific capabilities of a PSMB network from which the lessons learned are being used as input to the design of FirstNet.

Q65. Can you identify evidence or examples that illustrate the effects of PSMB capability on PSA outcomes?

See the response to Q 64.

Q66. What method(s) should be used to value the effects of PSMB capability on PSA outcomes?

The establishment of a "baseline" on the methods associated with PSA service delivery using narrowband communications would enable measurement of the impact of the PSMB capability on PSA service delivery.

Q67. Is there research that considers how the costs of responding to natural disasters, crime or other events could be affected if PSAs had access to mobile broadband?

No specific research has been identified although mention is often made in discussion papers e.g. the ITU has produced a report for consideration at WRC 2015 that deals with the impact of PSMB on Personal Protection and Disaster Recovery (PPDR) spectrum.

Reviews of the major inquiries into disasters within Australia (Black Saturday, Victorian floods, Queensland floods and the Tasmanian bush fires) indicate a common theme around communication issues and provide a clear indication of the community's expectations. In short there is common criticism of coverage, capacity, availability and community messaging. A great deal of progress has been made in relation to community messaging via dedicated processes via commercial telecommunications providers, however limited progress has been made in relation to the dedicated networks (for a range of reasons, many contractual).

11. Potential Research Questions

What is the definition of “Mission Critical Data” in the context of public safety sectors?

What is the relationship between a PSMB capability and the introduction of NG000?

What is the relationship between the PSMB capability and the National Broadband Network (NBN)?

What does the Technology Roadmap for the Mission Critical ecosystem look like?

What impact will PSMB capability have on PSA staff and volunteers – the human impact?

12. Acronyms

ACMA: Australian Communications and Media Authority.

APTA: American Public Transport Association.

ARCIA: Australian Radio Communications Industry Association.

APCO: Association of Public Safety Communications Officials.

APT: Asia Pacific Telecommunity.

CAD: Computer Aided Dispatch.

CBA: Cost Benefit Analysis.

CIR: Critical Infrastructure Resilience.

COTS: Commercial Off The Shelf.

CSIRO: Commonwealth Scientific and Industrial Research Organisation.

ECP: Emergency Call Person.

ETSI: European Telecommunications Standards Institute.

DBCDE: The former Department of Broadband Communications and the Digital Economy.

ICT: Information and Communication Technologies.

IPND: Integrated Public Number Database.

ITU: International Telecommunications Union.

LMR: Land Mobile Radio.

LTE: Long term Evolution.

NBN:	National Broadband Network.
NDRS:	National Disaster Resilience Strategy.
NECWG:	National Emergency Communications Working Group.
NPSTC:	National Public Safety Telecommunications Council.
PPDR:	Personal Protection and Disaster Recovery.
PSAP:	Public Safety Answering Point.
PSAs:	Public Safety Agencies.
PSCR:	Public Safety Communications Research Laboratories.
PTIG:	P25 Technology Interest Group.
NBN:	National Broadband Network.
NIST:	National Institute of Standards and Technologies.
PTT:	Push To Talk.
RUSI:	Royal United Services Institute.
SDO:	Standards Development Organisation.
SMRDA:	Southern Melbourne Regional Development Australia.
TETRA:	Trunked Terrestrial Radio Association.
TISN:	Trusted Information Sharing Network.
VPN:	Virtual Private Network.
VSC:	Victorian Spatial Council.
WRC:	World Radio Congress.

Understanding the Changing Nature of Australia's Public Safety Communications Arrangements

Note: Working Draft Version 4. This paper may be subject to change.

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Abstract

Australia's complex public safety communications systems and arrangements provide a critical national capability in protecting and servicing the Australian community to ensure their day to day safety as well has supporting them when a disaster strikes. These systems have been transitioning from analogue to digital technologies and with advent of mobile broadband technology they are set to transform to the next generation of public safety communications capability. The Australian government has a unique opportunity to make technological investment decisions to ensure that there is a balance between establishing a new national public safety communications capability and the achievement of broader community benefits. This paper examines the nature of Australian public safety communications systems and considers how mobile broadband technologies will influence the operational and communications environment used to deliver public safety outcomes and services to the community.

1 Background

Telecommunication capabilities are a critical enabler for the effective delivery of public safety services and responses to disasters. Public safety communications is a term often used to describe the wireless telecommunications networks used by public safety agencies, primarily the police, fire, urban rescue services and emergency medical services. Whilst a full discussion on the technical design and operation of information and communications systems used by public safety officials is beyond the scope of this paper, in general terms in the developed world the predominate environment is a bespoke system based on radio voice communications (Cole & Hawker 2014). These radio voice communications occur on private radio networks which have evolved over time within a specific agency or between a limited number of agencies (Cole & Hawker 2014; Hawkins 2006). Historically, radio voice communications have occurred on analogue radio networks; however these networks have

been gradually transitioning onto digital radio networks. Public safety communications are now developing strategies to move towards the next generation of communications systems so that they can take advantage of technological innovation including Web 2.0 and mobile broadband technologies. It is anticipated that this transition will facilitate significant productivity gains through the use of advanced systems and applications which can be operated on mobile devices, for example mobile incident command and decision support tools. It is also anticipated that this transition will be a key step transforming into the next generation of public safety and disaster management systems.

2 Traditional Public Safety Communications

Public safety radio and communications networks have evolved from basic private radio networks designed to support the day-to-day or business as usual communications requirements of police, fire fighters, emergency medical services and other public safety agency personnel. Whilst disasters and catastrophic events occupy a relatively small portion of the duties performed by these agencies, these same radio communications networks are expected to support the integrated response to extreme events (Cole & Hawker 2014; Cornick & Gathercole 2012; Hawkins 2006). Due to the evolutionary approach that has occurred within individual agencies and jurisdictions, legacy analogue radio networks are complex and fragmented with low levels of interoperability. There has also been a high level of duplication whereby similar networks have been established in similar locations, but for different agencies (Hawkins 2006). The replacement costs for these networks is often unclear although a study conducted in 1998 estimated the replacement cost just for the fixed infrastructure and equipment of the United States of America's Land Mobile Radio (LMR) network was approximately $18.3 Billion USD (Hawkins 2006:24).

Internationally the two key or leading digital radio networks used by public safety agencies are based on either the Project 25 (P25) or Terrestrial Trunked Radio (TETRA) standards (Imel & Hart 2003). These are both based on open design standards which have been developed to improve interoperability and spectrum efficiency as well as supporting a more efficient and economically sustainable manufacture of secure digital radio systems (Imel & Hart 2003). Within Australia legacy public safety analogue radio networks are being replaced by digital radio networks mainly based on the P25 standard.

