



Australian Government
Productivity Commission

Public Safety
Mobile Broadband

Productivity Commission
Issues Paper

April 2015

The Issues Paper

The Commission has released this issues paper to assist individuals and organisations to prepare submissions to the study into public safety mobile broadband. It outlines:

- the scope of the study
- the Commission's procedures
- matters about which the Commission is seeking comment and information
- how to make a submission.

Participants should not feel that they are restricted to comment only on matters raised in the issues paper. The Commission wishes to receive information and comment on issues which participants consider relevant to the study's terms of reference.

Key study dates

Receipt of terms of reference	25 March 2015
Due date for initial submissions	25 May 2015
Technical workshops	June 2015
Release of draft report	Late August / Early September 2015
Draft report public roundtables	September 2015
Due date for submissions on draft report	October 2015
Final report to Government	December 2015

Submissions can be made

By email:	psmb@pc.gov.au
By post:	Public Safety Mobile Broadband Productivity Commission Locked Bag 2, Collins Street Melbourne VIC 8003

Contacts

Administrative matters:	Carole Gardner	Ph: (03) 9653 2194
Other matters:	Carl Toohey	Ph: (03) 9653 2114
Freecall number for regional areas:	1800 020 083	
Website	www.pc.gov.au	

The Productivity Commission

The Productivity Commission is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed most simply, is to help governments make better policies, in the long term interest of the Australian community.

The Commission's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

Further information on the Productivity Commission can be obtained from the Commission's website (www.pc.gov.au).

Terms of reference

PUBLIC SAFETY MOBILE BROADBAND

Productivity Commission Act 1998

I, Joseph Benedict Hockey, Treasurer, pursuant to Parts 2 and 4 of the *Productivity Commission Act 1998*, hereby request that the Productivity Commission (the Commission) undertake a study into the best way to secure a mobile broadband capability to meet the long term needs of Australia's public safety agencies (PSAs): the police, fire, ambulance and emergency services.

Background

A robust and effective mobile broadband capability is a critical enabler for Australia's PSAs.

Since June 2011, the Commonwealth has worked with jurisdictions and PSAs — through the Council of Australian Governments (COAG) Public Safety Mobile Broadband (PSMB) Steering Committee — to consider how best to deliver a strong PSMB capability. On 19 April 2013, COAG transferred responsibility for PSMB from the Steering Committee to COAG Senior Officials and, in doing so, noted the need for PSAs to have adequate capabilities to respond efficiently and effectively when disasters occur.

Delivering a PSMB capability is complex and involves using scarce and valuable resources, such as radiocommunications spectrum, to further the public interest. To inform this work and ensure the best path forward, the Commonwealth considers it appropriate to undertake a rigorous analysis of the most efficient, effective and economical means of developing Australia's PSMB capability.

Scope of the study

The Commission is to undertake a 'first principles' analysis of the most efficient, effective and economical way of delivering this capability by 2020, to coincide with the nationally agreed framework to improve government radio communications, including interoperability¹. Particular regard should be given to:

1. The most cost-effective combination of private and public inputs, services and expertise to deliver the capability. This should include an assessment of the relative costs, benefits and risks of:
 - (a) deploying a dedicated PSMB network
 - (b) an approach that is fully reliant on commercial networks, and/or

¹ This is outlined in the COAG-endorsed National Framework to Improve Government Radiocommunications Interoperability 2010-2020.

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- (c) a combination of the two.
2. The ability for the capability to:
 - (a) be nationally interoperable, within and across agencies and jurisdictions
 - (b) operate in both metropolitan and regional Australia
 - (c) integrate voice communications that are traditionally carried on narrowband networks
 - (d) maintain integrity and security of communications
 - (e) ensure accessibility, priority and sufficient capacity for PSAs, particularly during periods of peak demand and during a localised incident
 - (f) be resilient and maintain continuity of service including under adverse operating circumstances
 - (g) consider the sustainability of arrangements in the context of rapidly changing technology and increased demand, including convergence of voice and data services
 - (h) be cost-effective, in terms of both capital and operating cost
 - (i) be nationally available by or before 2020, and
 - (j) be compatible with a variety of end-user devices.
 3. Relevant domestic and international reports and experiences (e.g. work underway through the Asia Pacific Telecommunity Wireless Group (AWG), International Telecommunication Union (ITU), 3rd Generation Partnership Project (3GPP) and implementation of similar capability in other countries) that may be applicable to Australia.

In conducting the analysis, the Commission is to have regard to the Australian Communications and Media Authority's (ACMA) role as the independent national regulator and technical expert on communications matters, with final decision-making responsibility for allocation of and conditions of access to spectrum. The Commission should also, where practicable, have regard to the Government's broader review of the spectrum policy and management framework.

Based on information provided by PSAs about their operational requirements, the ACMA has previously conducted an engineering analysis into the spectrum requirements for a PSMB capability. This analysis was carried out within parameters established by the Public Safety Mobile Broadband Steering Committee (PSMBSC) and the Terms of Reference for that committee. However, spectrum alone will not achieve a PSMB capability as infrastructure and supporting networks with compatible end-user equipment are required. The Commission's analysis is concerned with an overall consideration of the most efficient, effective and economical way of delivering this capability, including a re-evaluation of user needs and project requirements given the passage of time.

Process

The Commission is to consult broadly, including with industry and non-government stakeholders, state and territory governments, and PSAs and relevant Commonwealth agencies.

The Commission will produce a draft and a final Report, both of which will be published. The final Report is to be provided to the Government within nine months of the receipt of these Terms of Reference.

J. B. HOCKEY

Treasurer

[Received 25 March 2015]

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1 What is this study about?

The Australian Government has asked the Productivity Commission to consider the best way to deliver a mobile broadband capability to meet the long term needs of public safety agencies (PSAs) — the police, fire, ambulance and other emergency services.

