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Australian Communications and Media Authority

Submission to the Public Safety Mobile Broadband Productivity Commission Issues Paper

Australian Communications and Media Authority (ACMA)

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Australian Communications and Media Authority

Canberra

Red Building

Benjamin Offices

Chan Street

Belconnen ACT

PO Box 78

Belconnen ACT 2616

T +61 2 6219 5555

F +61 2 6219 5353

Melbourne

Level 44

Melbourne Central Tower

360 Elizabeth Street

Melbourne VIC

PO Box 13112

Law Courts

Melbourne VIC 8010

T +61 3 9963 6800

F +61 3 9963 6899

Sydney

Level 5

The Bay Centre

65 Pirrama Road

Pyrmont NSW

PO Box Q500

Queen Victoria Building

NSW 1230

T +61 2 9334 7700

1800 226 667

F +61 2 9334 7799

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Overview

The Australian Communications and Media Authority (the ACMA) welcomes the opportunity to make this submission to the Productivity Commission's 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 ACMA's role in this process is that of the regulator and manager of radiofrequency spectrum in Australia. A key component of this role is balancing the spectrum needs of PSAs, of which the ACMA is a strong supporter, with those of the community more broadly.

Spectrum requirements, be they spectrum for PSA use or spectrum held by commercial telecommunications carriers, will be a key consideration of the PC's study into a Public Safety Mobile Broadband (PSMB) capability. Spectrum management in Australia is carried out by the ACMA in accordance with legislation that, among other things, identifies the objective that adequate provision of spectrum is to be made for agencies involved in the defence or national security of Australia, law enforcement and emergency services. Similarly, the ACMA has the objective under legislation to maximise, by ensuring the efficient allocation and the use of the spectrum, the overall public benefit derived from the allocation of spectrum.

The ACMA has had a long association with PSAs in Australia and engages at both the working and strategic levels to ensure that PSAs have sufficient access to adequate radiofrequency spectrum to enable them to undertake their role within the community.

For more than a decade the ACMA has been exploring how best to meet the spectrum needs of PSAs to support both narrowband and broadband communications capabilities. An important body of work currently underway is the implementation of the ACMA's reforms to the 400 MHz band, which is critical to the operation of narrowband (mostly voice) public safety communications. This implementation process is well advanced. It puts into effect a number of critical re-planning decisions on the 400 MHz band that were made in 2010, including the consolidation of public safety communications into the Harmonised Government Spectrum (HGS) in the 400 MHz band.

The HGS is a key enabler of national interoperability, which has come about through close engagement between the ACMA and jurisdictional capability managers. The ACMA also works closely with the National Coordination Committee for Government Radiocommunications (NCCGR) in implementing these reforms, as well as a range of other matters. The NCCGR is responsible for the implementation of the COAG-endorsed National Framework to Improve Government Radiocommunications Interoperability ('the Framework') and the ACMA-initiated 400 MHz reforms are a key plank in meeting the requirements of the Framework.

The ACMA is a strong supporter of both the Framework and government radiocommunications interoperability more broadly. Legacy narrowband communications have for many years formed the bedrock of mission critical public safety communications capabilities. However, when considering modern public safety communications needs holistically, it is clear that there is no single technology or frequency band solution to meet all of these requirements. Narrowband communications alone can no longer meet all of the operational needs of PSAs and, in reality, will meet a diminishing proportion of those needs as more modern technologies are brought into service.

Access to high speed data capabilities, which are expected to become a critical component of public safety capabilities in the medium term, is a requirement that has been acknowledged for some time. In response to these assessments, and consistent with the ACMA's 400 MHz reforms, some years ago the ACMA set about making 50 MHz from the 4.9 GHz band available to support local, non-cellular wireless broadband applications (eg. wireless hotspots and data links). This culminated in a Class Licence being made in 2013 that effectively provides exclusive access to PSAs. However,

there is an increasing need for a *mobile* (cellular) broadband capability that will provide access to data by PSAs across wide coverage areas.