In Victoria the initial implementation of a multi-agency Metropolitan Mobile Radio network used in the Melbourne metropolitan area by Victoria Police, Ambulance Victoria and the Metropolitan Fire Brigade cost $261 million (VBFRC 2009). In addition to the radio networks, public safety communications systems include paging services, Emergency Alerting Systems and mobile data networks to connect in-vehicle computers to operational databases and radio dispatchers. When the Victorian Mobile Data Network was established data terminals were installed into Ambulance Victoria and metropolitan Victoria Police vehicles at the cost $187 million (VBFRC 2009). In 1999 the South Australia Government radio network consisted of approximately 40,000-45,000 users operating on 28 separate

networks across 17 Government agencies, utilising 1200 communication sites, 12,000 radios and 8,000 pagers. A project was initiated by the South Australian government to establish a new, single integrated State owned Government Radio Network (GRN) for South Australia at an estimated cost of $247.7 million (PoSA 1999:4-5). In Queensland the Government Wireless Network was established to provide an integrated and secure radio communications network for Queensland's public safety agencies especially for major events like the G20 and the 2018 Commonwealth Games. This network cost approximately $457 million (QG 2015). In New South Wales (NSW) the Government Radio Network provides a common platform for NSW government agencies and authorities who use mobile radio communications (NSWGTA 2015). In 2006 the Northern Territory Government allocated approximately $13 million to implement a digital radio network to link Darwin, Katherine and Alice Springs for the police, fire and emergency services (The Drum 2010:4). The Tasmanian Government has invested $29 million in upgrading the Trunk Mobile Radio Network (TMRN) which is mainly used by Tasmania Police and the Tasmanian Electricity Supply Industry (TESI). It is envisaged that the TMRN will form the basis for a whole of government public safety radio network (TAO 2014). In 2012 the Western Australian Government provided $94.5million from the Royalties for Regions program to replace the old analogue Police Regional Radio Network with a P25 digital radio system covering more than 18,000 square kilometres (GoWA 2012).

Whilst these projects mainly relate to upgrading metropolitan integrated government radio networks with a combined value of nearly $2 billion, there are a significant number of legacy and rural networks that are not included in this investment. The exact value of the total (both analogue and digital) public safety communications network investment in Australia is unknown. These projects show that the P25 standard has become Australia's de facto standard for public safety digital radio communications networks.

The current version of the P25 standard contains two key features that could technically support a fully interoperable national public safety radio network across these P25 systems. The first standard is the Inter-RF Subsystem Interface (P25 ISSI) which supports the interfacing of P25 systems from different manufacturers to be directly interconnected at the controller level thereby supporting seamless cross-system intercommunication and system-to-system roaming when operating on same-band wireless radio networks. Similarly, the P25 Console Subsystem Interface (P25 CSSI) feature allows the dispatch consoles from different manufacturers to be connected to the controller/core of other manufacturers' systems (Motorola 2015; Zetron 2010).

2.1 Business as Usual

Public safety agencies normal day-to-day operations are based around either routine activity or a response to a community request for assistance. For example, routine activity includes proactive patrols by police vehicles and patient transportation by medical services. Whereas a request for assistance normally comes via a dedicated three digit telephony service, for

example 911 (United States and Canada), 999 (United Kingdom), 112 (Europe) and 000 (Australia) (UoM 2014).

During routine activity personnel in the field use the public safety radio and communications networks to provide updates on what they are doing and to access information, for example accessing the details of a person's driver licence. With the advent of mobile data terminals, this can include accessing images of a person. Some agencies also use vehicle location systems to automatically transmit a georeferenced location of their vehicles to their communications centres.

When a person uses the dedicated emergency telephony service to request assistance or to report an incident there are generally five key stages of action as shown in Figure 1. These five stages consist of:

- **Call Receipt and Validation**. When a member of the community makes a call to the dedicated telephony service that call goes through a verification process. To do this an automatic number identification (ANI) system captures details of the call (for example the telephone number of the caller) and verifies the address location of the caller from a national address database. The call is handed to the relevant call centre or public safety answering point (PSAP) and directed to the first available operator who will obtain details regarding the incident from the caller and enter those details into the relevant computer-aided dispatch (CAD) system. The CAD system will create a unique job reference for the call (Hawkins 2006). PSAPs often use a system of structured call taking to ensure that all relevant information is obtained from the person calling to ensure that units are dispatched in accordance with agreed response protocols, for example the number and types of units sent to an incident. During this process it is critical that an accurate location of the actual incident is established.
- **Dispatch.** CAD systems are a complex system of systems where communications personnel use general purpose consoles to interface or operate telephones, alarms, paging services, voice radio systems, mobile data systems, record management systems and geographic information systems (GIS). Operational units are tasked by operators via these consoles to respond to the particular issue or incident based on the initial information received, the location of the incident, availability of appropriate units and location of those units with respect to the actual incident. The original call and all conversations between the operator and operational units are recorded into an audio logging system (Hawkins 2006). The logging of calls and the retention of data pertaining to calls is a key accountability mechanism which can also be used to play back the call to check details of a conversation if required or used as evidence during an investigation or court proceeding. This logging system and associated records can also be used to analyse the demand for service and assess the performance of the PSAP.
- **Response.** Operational units then travel to the scene according to agency guidelines, for example depending upon the situation; standard operating procedures may dictate

that a single or multiple units attend the incident. Upon arrival the operational unit (s) assesses the incident and take any relevant action.

- **Response support/escalation**. Depending upon the circumstances and magnitude of the event the first responders may require additional support from other units and agencies or seek additional information from communications personnel. These first responders can include police, fire-fighters and emergency medical services. These first responders need to receive timely information about the incident including location, scope, who else is responding as well as any operational/tactical plans which are developed to resolve or manage the situation (Hawkins 2006). During a significant event like a disaster a dedicated radio channel may be assigned to support the management of the incident. This step allows agencies to continue to deliver normal business as usual services whilst simultaneously responding to the disaster or significant incident.
- **Resolution/finalisation.** Once the incident has been resolved operational units will complete the relevant reports required by their particular agency and the communications officer will complete any relevant case notes or outcomes in the CAD system to finalise the job. Where the incident is a disaster the CAD job will normally be closed once the response phase has concluded. As activity moves into the recovery phase of disaster management an appropriate management system will be implemented by the relevant agencies involved in this activity.