Specifically, the Commission has been asked to undertake a ‘first principles’ analysis of the most efficient, effective and economical way of delivering a public safety mobile broadband (PSMB) capability to PSAs by 2020, giving consideration to:

- the relative costs, benefits and risks of different options
- particular characteristics of the capability provided to PSAs (such as operation in metropolitan and regional Australia; integrity and security; resilience; and ensuring accessibility, priority and sufficient capacity during peak demand periods) that are important given the mission critical circumstances they operate in
- other characteristics (such as interoperability across agencies and jurisdictions, compatibility with a variety of end-user devices, sustainability and cost-effectiveness)
- relevant domestic and international reports and experiences.

2 How can you contribute to this study?

The Commission wants to gather your ideas, views, information and evidence to ensure that this study is well-informed and relevant. We are seeking submissions from PSAs, communication service and equipment providers, state and territory governments, relevant Commonwealth agencies and other interested parties.

We have released this issues paper to assist you in the preparation of initial submissions. It identifies a range of matters about which feedback and information is sought. However, **you do not need to address every question in this paper; nor do you need to limit submissions to the issues raised.**

Where possible, you should provide evidence in support of views, such as data and documentation. The Commission has a strong preference for public submissions so the material is fully available for use in Commission reports, but will accept confidential information where necessary. Attachment A provides further details about how to make a submission.

3 The Commission's proposed approach

The principal objective of this study is to identify the most efficient, effective and economical way of delivering a PSMB capability to PSAs by 2020, using a 'first principles' analysis (box 1). This includes assessing the relative costs, benefits and risks of alternative options for deploying PSMB capability. In broad terms, the options include:

- establishing a dedicated PSMB network
- relying fully on commercial networks
- some combination of the two.

To support this work, the Commission considers that there would be merit in using cost benefit analysis (CBA). CBA provides a framework to evaluate and compare information about different options (including their associated costs and benefits). Moreover, this approach is consistent with the Commission's Act, which requires that it have regard to enhancing the wellbeing of the community as a whole.

Box 1 A 'first principles' analysis

The Commission is proposing to undertake its first principles analysis drawing on principles for best practice policy and regulation, and cost-benefit analysis. The general approach the Commission intends to apply in this study is outlined below.

- *Identify the issue to be addressed* — Providing mobile broadband capability to PSAs.
- *Identify the policy objectives* — The most efficient, effective and economical way of delivering this capability.
- *Identify any constraints* — Consider the ability of the capability to be: nationally interoperable; operate in both metropolitan and regional Australia; integrate voice communications traditionally carried on narrowband networks; maintain integrity and security of communications; ensure accessibility, priority and sufficient capacity for PSAs (particularly during peak periods of demand during a localised incident); resilient and maintain continuity of services including under adverse operating circumstances; sustainable in the context of changing technology and increased demand; nationally available by or before 2020; and compatible with a variety of end-user devices.
- *Identify options* — Consider three broad approaches: deploying a dedicated PSMB network, relying on commercial networks, or some combination of the two. While these categories provide broad guidance, specific options will be developed and evaluated in this study in order to establish the best way forward.
- *Evaluate the costs, benefits and risks of different options* — Identify the sources of costs, benefits and risks associated with each option developed for evaluation, and where possible quantify these impacts.
- *Identify the option that provides the largest 'net benefit' to the community* — Compare the results of the qualitative and quantitative analysis undertaken in the study, and reach views on the best way to proceed. This discussion may also take into account likely institutional, implementation and funding arrangements for different options.

Sources: PC (2014); Department of Finance (2006).

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

In undertaking its analysis, the Commission has been asked to consider relevant domestic and international reports and experiences. Examples of potentially relevant past or upcoming developments in PSMB are outlined below.

International developments and previous studies on PSMB

Progress on the international harmonisation of spectrum for ‘Public Protection and Disaster Relief’ (PPDR) has continued in recent years. In 2003, the United Nations International Telecommunications Union identified that the 800Mhz band could be used for PPDR purposes in the Asia-Pacific region (which includes Australia), and work is progressing in this area.

There has also been ongoing work on the development of technical standards that underpin mobile broadband capability and applications. For example, the 3rd Generation Partnership Project (3GPP) unites seven telecommunications standard development organisations to produce the ‘Reports and Specifications’ that define 3GPP technologies, including ‘Long Term Evolution’ (LTE) mobile broadband. A 3GPP working group was recently established to develop technical specifications for mission-critical applications on LTE, including for PPDR (3GPP 2013; APCO 2011; TCCA 2013).

There has also been activity at the individual country-level in developing a PSMB capability. For example, the US Federal Government has committed to building a stand-alone network for PSMB. A public authority ‘FirstNet’ has been established and is currently providing a framework within which state-specific solutions can be designed (Essid 2012; FirstNet 2014). Under a different model, the UK Government is accepting tenders for commercial provision of mobile broadband capability to its PSAs, with a reliance on existing mobile networks (UK Home Office 2015).

Some previous studies have examined the costs and benefits of options for delivering a PSMB — for example, studies by the OBI Technical Paper (FCC 2010), Ford and Spiwak (2011), Grous (2013a, 2013b) and Ure (2013). Each approaches the issue from a different perspective and draws varying conclusions. Work has also previously been undertaken as part of the Council of Australian Government (COAG) PSMB Steering Committee process, and some of this material is publicly available.

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

Other relevant policy considerations

In undertaking this study, the Commission will also have regard to:

- the Australian Government’s broader review of the spectrum policy and management framework (The Australian Government has released a Potential Reform Directions Paper (Department of Communications nd))
- ACMA’s role as the independent national regulator and technical expert on communications matters, and its ongoing work on spectrum allocation matters.