In considering these requirements, it needs to be emphasised that the ultimate deliverable is *data capacity.* While it is tempting to focus on spectrum as though it is a proxy for data capacity, in reality spectrum is only one of several *inputs* (which also include infrastructure, technology, governance, training and support) that would be used in combination to achieve a desired *output* (capacity). While data capacity can be delivered in many different ways, in the PSA context it is inarguable that whatever mechanism is used to deliver this capacity must be 'fit for purpose'. That means being able to deliver the required data throughput to operators when and where they need it, regardless of network load, environmental/climatic conditions or operational scenario. Ultimately, it is only the capability outcome that should matter to the community. Different combinations of inputs can result in the same capability outcome, and there will be interrelationships, with scope for trade-offs, between the different inputs.

Each different approach to delivering a capability comes with its own cost – and spectrum – implications, so to that end the ACMA thoroughly welcomes the Productivity Commission undertaking a first principles review of this important matter. There are well established trade-offs between the amount of capital expenditure and spectrum bandwidth required to deliver a specified amount of capacity, which themselves differ depending on whether dedicated, commercial or hybrid delivery models are used.

There are also issues of scalability, with differing operational, environmental (urban, suburban, rural), geographic and even temporal factors to be considered. For example, it may be prudent to put in place surge capacity for extreme events so as to not tie up valuable resources for the vast majority of time. This may necessitate a modular approach rather than a 'one size fits all' solution. And another issue sitting in the background is the opportunity cost of the spectrum itself, which is a key consideration for the ACMA in its role as an 'economy wide' regulator of spectrum. These issues are multi-dimensional and require consideration of a broad range of interdependent variables. Radiofrequency spectrum is just one of these variables.

International engagement is also an important, if somewhat less visible, aspect of the ACMA's work that has implications for domestic PSAs. A key goal of our engagement in forums such as the International Telecommunication Union (ITU) and the Asia-Pacific Telecommunity (APT) is providing opportunities for economies of scale for public safety radiocommunications equipment, and to a lesser extent, interoperability with overseas counterparts.

The benefits to Australians of the resultant economies of scale are not trivial. For example, the international harmonisation of the 'APT 700 MHz band' – a band used in Australia for 4G services and fast becoming one of the key 4G bands worldwide – has greatly improved the opportunities for economies of scale for network and user equipment operating in that band. The ACMA took a leading role in the identification and harmonisation of this band through its leadership in the APT Wireless Group (AWG) process, and now Australian consumers are realising the benefit in terms of both equipment costs and international roaming (and will do so for many years).

In November this year, the ACMA will lead a delegation to the ITU's World Radiocommunications Conference 2015 (WRC-15), held in Geneva, Switzerland. This is the culmination of over three years of studies on a range of agenda items, including a key agenda item concerned with international arrangements for broadband public safety radiocommunications.

Domestically, the ACMA works on a daily basis with state and federal PSA stakeholders across a range of issues extending from licensing and planning support to strategic engagement through a

range of committees and other forums. An example of this is the ongoing provision of advice on the efficient utilisation of the abovementioned 4.9 GHz band.

The ACMA was previously involved in the work of the PSMB Steering Committee (PSMBSC), established in 2011. While the Terms of Reference (ToRs) of this committee were more specific than the broad focus of the PC's study, the significant body of work that resulted should serve as a valuable reference for the PC's work, in particular the detailed analysis of PSA data capacity requirements.

In response to the evidence gathered by the PSMBSC, in October 2012 the ACMA made an in-principle decision to set aside spectrum from the 800 MHz band, specifically within the recently internationally standardised spectrum below the existing 850 MHz band used by Telstra and VHA, to support the deployment of a PSMB capability. This selection of this particular frequency band was in accordance the committee's ToRs, and the ACMA identified that the spectrum made available would be incorporated into its review of the broader 803-960 MHz band.