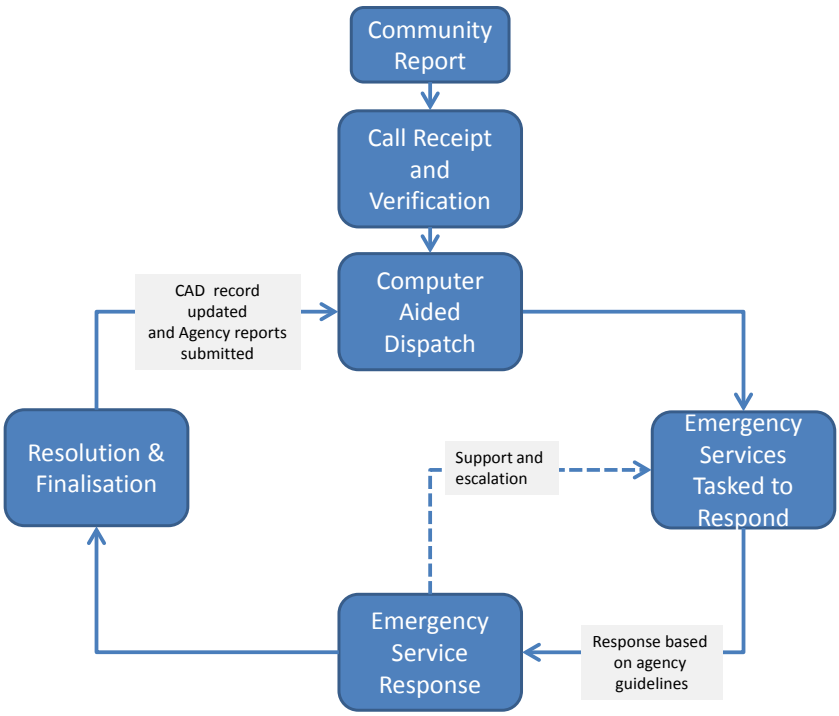

Figure 1 Common Stages of a Modern Emergency Response Process

The CAD system is a critical component of this process and Figure 2 provides an overview of a typical modern CAD system's business work flow. As can be seen in this diagram GIS systems are a key component to an effective CAD system as the location attributes of the incident allows a communications operator to draw together a range of systems as well as

providing the operator with the location of potential response units in relation to the incident (ESRI 2007).

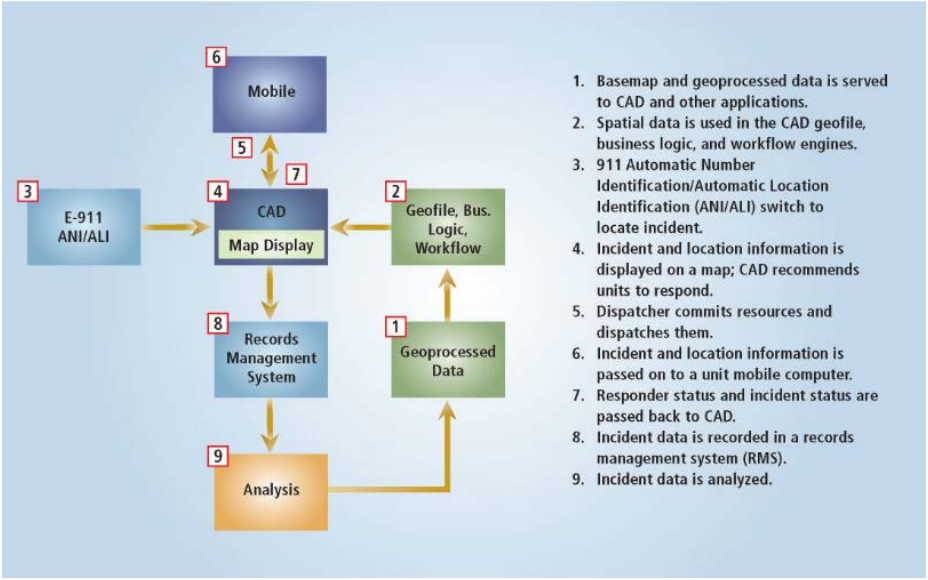

Figure 2 Typical CAD System Data Flow (Source: ESRI 2007:2)

When operating through this process unless they are operating on a integrated radio network like the P25 systems being implemented across Australia, the first responders normally only have access to their own agency's communications systems and some smaller agencies may have very limited communications capability. The location of the incident may result in reduced network coverage and capacity for example when operating in mountainous terrain or in a building. A disaster may also destroy critical communications infrastructure which could potentially reduce the network's coverage and capacity thereby hampering communications (Cole & Hawker 2014).

Internationally, public safety officials are examining and designing how the future dedicated three digit telephony service may operate. This concept is often referred to as the Next Generation or NG applied to the relevant number for example NG911 or NG000 (UoM 2014). Social media is recognised as being a component of this future system; however, an agreed model on how to integrate it or of what role it plays is yet to emerge. At this stage public safety officials are coming to terms with introducing the ability to send a text to a PSAP using these dedicated telephony services (FCC 2014). The integration of a full range of multi-media, especially multi-media sourced via social media, represents a revolution in practice at the PSAP level and it is anticipated that it will be challenging for some agencies. Multi-media received at the PSAP will have the attributes of big data, namely volume, variety and velocity and the historic standard operating procedures based on dispatching resources as a result of a telephone request for assistance will have to be reconceptualised to cope with the onslaught of this data. For example, whilst voice logging has been a key component of the existing system the implications associated with the storage of large volumes of multi-media data are not clear. The psychological impact on staff working within the PSAP, for example

cognitive load limitations and post-traumatic shock associated with viewing and managing this material is also not well understood. The delivery of the next generation public safety communications system will be an iterative process that eventually delivers a robust radio voice and mobile broadband service for public safety officials which can service the needs of the communities that they serve (EMV 2014).

Within both the current and future environment interoperability has been identified as being a critical attribute of emergency response systems and processes. The following section explains the concept of interoperability further.

2.2 Interoperability

Following the 11 September 2001 terrorist attacks in the United States, the lack of communications interoperability was highlighted as a major issue of concern for public safety officials. A subsequent survey by the National Task Force on Interoperability (NTFI) identified five key reasons for this lack of interoperability, namely:

- incompatible and aging communications equipment;
- limited and fragmented funding;
- limited and fragmented planning;
- lack of coordination and cooperation; and
- limited and fragmented radio spectrum.

(Hawkins 2006:22)

The Department of Homeland Security (DHS) has since developed the Interoperability Continuum as a tool to improve emergency response communications and interoperability (Hawkins 2006). The lack of communications interoperability across and between Victorian emergency services was a key issue which was examined during the Victoria Bushfire Royal Commission in 2009 (VBFRC 2009). Under the DHS Continuum interoperability must address five key dimensions, namely:

- Governance;
- Standard Operating Procedures;
- Technology;
- Training and exercises; and
- Usage.