3. *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?*

4 Public safety mobile broadband in Australia

Public safety agencies (PSAs) in Australia

PSAs undertake a range of different functions, and often work closely with each other and government departments. The terms of reference state that PSAs include police, fire, ambulance and emergency services. ‘Emergency services’ includes State and Territory Emergency Services (SES), and could also include marine search and rescue services provided by the Australian Maritime Safety Authority.

4. *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?*

Most PSAs are agencies of state or territory governments, which have primary responsibility for delivering emergency services to the community. Generally, PSAs are run as statutory agencies or as units within a government department. A handful of PSAs are the direct responsibility of the Australian Government, including the Australian Federal Police and Australian Maritime Safety Authority. The Australian Government also provides coordination functions and funding support in certain instances (RoGS Steering Committee 2015).

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5. *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?*

PSA current use of communication services and spectrum

Historically, PSAs have relied on narrowband (particularly voice) communications to support their operational activities, which have primarily been delivered through dedicated ‘land mobile radio’ (LMR) networks. These networks:

- have traditionally been owned and operated by a relevant entity of the state and territory government, although there are examples of private providers managing these networks (Telstra 2012b)
- are typically run using proprietary hardware and equipment, such as handsets
- may be used by an individual PSA, a group of PSAs or across all PSAs within a jurisdiction
- have varying levels of network coverage, but in some cases provide very extensive geographic coverage within a jurisdiction
- are typically designed with the objective of providing capability to PSAs in mission critical circumstances so that emergency communications are available, reliable, secure and include adequate redundancy, even under adverse operating conditions (Grous 2013b).

6. *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?*
7. *What applications do PSAs currently use on their LMR networks that are provided for mission critical purposes? Does this differ by jurisdiction?*
8. *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?*

Radio frequency spectrum is a key input for delivering mobile communications services (other major inputs include infrastructure, supporting networks and end-user devices). Different parts of the spectrum band have varying technical capabilities. For example, lower frequency bands generally provide greater coverage from a single base station, while higher frequency bands generally provide greater data capacity but over shorter distances (ACMA 2013a).

Narrowband networks used by PSAs (such as LMR networks) are primarily supported by dedicated spectrum in the 400 MHz band, with a small number of networks utilising lower spectrum bands in the 148-172 Mhz range (ACMA 2013a). In keeping with the objective of ensuring that ‘adequate provision of the spectrum [is made] for use by agencies involved in ... the provision of emergency services’ (*Radiocommunications Act 1992* (Cwlth) s. 3), these spectrum bands were reserved for PSAs under the Australian Radiofrequency Spectrum Plan (ACMA 2013a).

PSA demand for communication services varies depending on the type of functions they perform, and the nature of the events or incidents they are dealing with. These demands can be broadly classified into three categories:

- *Business as usual* activities — such as responding to incidents that involve a limited number of PSA officers or response teams. During these periods, demand for communication services is expected to be lower, and more stable and predictable relative to other categories.
- *Planned events* — such as major sporting events, music festivals or G20 meetings which require a larger than usual PSA presence. During these events, demand for communication services is expected to be relatively high in highly localised areas, but predictable.
- *Large scale emergency incidents* — such as natural disasters, terrorist attacks or other infrequent incidents which require a large, cross-agency PSA response. During these incidents demand for communications is expected to be very high in localised areas, and there is uncertainty about timing and location of such events, making them more challenging to plan for. Moreover, in some instances the emergency incident itself may destroy or impair the communications infrastructure or capacity (even if well planned), so the level of network resilience provided is important (discussed below).

9. *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?*

PSAs also use fixed-line, wireless and satellite services provided by commercial providers for communication, organisational and administrative functions.

What is mobile broadband?

Mobile broadband refers to the variety of ways a broadband internet service is delivered via a mobile network, and can be accessed using a range of wireless devices such as smartphones, tablets and laptops (ACMA 2014a).

Mobile networks can be distinguished from other types of networks used to provide broadband services, including fixed-line networks, fixed wireless networks and satellite

networks (ACMA 2010). That said, many mobile devices can be used on a range of networks (Deloitte Access Economics 2013). (Box 2 contains information on mobile networks which provides important context for this study.)

Box 2 Mobile networks

Mobile networks are designed as a series of geographically distinct signal areas or ‘cells’. Within each cell is a base station(s) and associated equipment which sends and receives the transmissions to and from a user’s handset. Some cells join or overlap to ensure that users can roam across the network without losing connection. Other key network elements include access to transmission backhaul capacity and core network infrastructure.

A range of factors influence mobile network performance and the service quality experienced by end-users on mobile networks. This includes network configuration and design, the number of concurrent users in a cell area and their usage levels, topography/environmental factors, the amount of spectrum used and spectrum frequency.

Sources: Mobile Network Guide (nd), ACMA (2013b), Nokia Siemens Network (2011); Rumney ed. (2013).

There is a well-developed market for the provision of mobile broadband services in Australia. Three mobile network operators (MNOs) — Telstra, Optus and Vodafone Hutchison Australia (VHA) — own and operate their own networks and deliver services to end-users. There are also mobile virtual network operators that purchase wholesale capacity from MNOs and resell services to end-users. Each MNO in Australia uses a different mix of spectrum holdings to deliver mobile services (for a full accounting see ACMA (2014a, p. 18)).

Mobile broadband technology has evolved rapidly, expanding the potential uses of high capacity data applications on mobile networks. For example, Australian MNOs are at different stages of rolling out fourth generation (4G) networks based on the LTE standard. LTE networks support higher data speeds and lower levels of latency (delay) than third generation (3G) networks. They allow end-users on wireless devices to access an increasingly wider range of broadband data applications — such as video-based applications on mobile tablets or handsets, and the ability to quickly receive and transfer large data files and images (Nokia Siemens Network 2011; Rumney (ed) 2013).

PSAs in some jurisdictions (including overseas) have started using mobile broadband-enabled devices and capability, on a limited basis, to supplement use of their own narrowband networks. Changes have been made (and are continuing) at the commercial carrier level to support these developments (box 3).