With the PC's study delivering its final report in December 2015, there remains a significant body of work in determining how to deliver a PSMB capability. Previously, lack of agreement on this had delayed the ACMA's progression of the 803-960 MHz band review given the interrelationship between PSMB spectrum outcomes and other aspects of the band, as well as the ACMA's desire to deliver a consolidated planning outcome for the band.

However, the ACMA is now working towards identifying a way to progress the review with flexible provisions for a potential PSMB capability operating in that band, contingent upon outcomes from the PC's work. The intent of this approach is to reflect the importance of PSMB and afford it a priority status for planning purposes, but also provide flexibility that will ultimately optimise how the band is used against a range of potential findings by the PC.

For its part, the ACMA (as the independent statutory Authority responsible for regulating access to spectrum) does not have a role to play in defining the specific components and requirements of a PSMB capability. With that in mind, this submission does not provide answers to the entire list of questions set out in the PC's Issues Paper. Instead, it addresses a subset of those questions that pertain directly to the ACMA's regulatory role. It also provides some background and context on the spectrum management environment in Australia and internationally, the ACMA's role (broadly and with respect to public safety spectrum) and relevant trends in standardisation and spectrum harmonisation.

Terms of reference

Pursuant to Parts 2 and 4 of the *Productivity Commission Act 1998*, the Productivity Commission will undertake a study into considering how best to deliver a strong Public Safety Mobile Broadband (PSMB) capability. The scope of the study will place particular regard 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
    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

About the ACMA

The ACMA is the independent statutory authority within the federal government Communications portfolio, tasked with ensuring most elements of Australia's media and communications legislation, related regulations, and numerous derived standards and codes of practice operate effectively and efficiently, and in the public interest.

The ACMA is a 'converged' regulator, created to bring together and regulate four key elements of the communications and media regulatory landscape, being telecommunications, broadcasting, radiocommunications and the internet. The agency has responsibilities under four major pieces of primary legislation: the *Radiocommunications Act 1992* (referred to herein as 'the Act'), the Telecommunications Act 1997, the *Telecommunications (Consumer Protection and Service Standards) Act 1999* and the *Broadcasting Services Act 1992*. The ACMA was formed on 1 July 2005 by a merger of the then Australian Broadcasting Authority (ABA) and the Australian Communications Authority (ACA).

A key ACMA role is the management of – and planning for – access to the radiofrequency spectrum. This involves considering and balancing competing demands for spectrum in order derive the optimal public benefit from its use.

Spectrum management in Australia

The Radiocommunications Act

The *Radiocommunications Act 1992* (the Act) is the primary legislation that governs radiocommunications services in Australia. Access to the spectrum is facilitated by the ACMA through the planning, licensing and allocation of spectrum to uses and users, and includes compliance and enforcement roles to ensure the spectrum management framework is followed.

The Object of the Act (section 3) provides high level guidance in undertaking these activities:

(a) maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum;

(b) make adequate provision of the spectrum:

(i) for use by agencies involved in the defence or national security of Australia, law enforcement or the provision of emergency services; and

(ii) for use by other public or community services;

(c) provide a responsive and flexible approach to meeting the needs of users of the spectrum;

(d) encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided;

(e) provide an efficient, equitable and transparent system of charging for the use of spectrum, taking account of the value of both commercial and non-commercial use of spectrum;

(f) support the communications policy objectives of the Commonwealth Government;

(g) provide a regulatory environment that maximises opportunities for the Australian communications industry in domestic and international markets;

(h) promote Australia's interests concerning international agreements, treaties and conventions relating to radiocommunications or the radiofrequency spectrum.

Principles for Spectrum Management

The ACMA has developed the Principles for Spectrum Management, which are intended to guide the ACMA's management of the radiofrequency spectrum within its existing legislative responsibilities and government policy settings. The key theme of the Principles is that maximising the overall public benefit from use of the radiofrequency spectrum requires a balanced application of both regulatory and market mechanisms. The ACMA's decision making processes are carried out in accordance with statutory requirements and are broadly guided by the Object of the Act. The spectrum management decision making framework is set out schematically in Figure 1.