(Hawkins 2006:42)

As can be seen in Figure 3, interoperability maturity can be evaluated across these five dimensions as an agency moves from an internal or individual focus towards a broader integrated or networked framework. Under this model, the placement of an agency along the continuum is an indication of an agency's level of leadership, planning and collaboration. The value of this interoperability continuum has been recognised around the world, for example it now forms the basis for the *Communications Interoperability Strategy for Canada* (GoC 2011). With the advent of public safety mobile broadband capability the findings of the NTFI

and the DHS interoperability continuum can be used as a guide to strategically plan the development of the next generation of interoperable public safety communications systems based on mobile broadband technologies. This progress is 'expected to follow a multi-path approach to network infrastructure use and development' (DHS 2014:8). Mobile broadband capability is set to transform how emergency response personnel communicate and access information. The unparalleled connectivity and bandwidth will enable the development of advanced applications which provide significantly enhanced levels of situation awareness, operational efficiency and service deliver to the community (DHS 2014).

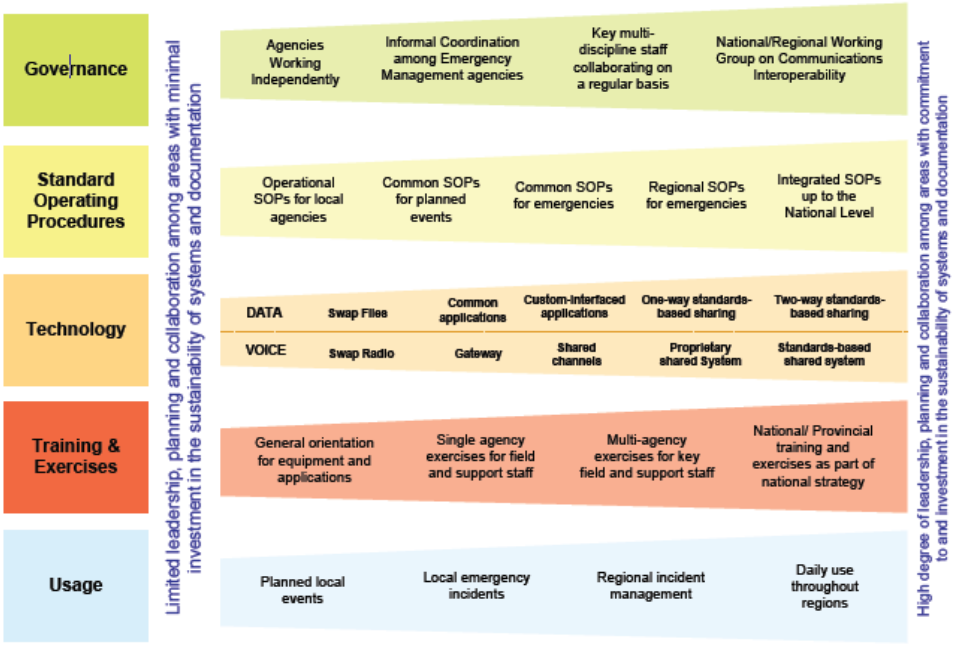

Figure 3 Interoperability Continuum (Source: GoC 2011:12)

Within Australia the Council of Australian Governments (COAG) has endorsed the National Framework to Improve Government Radio Communications Interoperability 2010-2020 (NCCGR 2009). This Framework outlines a number of guiding principles and key areas of work over a 10 year period to align technical requirements with their procurement cycles with a view of enabling the transition towards radio communications interoperability across jurisdictions. As shown in Figure 4 there are a range of committees involved in implementing this framework under a complex reporting and communications structure. An evaluation of the effectiveness of this governance structure is outside the scope of this paper.

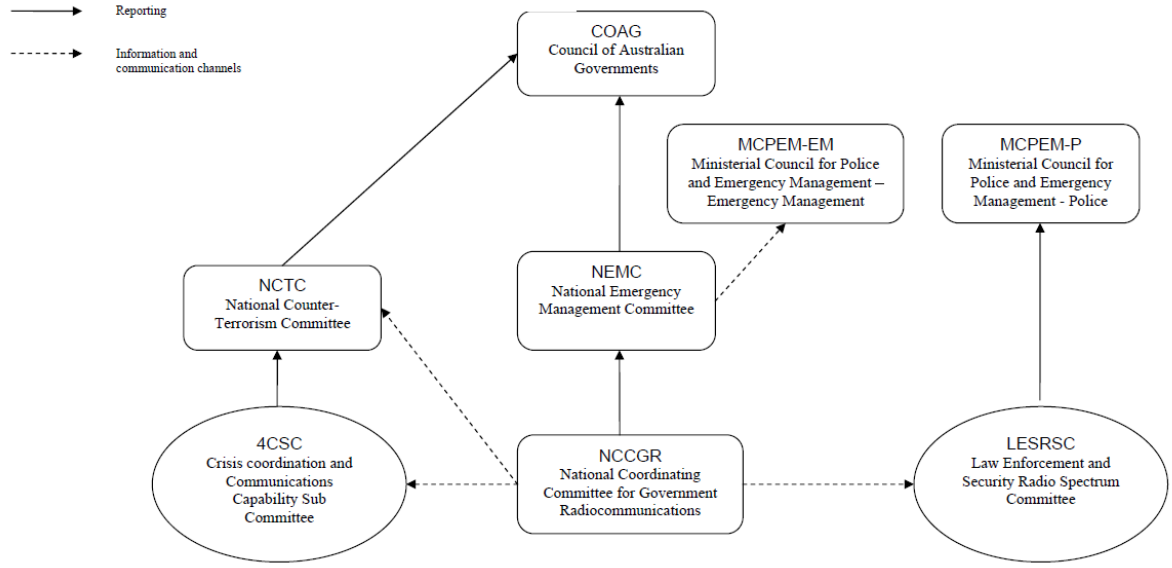

Figure 4 National Framework Reporting and Communications and Information Arrangements(Source: NCCGR 2009:i)

This Framework's seven guiding principles are:

1. Jurisdictions to work together to develop a framework to deliver an appropriate level of interoperability between and across jurisdictions and agencies;
2. Jurisdictions to work collaboratively to establish a national baseline [plan] of interoperability with existing systems and develop transitional interoperability arrangements pending the adoption of future systems;
3. Jurisdictions to work collaboratively to define interoperability standards;
4. Jurisdictions to work collaboratively towards harmonising and aligning technologies, including addressing any impediments to moving towards fully compatible mobile radio networks;
5. Jurisdictions to develop and implement networks in appropriately identified harmonised spectrum;
6. Jurisdictions to establish arrangements for the effective and efficient operation of radio communications equipment nationally; and
7. Jurisdictions to assess common requirements for high speed mobile data interoperability as well as assessing emerging technologies that support increased interoperability.