Box 3 **Examples of PSA use of mobile broadband**

Use of devices and applications

PSAs in some jurisdictions are trialling or undertaking a limited roll out of devices and applications that use mobile broadband technology. These applications provide a flavour of what can be achieved with use of broadband capability. For example:

- Several jurisdictions in Australia are at various stages of providing their frontline police with mobile devices (such as smartphones and tablets), allowing them to perform tasks such as accessing central databases and performing background checks while in the field.
- In the UK, 4G services are being piloted by select Ambulance Trusts, which are investigating new capabilities such as patient telemetry.
- Commercial mobile networks also form part of the PSAs toolkit for communicating with the community. For example, the Emergency Alert national warning system provides PSAs with the capability to send text messages to mobile phones located in a declared warning area.

Commercial models for PSMB capability

Telstra LANES model — In 2013 and during the G20 Leaders Summit in Brisbane in November 2014, Telstra undertook pilot trials of its Long Term Evolution (LTE) for Advanced integrated Network for Emergency Services (LANES) model. Broadly, the LANES concept is a proposal to provide dedicated capability to PSAs (based on dedicated spectrum for PSAs) using commercial network infrastructure, and to supplement this with preferential data treatment on the Telstra Mobile Network where LTE is enabled.

Airwave 4GMax — During 2014, Airwave (the operator of the UK's TETRA network) conducted a pilot study of its 4GMax technology with Surrey Police. This technology improves mobile broadband bandwidth and coverage for PSAs by combining 3G and LTE signals from four commercial networks.

Sources: Airwave Solutions (nd); Bray (2014); Cowan (2014); Coyne (2015); Emergence Alert (nd). RadioComms (2014); Taylor (2014)..

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10. *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?*
 11. *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?*
 12. *What lessons or insights can be taken from the previous trials of Telstra's LANES model, including during the G20 summit in November 2014?*
 13. *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?*
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Potential opportunities for PSAs to use mobile broadband

In recent years, a range of stakeholders (including PSAs) have identified an opportunity for PSAs to take advantage of emerging digital mobile technologies. There has been ongoing policy discussion amongst the Australian and state and territory governments about ways to deliver PSMB capability. Current and potential use of communications services by PSAs has also come into focus during various inquiries into natural disasters, such as the Royal Commission into the Victorian Bushfires, and the Queensland Floods Commission of Inquiry (QFCI 2012; VBRC 2010).

Mobile broadband services and applications have the potential to improve the operational capabilities of PSAs in several respects. Examples of applications identified by PSAs include (PJCLE 2013):

- *video streaming and live video feed* — such as applications to enable remote medical support and patient monitoring, video feed of in-progress incidents or surveillance of particular sites, wireless clip-on cameras for use in building fire rescue, and airborne assessment of fire or flood scenes
- *download/upload of high resolution imagery* — such as applications to enable downloading earth exploration satellite images, real-time medical imaging, biometrics (fingerprints), images of persons of interest, and building layout maps
- *voice applications on LTE networks* — such as applications to enable push-to-talk, dispatch, and group communication.

As noted above, mobile networks can also be used as a tool for PSAs communicating with the community — for example, the existing use of the Emergency Alert national warning system. A further potential opportunity in this area is the use of crowdsourcing for situational awareness — such as the Real-Time Emergency Response application under development at McGill university, allowing PSAs to filter and organise real-time information including live video, Twitter feeds and other social media (Shared Reality Labs 2015).

14. *What applications could PSAs use if they had access to PSMB capability? How could this be expected to vary across PSAs?*
 15. *To what extent could these applications replace or supplement the capability and systems currently used by PSAs on their narrowband networks?*
 16. *How important are communications between PSAs and the community during emergency incidents?*

5 Developing options for evaluation

While there is a general view that mobile broadband capability is an important enabler of PSAs, and access is highly desirable, there may be different views about how PSMB capability is best provided. As such, one of the key tasks in this study will be to develop and evaluate *specific* PSMB options, taking into account the three broad approaches, and key characteristics of a PSMB capability, identified in the terms of reference.

Three broad approaches to delivering PSMB capability

The terms of reference direct the Commission to consider three ‘high level’ approaches for delivering a PSMB capability: deploying a dedicated network for PSAs; relying fully on commercial networks; or some combination of the two.

A dedicated PSMB network

PSAs have historically relied on dedicated narrowband networks (such as LMR networks) that are either exclusively used by a single PSA, or shared between multiple PSAs within a state or territory. One way forward is to extend this model to delivering a PSMB capability. In broad terms, this might entail:

- deploying dedicated network infrastructure and systems (potentially, but not necessarily, owned and controlled by PSAs or the relevant state or territory government entity)
- the allocation of dedicated spectrum (potentially on an exclusive basis)
- reuse of elements of existing PSA narrowband networks.

A commercial network(s) solution

An alternative approach would be to rely fully on commercial networks to deliver mobile broadband capability to PSAs. In broad terms, this might entail:

- PSAs purchasing PSMB capability as a ‘service’ from commercial operators, subject to agreed service levels
- commercial providers drawing on their own networks and resources (including spectrum) to meet their contractual obligations with PSAs
- commercial providers augmenting (or ‘hardening’) parts of their networks to meet PSMB service requirements and agreed service levels.

Combination (or ‘hybrid’) approaches

In principle, between the above ‘book end’ approaches there are various combinations of public and private inputs and operating models (such as public or private operation and control) that could be used to deliver PSMB capability.

For example, possibilities include:

- partly relying on one or more commercial networks, and partly relying on a dedicated PSMB network (for example, targeting specific disaster prone areas or significant population centres)
- fully relying on commercial network infrastructure (for example, cell sites and Wi-Fi network points) to deliver PSMB capability, but with dedicated spectrum being allocated for this purpose.