The Principles are intended to serve multiple purposes: to ensure that ACMA processes are in line with best practice regulation; and also to provide guidance to stakeholders about the approaches that the ACMA are expected to take to decision making. Along with the abovementioned Object of the Act, and in conjunction with the application of a total welfare standard (TWS), the Principles form the basis of the ACMA's standard approach to the management and allocation of spectrum.

In summary, the Principles are as follows:

1. Allocate spectrum to the highest value use or uses
2. Enable and encourage spectrum to move to its highest value use or uses
3. Use the least cost and least restrictive approach to achieving policy objectives

4. To the extent possible, promote both certainty and flexibility
5. Balance the cost of interference and the benefits of greater spectrum utilisation.

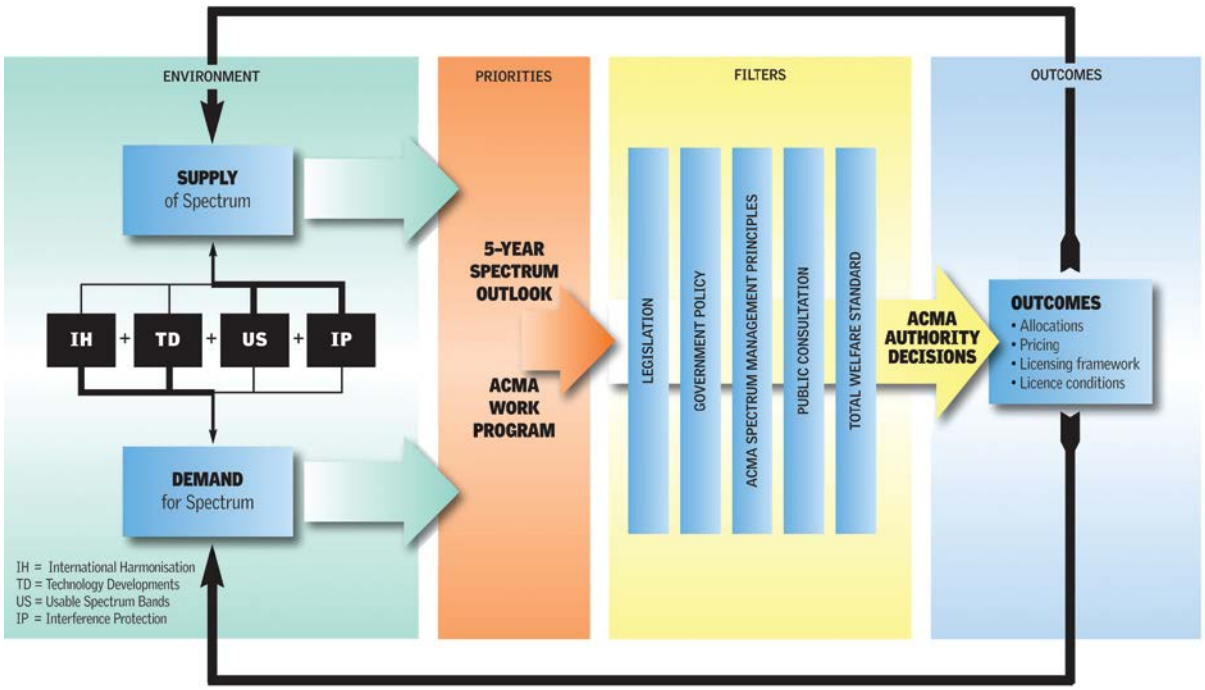


Figure 1. ACMA's Spectrum Management Decision Framework.

International Obligations

Domestic spectrum management has important linkages to international arrangements established through the International Telecommunication Union (ITU) processes, a specialised agency of the United Nations. The ITU's radiocommunications sector (ITU-R), broadly speaking, coordinates the shared global use of radio spectrum.