(NCCGR 2009)

The financial cost of disasters in Australia has been projected to increase from a current annual cost of $6.3 billion to approximately $23 billion a year by 2050 (DAE 2013:5). This increase is due to the increasing population density in Australia and the increasing frequency and severity of storms, floods, cyclones and bushfires across the nation. Investments made in interoperable public safety communications systems including the next generation of mobile broadband solutions will help to reduce the cost of disasters in Australia. COAG has previously identified that 'shortcomings in communications systems have been a recurrent theme in past coronial inquests and independent inquiries' (NCCGR 2009:6). Whilst these seven principles are useful, the Framework itself is not of a standard that could be described

as a National Public Safety Communications Plan which is surprising given COAG's previous observation and the value of investments being made in public safety communications networks. Due to the complexity of the new public safety communications environment the US Department of Homeland Security has developed the National emergency communications Plan to 'accelerate improvements for public safety communications nationwide' (DHS 2014:v). As disasters frequently cross Australian jurisdictional boundaries and have a national impact there is a need to develop a similar type of national plan within Australia.

To fully understand and appreciate interoperability, public safety communications needs to be conceptualised as an ecosystem that enables public safety officials to deliver a critical service to the community (DHS 2014). As represented in Figure 5, attempts to modernise public safety communications have shown that this ecosystems is made up of a number of inter-related components and functions that now include 'communications for incidents response operations, notifications and alerts and warnings, requests for assistance and reporting, and public information exchange' (DHS 2014:11).

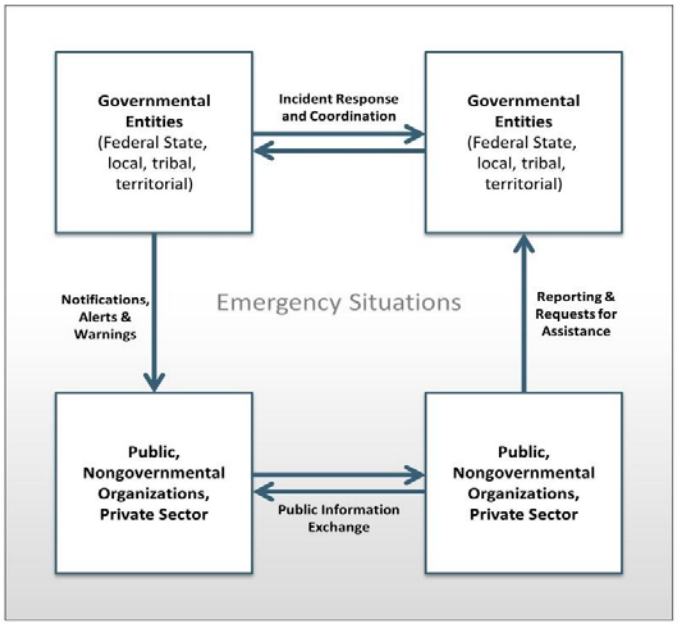

Figure 5 Emergency Communications Ecosystem (Source: DHS 2014:11)

As discussed in Section 2, this ecosystem has to operate during both business as usual operations as well as during the response to catastrophic events. Whilst business as usual operations normally occur within jurisdictional boarders, catastrophic events have a national impact and generally involve a national response. For optimal efficiency and service delivery a maximum level of interoperability needs to achieved between all stakeholders operating within this ecosystem. Whilst a mobile broadband network provides the wireless interface it enables the development of a significant range of devices and capabilities which can be used by public safety personnel. The next section discusses potential capabilities and issues associated with mobile broadband capabilities.

2.3 Mobile Broadband

Whilst public safety officials have had the capability to access limited mobile data services, new developments in technologies provide an extensive range of tools and services which are becoming more prominent within the public safety agencies and the community more generally. Officials are now trying to understand these tools and define mission critical data (Cole & Hawker 2014; Cornick & Gathercole 2012; DHS 2011a). These developments are occurring on commercial mobile broadband networks; however the establishment of a dedicated mobile public safety broadband network represents the most significant enhancement to public safety communications in recent history (Cole & Hawker 2014; Cornick & Gathercole 2012; DHS 2011a; UoM 2014).

Public safety agency use of mobile devices like tablets, smartphones and laptop computers on commercial mobile data networks has raised the awareness of the potential of new tools and devices on a dedicated public safety mobile broadband network to increase emergency preparedness and response capabilities (DHS 2011). These tools include the ability to access video streaming in the field, advanced decision support applications and the ability to simultaneously collaborate on a virtual platform when developing tactical plans. Potential applications for a dedicated public safety mobile broadband network include:

- Automatic Vehicle/Personnel/Asset Location;
- Incident Command White Board;
- Aerial Video;
- Vehicle-Mounted Video;
- Helmet and Body worn Cameras;
- Mapping/Location Based Services;
- Large Data File Transfers;
- Telemetry;
- Third-Party Camera Resources;
- Mobile Data Computers;
- Patient, Evacuee, and Deceased Tracking;
- Internet Connection;
- Voice over LTE Communications;
- Video Conferencing;
- Sensing and Monitoring devices;
- Augmented Reality Environments;
- Bio Telemetry; and
- Third-Party Sensors.

(Cornick & Gathercole 2012; DHS 2011:5; DHS2014:9)

Robson (2014:13) identified that faster broadband has the potential to provide a range of benefits including:

- increased benefits from using existing products as well as benefits derived from using new products and services;
- efficiency gains in terms of time savings and productivity improvements;
- reduced transaction costs; and
- travel time savings.

As public safety officials have more exposure and use of mobile broadband enabled devices on commercial networks their attitudes regarding what applications are important has changed. For example, in the United Kingdom a questionnaire was given to public safety officials where they were asked to identify what features they thought were very important. This study was conducted in 2009 and again in 2014 and as shown in Table 1 the importance of voice, internet access to information and access to incident management systems increased where as the focus on video streaming decreased (Cole & Hawker 2014).

Functionality	**2009**	**2014**
Voice	87.5%	100%
Images	49%	44%
Video Streaming (Live)	47%	19%
GIS	76%	88%
Access Information via the Internet	61%	88%
Access information on Incident Management Systems	65%	75%

Table 1 Perceived Functionality Requirements (Source: Cole & Hawker 2014:28)

As identified in a recent study in the United States, the *'development of a nationwide public safety broadband network, for data, video and eventually voice communications between and among first responders and emergency call centers and control rooms, poses questions regarding myriad prospects of coordination, funding, resource sharing and interoperability yet to be fully explored. These matters must be weighed in conjunction with investments to be made for improving emergency calling and establishing NextGen 911 networks and systems'* (Magnussen 2015:3). This observation is equally relevant to the Australian public safety communications ecosystem.