Characteristics of a PSMB capability

The Australian Government has indicated that — in developing and evaluating options for deploying PSMB capability — consideration should be given to particular characteristics of that capability. The Commission is seeking feedback on how these characteristics might influence the options that are developed and evaluated in this study, and the associated costs, benefits and risks of alternative options.

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

Interoperability

Radiocommunications interoperability — in the context of PSAs — refers to the ability of individual agencies to share voice and data communications with other PSAs, both within and across jurisdictions (PJCLE 2013).

Inquiries following the Victorian Bushfires in 2009 and the Queensland floods in 2011 highlighted that the interoperability of narrowband networks used by PSAs is often poor, and can limit the effectiveness and efficiency of PSA activities. Furthermore, both of these inquiries found that there were some examples of ineffective coordination with respect to information systems used within and across agencies (including dispatch and fire management systems) (QFCI 2012; VBRC 2010). The ‘National Framework to Improve Government Radiocommunications Interoperability’ was introduced by COAG in 2010 with the objective of transitioning all domestic radiocommunications equipment to interoperable systems by 2020 (COAG 2009).

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18. *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)?*
 19. *Does delivering a PSMB capability raise any new opportunities for achieving national interoperability?*
 20. *Would the benefits, costs and risks of achieving national interoperability vary under different deployment options? If so, how?*
 21. *What progress has been made in putting in place arrangements to better coordinate emergency communications within and across PSAs and jurisdictions?*

Operation in both metropolitan and regional Australia

To deal with emergency events, PSAs often require network coverage across large areas of metropolitan and regional Australia. Network coverage can be measured in different ways, for example, by estimating the percentage of the population that resides in the coverage area, or by estimating the land area or road miles covered by a network (FCC 2013).

The level of mobile network coverage provided on commercial networks is determined by a range of factors, including commercial decisions about the type and amount of network infrastructure deployed, the amount and type of spectrum used and topographical factors (FCC nd). There are potential ways that mobile network coverage available to the end-user can be extended in particular areas — for example, on a temporary basis by deploying 'Cells on Wheels' in an localised incident area, or by roaming across multiple networks.

22. *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?*
23. *What level of mobile broadband network coverage do PSAs require across metropolitan and regional Australia? Does this vary for different PSAs?*
24. *What is the most appropriate measure of network coverage for use in this study?*
25. *What options are there for extending the mobile coverage of commercial networks?*
26. *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?*

The ability to integrate voice communications

As noted in section 3, narrowband networks used by PSAs (such as LMR networks) have primarily been used for voice communications. Various characteristics of voice service quality are important to PSAs, including the time taken to initiate communications, the ability to have ‘one-to-many’ communications on open channels, and the level of network robustness and resilience (Windsor Place Consulting 2014).

Mobile networks operating in Australia provide voice and data capability to end-users. It will be important to understand in this study any technical, institutional, commercial or other challenges that may exist in using mobile broadband networks to deliver voice capability to PSAs for their operational activities, and potential ways these could be overcome.

- 27. 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?*
- 28. 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?*
- 29. 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?*

Maintain the integrity and security of communications

In developing deployment options, the Commission is to have regard to the security and integrity of PSA communications. Both physical and virtual security are relevant to consider. *Physical security* refers to the ability to protect and secure physical network infrastructure, while *virtual security* refers to the ability to prevent malicious attacks at the system and application level — such as cyber-attacks. Any new security issues or risks that a PSMB capability might involve, mitigate or exacerbate are relevant to consider in this study.

Other sectors that have high security requirements for their telecommunications services — for example, in the financial services sector — use commercial infrastructure yet have no dedicated spectrum allocated to them.

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30. *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?*
 31. *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?*
 32. *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?*
 33. *What additional security needs do PSAs have compared to other sectors with high security requirements for their communications?*

Accessibility, priority and sufficient capacity for PSAs (particularly during periods of peak demand and localised incidents)

Uncertainty around the timing, location and severity of emergency events means that demand peaks are hard to predict and plan for. Moreover, the consequences of PSAs *not* having access to communications capability could have significant costs for the broader community. The capacity or ‘throughput’ of a mobile network (the amount of traffic that can be transmitted) is usually measured in ‘bits’ per second. The capacity or throughput of a mobile network determines the types of applications that can be used on the network. There are different measures of capacity on mobile networks — for example, theoretical peak speeds, ‘cell edge’ data rates or average sector throughput data rates which takes into account expected aggregate traffic.(FCC 2010; Frias and Pérez 2012; GQ-AAS 2010; Motorola 2010; Nokia Siemens Network 2010).

34. *How should PSA demand for mobile broadband capability be estimated in this study, including their expected demand requirements into the future?*
35. *What methods or metrics could be used to define and/or measure the level of service capacity provided to PSAs?*
36. *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?*
37. *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?*
38. *How would the benefits, costs and risks of ensuring sufficient capacity vary under different deployment options?*

Resilience and continuity of services

Resilience can be defined as ‘the ability of the network to provide and maintain an acceptable level of service in the face of various faults and challenges to normal

operation’ (ENISA 2011, p. 12). In practice, there are likely to be different views of, and ways to define, the minimum acceptable level of resilience for a PSMB capability, bearing in mind the nature of PSA operations (including mission critical operations) and the importance of maintaining continuity of service under adverse operating conditions.

There is a range of factors that could have influence network resilience. For example, the level of battery back-up capability provided, and the timescale for providing replacement services in the event of a physical or network based disruption.

- 39. What level of resilience do PSA narrowband networks usually provide and how does this differ from commercial mobile broadband networks?*
- 40. What methods or metrics could be used to define and/or measure the level of resilience provided by the networks used to deliver PSMB?*
- 41. 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?*
- 42. 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?*

Sustainability of the arrangements

As far as practicable, any PSMB solution would need to be sustainable in the face of future developments in technology (including at the network, application and end-user device level), and flexible enough to take advantage of any such (cost-effective) opportunities. Sustainability in the face of expected growth in the demand for mobile broadband capability and capacity is also relevant — any PSMB solution needs to account for future PSA requirements (ACMA 2014a).