More specifically, the ITU-R is responsible for the development and maintenance of the international Radio Regulations, a treaty-level set of documents which establish an international spectrum management framework. Australia is a Member State of the ITU and conforms to its legal treaties. While Australia, being an island continent, has some flexibility in how it applies/conforms to the more detailed aspects of the RRs, the globalised nature of radiocommunications means that engagement in this process is critical to domestic industry and operators alike.

The RRs are reviewed every three to four years at the World Radiocommunications Conference (WRC). Each WRC is a culmination of technical and regulatory studies undertaken during the intervening period since the previous conference, considering a range of WRC agenda items that essentially propose reforms to the RRs to satisfy a particular requirement. The next WRC is in November 2015 (WRC-15) and agenda item 1.3 is of direct relevance to the delivery of PSMB:

> *Agenda Item 1.3 – to review and revise Resolution **646 (Rev.WRC-12)** for broadband public protection and disaster relief (PPDR), in accordance with Resolution **648 (WRC-12)***

For spectrum allocation purposes, the RRs divide the world into three Regions that loosely comprise of Europe/Africa (Region 1, including Russia and most of the Middle East), the Americas (Region 2)

and Australia, Asia and the Pacific (Region 3). Where possible, regional positions on WRC agenda items are developed in order to provide strength at meetings of all regions (including WRCs), however these are often difficult to achieve and administrations are also represented individually at those meetings. The body responsible for representing Region 3 in the ITU is the Asia-Pacific Telecommunity (APT).

Both the ITU and APT also develop recommendations and reports on radiocommunications services, in many cases independent of the current WRC agenda. ITU-R Working Party 5A and the APT Wireless Group (AWG) are responsible for the development of publications that are relevant to Public Protection and Disaster Relief (PPDR)[1]. Australia regularly participates in these fora, with delegations comprising representatives from industry and government under the ACMA's leadership.

Relevant ACMA projects/reviews

A number of current ACMA initiatives are relevant to the PC's study. Much of the ACMA's work on making spectrum available for the delivery of mobile broadband services, including specific frequency band reforms and more strategic, long term planning (eg. development of a mobile broadband strategy and the engagement with WRC-15 Agenda Item 1.1[2]) has indirect relevance to the PC's study. Much of this work is geared towards addressing the increasing demand for mobile broadband data.

More directly relevant, however, are:

> The review of the 803-960 MHz band; and

> Consideration of WRC-15 Agenda Item 1.3.

The review of arrangements in the 803–960 MHz frequency band was commenced in May 2011. Two consultation papers were released and the ACMA is working towards releasing a third paper that will detail a new structure of the band and outline a transition strategy to these arrangements. Previous rounds of consultation sought comment on a range of specific band planning proposals, including options for refarming the so-called '850 MHz expansion' bands[3] for additional mobile broadband services, among a range of other replanning options.

As part of its involvement in the work of the PSMBSC, the ACMA had previously made an in-principle undertaking to set aside spectrum for PSMB purposes as part of its review of this band. The intent was that this spectrum would be made available from the abovementioned 850 MHz expansion band, however these arrangements were made under the PSMBSC's Terms of Reference which specifically singled out this frequency band as being the candidate band for a spectrum provision for PSMB. While radio spectrum isn't singled in the PC's ToRs, Part 1 of the ToRs considers the trade-offs between dedicated and commercial PSMB solutions, which will ultimately have spectrum implications.

[1] An ITU term for public safety communications

[2] *To consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution* ***233 (WRC-12)***

[3] '850 MHz expansion' band refers to the harmonised International Mobile Telecommunications (IMT) frequencies that are frequency lower-adjacent to the existing 850 MHz mobile phone band and standardised by 3GPP for 3G and 4G technologies (under the band names 26 and 27).