Within Australia a range of options for the technical design of a public safety broadband network have been suggested; however a universally accepted design is yet to emerge (Cornick & Gathercole 2012). New technologies to support Deployable Airborne Communications Architecture (DACA) are also emerging (ABSOLUTE 2015; FCC 2011). These types of innovations and technology introduce new approaches to the traditional design of communications networks based on tower, satellite and microwave air-interfaces. Figure 6 attempts to provide a high-level overview of the emerging public safety communications ecosystem. As shown in this image there are six critical elements, namely the ability of the

community to contact the public safety answering point (PSAP), the internal functions and processes within the PSAP, the air interface with mobile units, the backhaul transmission networks, access to sensor networks and agency record management systems and applications. Community emergency alert systems should be considered within this system during the response to disasters.

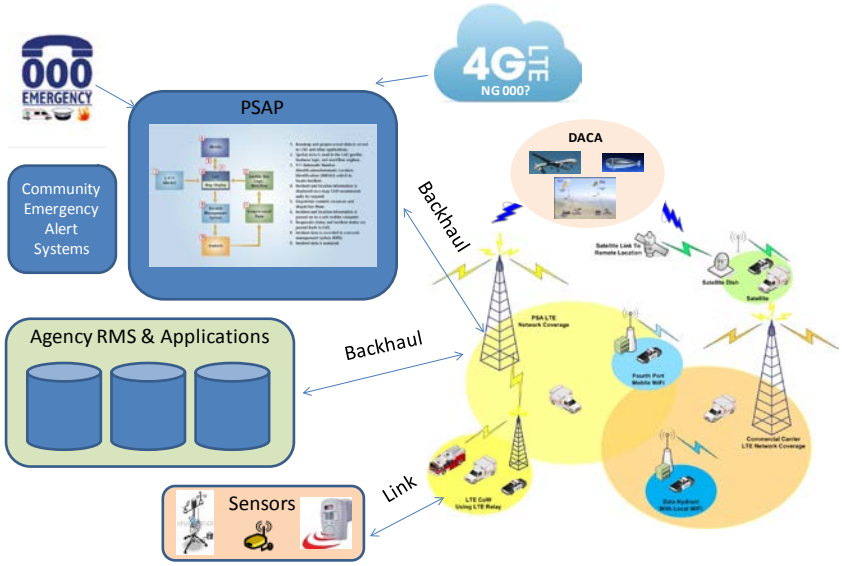

Figure 6 Public Safety Communications Ecosystem (Source Adapted from Cornick & Gathercole 2012:35)

Within Australia there are a number of reviews and developments currently underway which will have a significant impact on this ecosystem, namely:

- the 000 Review which looks at the dedicated triple digit telephone service and the potential for it to capture a range of alternative data formats for example videos and images. This equates to the initial receipt of information from the community;
- the role out of the National Broadband Network (NBN). This relates to the potential backhaul mechanisms; however to date the potential of the NBN to support the national backhaul requirements of a national or state/territory public safety communications network doesn't appear to have been fully considered;
- The Department of Communications Spectrum Review which relates to radio spectrum generally or the general air interface for radio networks; and
- the Productivity Commission's public safety mobile broadband review which relates to the broadband air interface (presumably based on LTE/4G technology).

In the absence of greater coordination, the fragmented approach of these reviews may deliver sub-optimal public safety outcomes. This situation is further exacerbated by the constitutional arrangements governing the roles and responsibilities of the Australian Government and the State/Territory Governments. Despite these challenges the Australian government is in a unique position to make strategic investments decisions which will enhance the long term national public safety communications capability. To do this it is essential that a national public safety communications plan be developed to provide a sound foundation to develop and fund an integrated national capability. This plan would include the

development of a technical design for a system of systems to support the national public safety communications ecosystem. It should also consider the impact of developing technologies, for example 5G and quantum communications capabilities. The plan would also have take into account of the changing nature of public safety communications whereby there are a greater number of tiers of communications requirements beyond the requirements of the traditional first responders. This type of approach would reduce the operating cost of supporting legacy technology and provide a higher level of interoperability across a broader range of stakeholders (Magnussen 2015). It will also help to enhance the benefits of the investments made in the national public safety communications capability for the Australian community. For example Figure 7 demonstrates four tiers of stakeholders that should be considered within a holistic public safety communications ecosystem.

These tiers consist of:

- **First Response** which consist of the traditional public safety agencies, primarily the police, fire, urban rescue services and emergency medical services;
- **Support Agencies** which consist of a range of agencies and organisations that provide critical support to the first response public safety agencies depending upon the type incident or extent of a disaster, for example State Emergency Services (SES) and Environmental Protection Agency (EPA). During large scale and catastrophic events national agreements and mechanisms can be used to secure the Australian Defence Forces to support specific aspects of the disaster response and recovery;
- **Critical Stakeholders** can be a broad and diverse range of government departments (national, state/territory or municipal), agencies and owners and operators of critical infrastructure; and
- **The Community** served by the public safety agencies. During the early stages of a disaster it is often the impacted community itself which provides the initial response whilst the official response is activated.

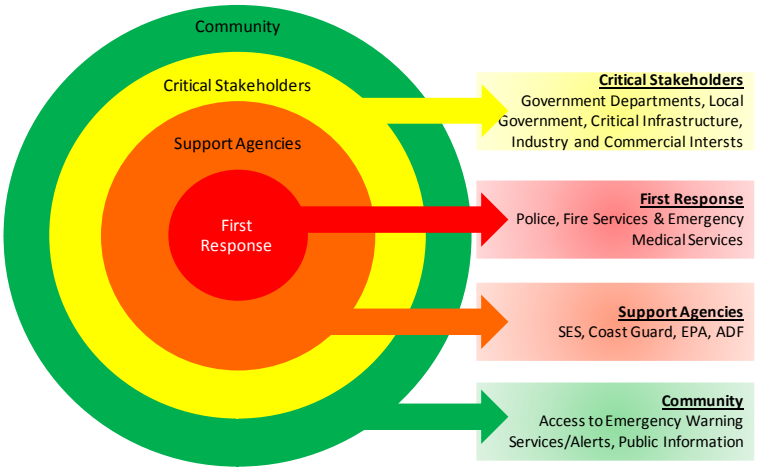

Figure 7 Tiers of Public Safety Communications Stakeholders

At these different levels there will be different information and communications requirements which will lend themselves to a range of technical and procedural interventions.