- 43. 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?*
- 44. How will the convergence of voice and data services affect the sustainability of PSMB capability under different deployment options?*

Nationally available by or before 2020

The Australian Government has indicated that a PSMB capability should be nationally available by or before 2020 to coincide with the nationally agreed framework to improve government radio communications.

There are likely to be time pressures associated with many potential PSMB solutions. For example, a dedicated PSMB network may require significant design, construction and procurement work, while a commercial solution could involve complex contractual negotiations. Therefore, a key issue to consider in this study is the feasibility of meeting this timing under different options, and any associated risks.

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

Compatible with a range of end-user devices

PSAs use, or could potentially use, a range of field equipment, including off the shelf handsets (such as smart phones, tablets and laptops) and customised handsets, or other equipment that supports mobile broadband applications (for example, communication devices in ambulances or police cars). Any PSMB capability delivered to PSAs would need to be flexible enough to accommodate a range of existing and future end-user devices.

46. 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?

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

Developing specific options for evaluation

Although the aforementioned categories and characteristics provide broad guidance on the types of PSMB solutions to be considered in this study, specific options will need to be developed and evaluated in order to establish the best way forward. Various parameters and assumptions will need to be considered in this context, for example:

- the *type* and *amount* of network infrastructure used to deliver the PSMB capability, including the extent to which *existing* infrastructure (such as that owned by commercial carriers or PSAs) can be reused or leveraged
- the *type* and *amount* of spectrum utilised for PSMB capability (and whether it is allocated exclusively for PSA use, or shared)
- the amount of *network coverage* provided, and whether ‘overflow’ arrangements are in place, such as those which allow PSAs to roam on to alternative networks if needed

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- the *timing* of the capability becoming available and any intermediate solutions that might be put in place during a transition period
 - the *institutional and implementation arrangements* that underpin delivery of the capability, such as network ownership and management, or the pursuit of state-based or national solutions, and procurement models that may be used
 - *transitional costs* depending on the degree of interoperability preferred as well as other related factors.

It is important that the options developed during this study are realistic, technically feasible, and are able to be evaluated given publicly available information.

A further consideration in developing options is whether any characteristics or parameters are assumed to be common to *all* options evaluated. For example, one possible assumption would be that *all* considered options would be (largely) based on 4G/LTE mobile broadband technology and network architecture. This would be consistent with the view that the 3GPP LTE standard has been endorsed regionally, nationally and internationally as a preferred technology standard to support commercial and PPDR mobile broadband networks (GQ-AAS 2011; TCCA 2013).

Consultation with stakeholders will be important for considering these issues and determining the feasibility of potential options, particularly from a technical, commercial and institutional perspective. Some initial guidance may also be taken from past studies that have looked into the issue of providing a PSMB capability.

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

49. *What (if any) assumptions or parameters should be ‘common’ across all options?*

6 Identifying and estimating costs

The potential costs of delivering a PSMB capability are broad and complex and are likely to include:

- network costs — that is, the cost of building and operating a dedicated network, using (and potentially augmenting or ‘hardening’) existing commercial networks, or some combination of these approaches
- the opportunity costs of any spectrum allocated as part of a PSMB solution
- the efficiency costs of raising revenue via taxation for a PSMB solution
- any costs imposed on non-PSA users, such as reduced data transmission speeds or service availability

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- the option value of delaying investment (that is, the expected value of delaying some or all investment until more information becomes available — a ‘real options’ approach).

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

51. *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?*

52. *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?*

Network costs

Mobile networks are capital intensive and involve large fixed costs, and ongoing operating costs, both at the network and organisational-level (a high-level summary of network cost categories is provided in box 4). Mobile networks are also incrementally upgraded over time to expand coverage and capacity, and to incorporate new technologies.

The purpose of any cost estimation exercise in this study is to estimate the relative differences in total costs of different options for delivering PSMB, including total network costs. Broadly, this would require an understanding of the expected traffic volumes and network architecture associated with a given option — including the mix of infrastructure required to deliver a designated level of capability — and the costs associated with (or value of) different network infrastructure elements and operation.

There are different methods that could be used to assist the estimation of costs in this study, including those based on ‘top-down’ or ‘bottom-up’ cost modelling approaches (or variants of these). For example, a *top-down approach* could involve using actual (historical) accounting data from mobile network operators as a starting point for estimating costs. The network architecture and configuration of existing networks could also form the basis for reaching estimates on relevant capital and operating costs to deliver a PSMB capability. A *bottom-up approach* could involve modelling the network and cost structures of a representative ‘efficient’ operator that would not be constrained by technology, systems and architectural decisions of the past. A bottom-up model could identify all components of the network necessary to produce the level of capability in question. Cost causation relationships could then be defined to link the relevant quantities of network components with outputs and other relevant cost drivers (Brinkmann et al. 2007; Holmes and O’Rourke 2012).

There are likely to be a range of advantages and disadvantages in seeking to use these types of approaches (or other approaches) for estimating network costs in this study.

Whatever type of approach is used, a key consideration will be to ensure, as far as possible, that estimated costs are reflective of *economic* costs, rather than reported financial or

accrual accounting costs designed for other purposes. Economic costs are essentially the resource (opportunity) costs of a particular activity, and measure the value of foregone use of the resources in other activities (Department of Finance 2006).

Box 4 Network costs

The components of mobile network costs that could be considered in this study (but would be expected to differ depending on the deployment option) include:

- capital costs
 - radio access network equipment
 - site hardening costs (to improve security and reliability of the network)
 - backhaul transmission capacity
 - core network capability
 - other equipment
 - handsets and other terminals for PSAs
 - additional software upgrades or new applications
- operating costs
 - network-level costs (such as maintenance and network management costs)
 - organisational-level costs (such as administrative costs)
 - leasing land, equipment, facilities and services.