It is intended that the soon-to-be-released third consultation paper on the 803 – 960 MHz Review will set out long-term provisions for additional mobile broadband services in the 850 MHz expansion band. Contingencies will be put in place to ensure that PSMB needs can be accommodated if a result of the PC's study is that dedicated spectrum in this band is required. These contingencies may also include an ability for this spectrum to be made available sooner than commercial services can be deployed in other parts of this band, if possible. This approach acknowledges the importance of PSMB and affords it a priority status for planning purposes, but also provides flexibility that will ultimately optimise how the band is used, irrespective of the outcomes of the PC's study. It also reflects that the PSMB deliberations and the review of the 803-960 MHz band have a two-way relationship, in that they both have implications for one another. This requires flexibility, hence the abovementioned PSMB-contingent band planning arrangements.

A similar relationship exists between domestic PSMB considerations and Australia's engagement with the WRC-15 process, in particular consideration of WRC-15 AI 1.3. Outcomes of this agenda item will, in the longer term, have implications for the PSMB landscape internationally, including equipment markets. However the fact that there is a domestic study on PSMB requirements in place means that, again, flexibility is required in forming national views on AI 1.3. This is further complicated by the fact that the PC's study will not be complete until after the WRC-15 will be held in Geneva, Switzerland in November 2015.

The ACMA and its domestic coordination group on Agenda Item 1.3, which is made up of interested stakeholders from across industry and Government (including PSA representatives), have been engaged in relevant ITU-R meetings to ensure that a range of flexible options remain in place that might be conducive to implementation of the PC's ultimate recommendations.

As at April 2015, when the ITU-R held its 2nd Conference Preparatory Meeting[4] for WRC-15 (CPM15-2), the four discrete options identified to satisfy the requirements of AI 1.3 represent a broad cross-section of potential ways forward, with various combinations of either explicit regulatory implementation or lighter touch ways to achieve regional and international harmonisation for broadband PPDR communications. The ACMA is therefore confident that there is sufficient flexibility in the "CPM text" – the master document that WRC-15 will work from – to reflect the current domestic scenario.

Another current body of work that is of relevance, is the Department of Communications' Spectrum Review. While the Terms of Reference of this review are wide-reaching, the broad intent is to simplify the spectrum management framework by making arrangements "*more efficient, effective and flexible, while continuing to appropriately manage interference and providing certainty for incumbents*." This includes a first principles review of current licence types, which will ultimately affect all radiocommunications users, and development of a framework for determining how 'public interest' spectrum are considered, which could encompass issues such as PSMB. The report from this review was recently released.

The mobile broadband landscape

The demand for additional capacity for mobile broadband is well documented. Economically, the flow-through impacts of mobile broadband communications cannot be understated – a 2014 report commissioned by the ACMA and undertaken by The Centre for International Economics attributed an estimated $33.8 billion (some 2.28% of GDP) increase in economic activity in Australia to mobile broadband.

[4] The CPM is responsible for preparation of a consolidated Report (the 'CPM Report') on the ITU-R preparatory studies and possible solutions to each of the WRC Agenda Items, which is used as the starting reference for the WRC.

Growing demand for mobile broadband capacity is not limited to the commercial sector – PSMB being an obvious example of non-commercial requirements for access to this technology, with less obvious examples including consumer and industrial machine-to-machine applications being carried on mobile broadband platforms.

Domestically, this increasing demand for capacity can be satisfied through a combination of actions taken by either:

- Government, through-
  - releasing *new* spectrum for mobile broadband, eg. the 700 MHz, 2.5 GHz bands and the future release of the 850 MHz expansion band, and/or
  - refarming *existing* mobile spectrum to facilitate greater efficiency, eg. the reorganisation of the 900 MHz band into 5 MHz blocks (to enable LTE deployments), proposed in previous consultation on the 803-960 MHz review; and/or
- Industry, through-
  - Investment in infrastructure, particularly increased base station spatial density to increase overall network capacity with the available spectrum; and/or
  - Adoption of increasingly efficient technologies.