The potential advantages and opportunities of mobile broadband capability are significant; however, there has to be radio spectrum available to support the wireless air interface of the network. The following section outlines issues associated with spectrum allocation.

2.4 Spectrum Allocation

Spectrum associated with the mobile broadband air interface is a scarce and valuable public resource and as such it should be considered a valuable public asset (Freyens & Yerokin 2011, PJCLE 2013). Allocative and technically efficient methods are common approaches towards spectrum management (Freyens & Yerokin 2011). Collectively these approaches feed into economic efficiency but *"high rates of spectrum and technical efficiency may just be too costly to achieve compared to the benefits they create to a society as a whole"* (Freyens & Yerokin 2011:5). Alternatively as observed in the Australian rural areas, the speculative acquisition of spectrum may result in band idleness thereby reducing community benefits (Freyens & Yerokin 2011).

Globally, internet access is increasingly being recognised as a fundamental right with a number of countries officially recognising this right through legislation and official degrees as has occurred in Estonia, France, Costa Rica and Finland (UN 2011). The United Nations Special Rapporteur on Human Rights has observed that *'without Internet access, which facilitates economic development and the enjoyment of a range of human rights, marginalized groups and developing States remain trapped in a disadvantaged situation, thereby perpetuating inequality both within and between States'* (UN 2011:17).

Spectrum dedicated for public safety mobile broadband use can be based on a dedicated, shared or commercial network. As shown in Canadian research the traditional first response groups often prefer to have their own dedicated propriety system rather than sharing a network with commercial interests (CATA 2012). Given the cost of government radio voice networks, the funding stream for a dedicated public safety mobile broadband network using this approach is unclear. What is clear is that the provision of public safety communications is an evolutionary process as shown in Figure 8. The experience that agencies are obtaining using commercial wireless broadband networks will help them to understand the requirements of a public safety broadband network and provide the evidence base for supporting the Australian Government's decisions regarding spectrum allocation.

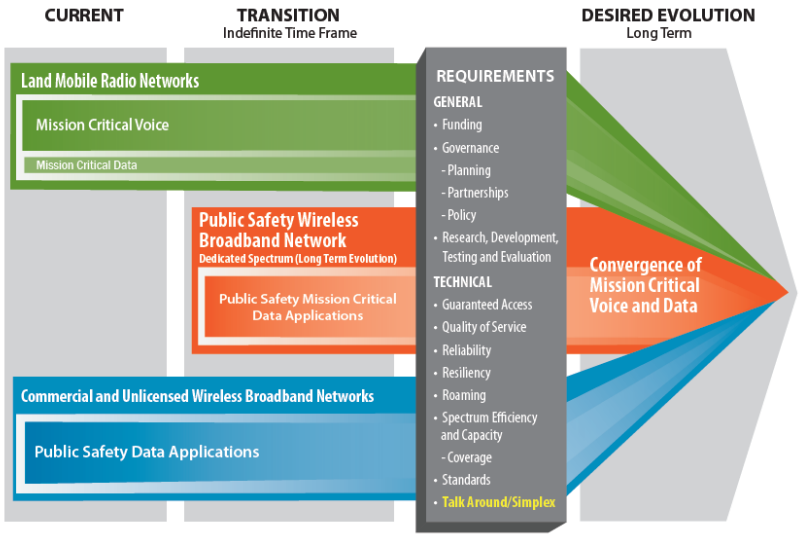

Figure 8 Public Safety Communications Evolution (Source: DHS 2011:4)

Given the scarcity and value of spectrum, any decision regarding its allocation for public safety communications needs to be balanced against broader public interests (Robson 2014). This decision should consider the potential financial benefits from releasing spectrum for commercial interests with a view of generating income which can support, at least in part, support the establishment of a national public safety broadband capability. Similarly, State/Territory governments may be able to generate income or reduce their jurisdictional cost liability from leasing or selling their existing communications infrastructure, for example radio towers to support the national role out of a mobile broadband network. The global demand for wireless devices and associated data-intensive applications are forcing governments around the world to optimise spectral efficiency and release more spectrum to commercial interests. This process includes developing new situational aware spectrum sharing technologies and the development of responsive ongoing spectrum regulatory and policy changes (DoD 2013). The Australian Government's strategic decisions regarding spectrum allocation will have a long term impact on both the community and the public safety communications ecosystem. As a result the final spectrum allocation strategy needs to consider communications trends and issues which may influence this ecosystem over the short to long term. The United Kingdom has developed their spectrum strategy against a timeline that identifies key events that will influence future spectrum allocation decisions as demonstrated in Figure 9 (DCMS 2014:43). A similar timeline highlighting international, national and jurisdictional issues/events relating to Australian public safety communications would assist the Australian Government's strategic decision making process.