Sources: Access Economics (2010); Gibson Quai AAS (2010).

Certain cost components may be interdependent with each other (and other assumed parameters), and it will be important to identify these relationships. For example, the quantum of spectrum used may have a bearing on the magnitude of network costs needed to provide a given level of capability to PSAs (ACMA 2014b). Moreover, the choice of spectrum band may influence end-user equipment costs, if only certain types of equipment (such as handsets) can be used at those frequencies (Senate Environment and Communications References Committee 2011).

Lessons on possible approaches to estimating costs of delivering PSMB under different deployment options may be able to be drawn from past studies (for example, the publicly available redacted version of the Gibson Quai-AAS (2010) report and the OBI Technical Paper (FCC 2010)).

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53. *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?*
 54. *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?*
 55. *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?*
 56. *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?*
 57. *What data sources could be used to estimate the cost of the infrastructure, equipment and operation in delivering PSMB capability under different deployment options?*

Opportunity costs of spectrum

The opportunity cost of the spectrum requirements associated with PSMB solutions is a further cost that will need to be considered. Broadly, this could be estimated using:

- *market valuation approaches*, which use available market information or data (for example, data from previous spectrum market transactions) to value the spectrum
- *direct calculation approaches*, which attempt to calculate the prices that firms might bid for spectrum if an auction were held (ACMA 2009; Plum Consulting 2008).

Under some options for delivering a PSMB capability, the spectrum allocated to PSAs could be shared with commercial providers. Telstra's proposed LANES approach is an example of how a sharing arrangement could work (Telstra 2012a). This could have implications for the type of approach used to estimate the opportunity costs of spectrum associated with PSA use.

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58. *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?*
 59. *What data sources could be used to estimate the opportunity costs of spectrum under different deployment options for PSMB?*
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Other considerations in a CBA

A key part of any CBA, particularly one which considers the deployment of long-lived infrastructure, systems and technology, is selection of a social discount rate. A discount rate converts all future cost and benefit streams into present dollars (due to the time value of money), and is also a measure of society's inter-temporal consumption preferences.

The Australian Government's Handbook of Cost–Benefit Analysis (Department of Finance 2006) contains a detailed discussion on setting the discount rate, and a number of government publications prescribe discount rates to be used for particular types of projects (Infrastructure Australia 2008; NSW Treasury 2007; Victorian Department of Treasury and Finance 2013). A CBA analysis would also normally use sensitivity analysis to test the effect of using different discount rates.

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

Another issue to be addressed as part of a CBA is how far into the future costs and benefits should be measured. On the one hand, the choice of a longer time horizon may more accurately reflect the relative net benefits of different options, especially if there are significant costs associated with maintaining or replacing infrastructure, or if certain benefits only accrue after some time. On the other hand, projecting costs and benefits further into the future is an uncertain exercise, particularly due to the rapid evolution of communications technology and its applications.

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

7 Identifying and estimating benefits

Mobile broadband services do not generate benefits in their own right. Rather, they facilitate the use of various applications which are themselves inputs to the services that PSAs provide. In conducting benefit analysis in this study it may be appropriate to focus on PSA outcomes, and the ultimate beneficiaries of PSA services (the community).

In this context, there is a range of potential benefits from delivering a PSMB capability. These include:

- improved outcomes for the community, for example, lives saved, better health outcomes in medical emergencies, or reduced personal injury and property damage
- higher PSA productivity, which is differentiated from the above point where it frees up resources for other uses

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- reduced danger to PSA officers
 - reduced equipment costs due to lower design costs and bulk purchasing of compatible end-user mobile devices (where not included above).

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

Broadly, there are two potential steps involved in estimating the benefits of providing PSMB. The first is to measure the *impact* of mobile broadband capability on PSA outcomes. The second is to estimate the *value* associated with the improved outcomes, such as the value of lives or property saved, or crime prevented.

However, this type of analysis is likely to present significant challenges. A range of inputs and variables contribute to positive (or negative) PSA outcomes, and it could be very difficult (and potentially, impossible) to accurately identify the contribution of PSMB capability specifically. This is further complicated by the fact that the benefits of PSMB capability are likely to vary across different types of agencies, geographic areas, incident types and applications used.

That said, it might be possible to develop an understanding of how a PSMB capability would effect PSA outcomes by drawing on:

- survey (or other) information provided by PSAs
- studies that have sought to evaluate the costs and benefits of PSMB capability, based on small-scale pilots and trials
- scenario analysis that estimates the impact of a PSMB capability on PSA outcomes using detailed hypothetical scenarios.

Estimating the value associated with improved PSA outcomes is also likely to present challenges, particularly given that PSA services are traditionally considered a public good, and therefore, there is no market where prices are set for end-users. Non-market valuation methodologies (such as stated preference and revealed preference techniques) can sometimes be used to calculate the value of goods and services that are not traded. Past studies might also provide insights about appropriate estimates of the value of PSA outcomes.

Ultimately, the feasibility of quantifying the benefits (and costs) of PSMB options in this study will depend on the quality and amount of data, evidence and information that is available to the Commission, both through submissions from interested parties and public sources.

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63. *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?*
 64. *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)?*
 65. *Can you identify evidence or examples that illustrate the effects of PSMB capability on PSA outcomes?*
 66. *What method(s) should be used to value the effects of PSMB capability on PSA outcomes?*
 67. *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?*

Attachment A — How to make a submission

The Commission invites interested people and organisations to make a written submission.

Each submission, except for any information supplied in confidence (see below), will be published on the Commission's website shortly after receipt, and will remain there indefinitely as a public document. The Commission reserves the right to not publish material on its website that is offensive, potentially defamatory, or clearly out of scope for the inquiry or study in question.