While capacity demand will ultimately need to be met through a well-balanced combination of all of the above, the latter point is an important one. Cellular mobile broadband technologies are standardised through the 3rd Generation Partnership Project (3GPP). This standardisation is a forward-looking process that sets out an evolutionary path for technology standards. For example, the current generation technology – 4G 'Long Term Evolution' (LTE)[5] – is not a single technology standard, rather a set of ever-evolving 'releases' that specify upgrades on the previous release.

3GPP Release 12 (frozen[6] March 2015) included a range of enhanced features, including provisions for device-to-device (D2D) communications. Some of the Release 12 features (particularly D2D – analogous to 'talk around' on legacy narrowband networks) will potentially be of greater benefit for public safety than others. In any case, the adoption of an evolving standard means that PSMB users will have access to the full range of improvements throughout the lifecycle of the current technology generation, whether specifically included for public safety purposes or not.

One feature being incrementally improved in 3GPP standards is carrier aggregation, which is the ability to significantly increase the throughput (bit rate to/from a device) by aggregating carriers on disparate frequencies. Commercial operators in Australia have already introduced this feature on 3 and 4G networks and are incrementally improving on it as standards evolve. The ability to implement carrier aggregation depends upon having access to multiple standardised frequency bands in different parts of the spectrum.

Release 13 (expected freeze date March 2016) will include further enhancements for public safety operations, including mission critical push-to-talk (MCPTT) and additional resilience for 'nomadic' or

[5] Some years ago endorsed by the Association of Public Safety Communications Officials (APCO) International for broadband public safety communications.
[6] Frozen means no further modifications or additions to functionality (only essential corrections can be made following freezing).

'isolated' eNodeB[7] scenarios for provision of deployable coverage (eg. using cells-on-wheels, or 'COWs') or when backhaul is not available, respectively.

These standards apply to specific frequency bands, commonly referred to as '3GPP bands'. For example, within the 803-960 MHz band, LTE is standardised for frequency division duplex (FDD[8]) operations in 3GPP bands 5 (the 850 MHz band), 8 (the 900 MHz 'GSM' band) and bands 26 and 27 (the 850 MHz expansion bands). This directly influences the ACMA's decision process when determining bands to be made available for mobile broadband, as use of standardised bands provides for economies of scale for equipment and international roaming for consumers.

Lastly, while 4G LTE is the current standard for cellular mobile broadband communications, international attention has already turned to the next generation, 5G. Demonstrations of potential 5G technologies have already been provided by some equipment manufacturers, although opinions still differ on what exactly 5G will 'look' like and will continue to do so until relevant 3GPP standards begin to take shape. It is likely that a key item on the agenda for the next WRC (WRC-19) will look at potential frequency bands to be identified for 5G services[9]. The ACMA will again take a lead role in Australia's engagement with this process.

It is logical that potential delivery models for PSMB should include a strategy to ensure that operators have access to the best available network features as technologies evolve through releases of standards. Adoption of non-standard technologies (or non-standard variants of standardised technologies) could prevent PSMB users from benefitting from this evolution and lock them into a bespoke solution in the long term. While this has obvious implications for operators, from a spectrum management perspective this would also mean that, in the longer term, the PSMB capability may no longer be optimally spectrally efficient.

[7] eNodeB means LTE base station.
[8] Time division duplex (TDD) bands are also specified but generally not planned for in Australia.
[9] WRC-15 Agenda Item 10 involves the identification of Agenda Items for the next conference. At this stage there is a strong international push to place an item on the WRC-19 agenda that examines the potential identification of specific bands (yet to be finalised) above 6 GHz for 5G use.

Public safety spectrum in Australia

Public safety communications remain a key area of importance to the ACMA. The ACMA's submission to the Parliamentary Joint Committee on Law Enforcement's (PJCLE) 2013 Inquiry into Spectrum for PSMB described the key areas of work in this field that the ACMA undertakes to reflect that importance.