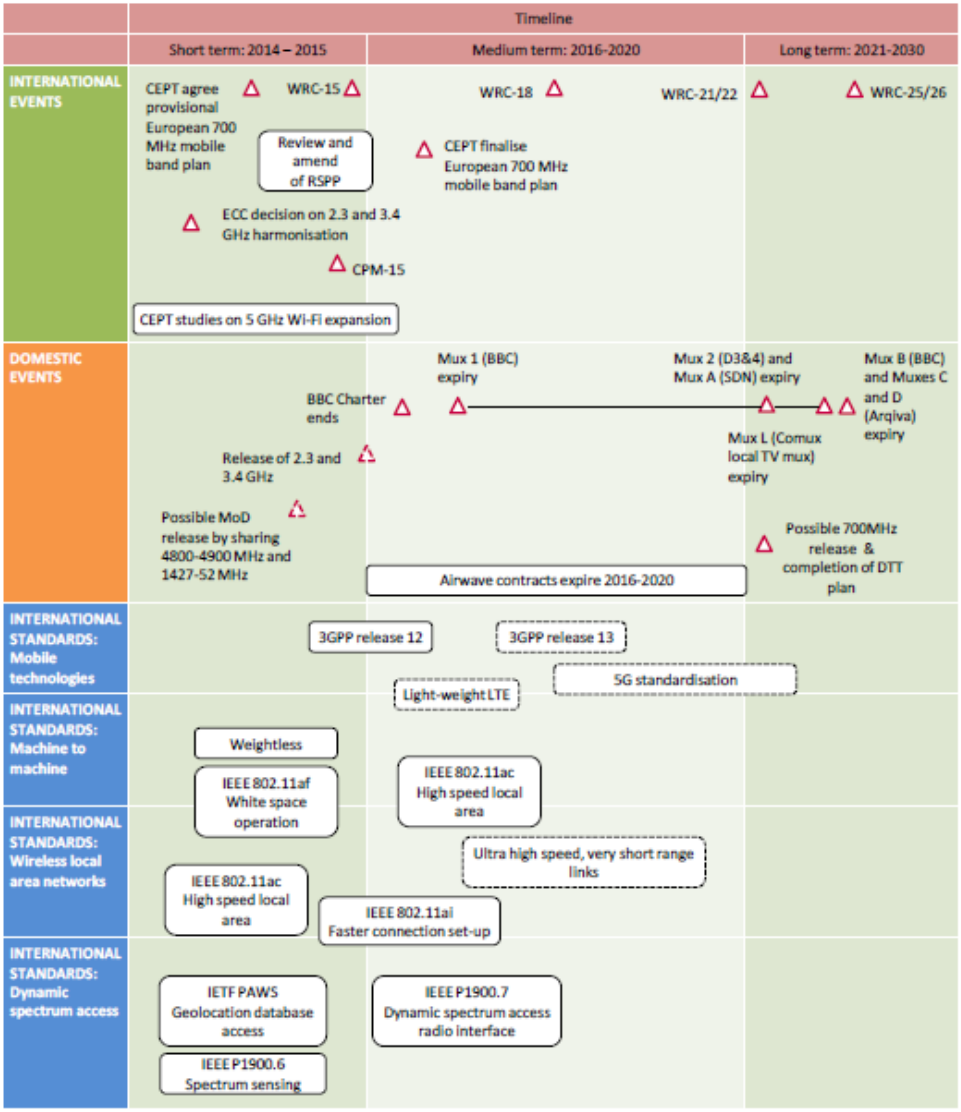

Figure 9 Timeline of key events for future spectrum use in the UK (Source: DCMS 2014:43)

The Australian Governments decision regarding spectrum allocation is a critical step in establishing a national public safety broadband capability; however, a full cost benefit analysis can not be conducted until a broader range of issues have been resolved. The following section highlights some of these broader issues.

2.5 Broader Issues

As discussed in Section 2.3 the wireless interface is only one element of the public safety communications ecosystem, however its commercial potential may support the development and establishment of the other five elements. The release of spectrum for a public safety mobile broadband network will not automatically guarantee that jurisdictions are capable of investing in this new capability by 2020 as articulated in the National Framework to Improve Government Radio Communications Interoperability 2010-2020 due to jurisdictional budget allocation and procurement processes (NCCGR 2009). Robson (2014:11) has previously attempted to clarify the uncertainty cost-benefits of broadband networks and this approach can be used to determine the potential cost-benefit of a public safety mobile broadband

capability. When this approach is applied to estimate the jurisdictional take-up rate of public safety mobile broadband capability it is anticipated that three broad scenarios will emerge, namely:

- **Pessimistic** scenarios where there is delayed take-up rate;
- **Intermediate** scenarios where there is a moderate take-up rate across jurisdictions or within a jurisdiction for example only in capital cities; and
- **Optimistic** scenarios where there is a rapid and widespread take-up rate.

There are also a number of unresolved issues that need to be determined to inform any strategic decision regarding spectrum allocation. These issues include:

- Clarifying the current extent of the existing investment in and capability of public safety communications;
- Evaluating the effectiveness of the national governance structure for strategically planning and developing the national public safety communications capability;
- The development of a national plan and road map to realise the potential benefits of a the national public safety communications capability that includes public safety mobile broadband;
- Clarifying the principles to guide the development of a national public safety mobile broadband capability, for example should the capability be based on business as usual requirements or cater for range of disaster incident modalities;
- Establishing an agreed understanding of what constitutes mission critical data;
- Determining what is the desired level of capability, for example an optimal capability or the minimum acceptable capability;
- Establishing the technical design and approximate cost (both capital and operational expenditure) of a public safety mobile network at a national and jurisdiction level based on a dedicated, shared and commercial network;
- Establishing the approximate cost (both capital and operational expenditure) of a terminals and devices that will operate on the public safety mobile network at a national and jurisdiction;
- Analysing the impact of mobile broadband on Australia's PSAPs (including an assessment of the financial, technical, operational, procedural, staffing, psychological, design and cost impacts); and
- Analysing the change management impacts at a national and international level, for example training programs.

The guiding principles within the National Framework to Improve Government Radio Communications Interoperability 2010-2020 align to a number of these issues. If the Framework has been successful the various jurisdiction representatives should be able to supply this information, at least in part fairly quickly.

3 Conclusion

Australia’s public safety communications systems have evolved from bespoke analogue radio networks. These networks have been supported by a national dedicated triple digit telephony service which allows the community to request assistance and report matters to public safety agencies. These legacy systems tend to be siloed and as a result there is a low

level of interoperability between agencies. Over the last decade jurisdictions around Australia have invested nearly $2 billion to transition a number of key networks onto secure digital radio networks. As a result of this evolutionary process Australia now has a complex public safety communications ecosystem that needs to service a range of stakeholders which are much broader than the traditional range of public safety agencies.

Advances in technology have led to the development of mobile broadband capability and Australian Governments at the national and jurisdictional level are evaluating the potential impact and opportunities of these developments. Spectrum to support the wireless air interface of this technology is a rare and valuable national resource. The global demand for spectrum to support wireless devices and associated data-intensive applications is both a challenge and an opportunity. New situationally-aware spectrum sharing technologies and the development of deployable airborne communications architecture provide new options for developing mobile communications networks. As the Australian community's uptake of new technology evolves, so does their expectations of public safety agencies ability to deliver services. The recurrent highlighting of shortcomings in communications systems during coronial inquests, inquiries and commissions indicates that the use of mobile broadband technologies will be an area of scrutiny in the future. Given the forecast annual cost of disasters growing to $23 billion by 2050 the investment in public safety mobile broadband is likely to deliver significant ongoing savings and national benefits. At the end of the day public safety agencies require a capability so that they can service their community. As long as a mission critical level of service can be delivered to these public safety agencies it should not matter if that service is delivered via a dedicated, shared or commercial network.

Access to a national mobile public safety broadband capability represents the most significant enhancement to public safety communications in history and it is a key step transforming into the next generation of public safety and disaster management systems. The release of spectrum for a public safety mobile broadband network will not automatically guarantee that jurisdictions are capable of investing in this new capability. A balanced and strategic decision on spectrum allocation including the release of spectrum to commercial interests should be made as part of an overall national plan to ensure that Australia can take advantage of this opportunity. Similarly, any decision regarding the wireless air interface has to be made in the context of the impact on the overall public safety communications ecosystem. The release of spectrum for mobile broadband services to commercial interests as part of either a shared or commercial network approach needs to be evaluated as a potential strategy to fund the development of a national mobile public safety broadband capability.

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