When providing a submission to the Commission, you may wish to remain anonymous or use a pseudonym. Please note that, if you choose to remain anonymous or use a pseudonym, the Commission may place less weight on your submission.

Copyright in submissions sent to the Commission resides with the author(s), not with the Commission. Submitters should ensure that they hold copyright in any submitted documents, or that the copyright holder has authorised the publication of any relevant documents on the Commission's website.

How to prepare a submission

Submissions may range from a short letter outlining your views on a particular topic to a much more substantial document covering a range of issues. Where possible, you should provide evidence, such as relevant data and documentation, to support your views.

This is a public review and all submissions should be provided as public documents that can be placed on the Commission's website for others to read and comment on. However, information which is of a confidential nature or which is submitted in confidence can be treated as such by the Commission, provided the cause for such treatment is shown. The Commission may also request a non-confidential summary of the confidential material it is given, or the reasons why a summary cannot be provided. You are encouraged to contact the Commission for further information and advice before submitting such material. Material supplied in confidence should be provided under separate cover and clearly marked 'IN CONFIDENCE'.

How to lodge a submission

Each submission should be accompanied by a submission cover sheet. The submission cover sheet is available on the study web page. For submissions received from individuals, all **personal** details (for example, home and email address, signatures, phone, mobile and fax numbers) will be removed before they are published on the website for privacy reasons.

The Commission prefers to receive submissions as Microsoft Word (.docx) files. PDF files are acceptable if produced from a Word document or similar text based software. You may

wish to research the Internet on how to make your documents more accessible or for the more technical, follow advice from Web Content Accessibility Guidelines (WCAG) 2.0 <<http://www.w3.org/TR/WCAG20/>>.

Do not send password protected files. Do not send us material for which you are not the copyright owner — such as newspaper articles — you should just reference or link to this material in your submission.

Track changes, editing marks, hidden text and internal links should be removed from submissions before sending to the Commission. To ensure hyperlinks work in your submission, the Commission recommends that you type the full web address (for example, <http://www.referred-website.com/folder/file-name.html>).

Submissions sent by email must not exceed 20 megabytes in size as our email system cannot accept anything larger. If your submission is greater than 20 mb in size, please contact the Administrative Coordinator (Carole Gardner, (03) 9653 2194) to organise another method of sending your submission to the Commission.

Submissions can be accepted by email or post:

Email*	psmb@pc.gov.au
Post	Public Safety Mobile Broadband Productivity Commission Locked Bag 2, Collins Street Melbourne VIC 8003 Productivity Commission

* If you do not receive notification of receipt of an email message you have sent to the Commission within two working days of sending, please contact the Administrative Officer.

Due date for submissions

Please send submissions to the Commission by Monday 25 May 2015.

Attachment B — Consolidated list of questions

1. *What is the merit (or otherwise) of the proposed approach to undertaking first principles analysis in this study?*
2. *What domestic or international developments, reports or experiences in PSMB (or related matters) are relevant to consider in this study?*
3. *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?*
4. *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?*
5. *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?*
6. *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?*
7. *What applications do PSAs currently use on their LMR networks that are provided for mission critical purposes? Does this differ by jurisdiction?*
8. *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?*
9. *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?*
10. *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?*
11. *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?*
12. *What lessons or insights can be taken from the previous trials of Telstra's LANES model, including during the G20 summit in November 2014?*
13. *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?*

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14. *What applications could PSAs use if they had access to PSMB capability? How could this be expected to vary across PSAs?*
 15. *To what extent could these applications replace or supplement the capability and systems currently used by PSAs on their narrowband networks?*
 16. *How important are communications between PSAs and the community during emergency incidents?*
 17. *What PSMB capability characteristics should be considered in this study?*
 18. *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)?*
 19. *Does delivering a PSMB capability raise any new opportunities for achieving national interoperability?*
 20. *Would the benefits, costs and risks of achieving national interoperability vary under different deployment options? If so, how?*
 21. *What progress has been made in putting in place arrangements to better coordinate emergency communications within and across PSAs and jurisdictions?*
 22. *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?*
 23. *What level of mobile broadband network coverage do PSAs require across metropolitan and regional Australia? Does this vary for different PSAs?*
 24. *What is the most appropriate measure of network coverage for use in this study?*
 25. *What options are there for extending the mobile coverage of commercial networks?*
 26. *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?*
 27. *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?*
 28. *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?*
 29. *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?*
 30. *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?*
 31. *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?*

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32. *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?*
 33. *What additional security needs do PSAs have compared to other sectors with high security requirements for their communications?*
 34. *How should PSA demand for mobile broadband capability be estimated in this study, including their expected demand requirements into the future?*
 35. *What methods or metrics could be used to define and/or measure the level of service capacity provided to PSAs?*
 36. *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?*
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 48. *What detailed options should be evaluated in this study? What underlying assumptions and key parameters would be associated with each option?*
 49. *What (if any) assumptions or parameters should be 'common' across all options?*
 50. *What are the sources of costs relevant to this study?*

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51. *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?*
 52. *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?*
 53. *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?*
 54. *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?*
 55. *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?*
 56. *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?*
 57. *What data sources could be used to estimate the cost of the infrastructure, equipment and operation in delivering PSMB capability under different deployment options?*
 58. *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?*
 59. *What data sources could be used to estimate the opportunity costs of spectrum under different deployment options for PSMB?*
 60. *What is the appropriate discount rate, or range of discount rates, to use in this study?*
 61. *How far into the future should costs and benefits be measured?*
 62. *What are the sources of benefits relevant to this study?*
 63. *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?*
 64. *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)?*
 65. *Can you identify evidence or examples that illustrate the effects of PSMB capability on PSA outcomes?*
 66. *What method(s) should be used to value the effects of PSMB capability on PSA outcomes?*
 67. *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?*

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