The ACMA engages with the public safety community on a regular basis, on both operational and strategic/policy levels. At the policy level, the ACMA has invested considerable resources over a long period of time to develop strategies to help ensure that PSAs have adequate access to spectrum to support their operations. Historically, these operations have been underpinned by narrowband communications, however some time ago a need for high speed data capabilities emerged. This is something that the ACMA had been thinking about for some time, with consideration of making spectrum provisions for non-cellular broadband wireless access networks dating back to 2007, and mobile broadband soon after that.

As it became clear that there could be no single-band solution to meet all of the mobile communications requirements of PSAs, given highly dynamic and ever-changing operational requirements, the ACMA adopted a layered approach to providing spectrum that was fit-for-purpose for public safety communications. In 2012, a paper was released that described three discrete, but related, layers of public safety radiocommunications, each with their own unique advantages, disadvantages and spectrum requirements. Even now there is already some convergence of these layers emerging – making it timely for a 'first principles' review of delivering these capabilities – as technologies evolve and the boundaries between commercial and non-commercial capability solutions are being softened.

One of the key areas of work described in the abovementioned paper was the important reforms being made to the 400 MHz band, which are critical to the delivery of narrowband public safety communications nationally. These reforms were the result of years of detailed planning and consultation with PSAs and other agencies, and included the identification of Harmonised Government Spectrum (HGS) within that band that will ultimately enable an unprecedented level of national interoperability – more on that later.

It was also announced that 50 MHz of spectrum from the 4.9 GHz band would be made available for exclusive access by PSAs, to support the abovementioned non-cellular wireless broadband (among other) requirements. A Class Licence was made that permits unlimited access by these agencies, free of charge, for various purposes. These purposes might include: deployment of high-capacity, local/incident area networks (LANs/IANs) or hot spots (potentially including fixed-installation hot spots in metropolitan areas); mesh or ad-hoc broadband networks; IP or other broadband data links; or video surveillance links, including from airborne platforms.

Deployments in this band are in their early stages and the ACMA has been providing assistance, through the NCCGR, in managing access to the band by PSAs. The band is incorporated in the 802.11[10] family of standards for WiFi and a market for public safety-grade equipment exists to support the abovementioned applications.

It is important to distinguish the *fixed* broadband applications of the 4.9 GHz band from the *mobile* broadband applications of the proposed PSMB capability, which is intended to be a specific cellular topology. While there is scope for using the two bands in combination with one another – eg. using

[10] A family of media access control and radio interface standards for wireless LANs produced by the Institute of Electrical and Electronics Engineers (IEEE). This family of standards specifies the more ubiquitously deployed consumer WiFi systems that operate in the 2.4 and 5 GHz bands.

4.9 GHz hot spots for 'data offload' from the PSMB network (in a similar way that ordinary smart phones can offload data from commercial mobile broadband networks through WiFi access points) – the 4.9 GHz band is not intended as a substitute for the type of service that will be provided by PSMB. Rather, it is intended to facilitate the deployment of technologies that are complementary to the PSMB capability, or alternatively stand-alone applications that meet specific business requirements.

On an operational level, the ACMA engages with the public safety community on a day-to-day basis, through ordinary planning and licensing activities, as well as support to strategic engagement with a number of committees, including the NCCGR and the Law Enforcement and Security Radio Spectrum Committee (LESRSC), as well as a number of other committees dealing with specific government radiocommunications issues. One function of the NCCGR is implementing the COAG-endorsed National Framework to Improve Government Radiocommunications Interoperability ('the Framework'), which the ACMA has long been a key supporter of.

To support this engagement, the ACMA dedicates a team of engineers that are focussed solely on planning for spectrum access by Government radio users – primarily Defence and public safety agencies.

Additionally, another team is dedicated to implementing the abovementioned reforms in the 400 MHz band. These reforms are, at a high level, intended to improve the utility and efficiency of the band for the delivery of narrowband services. As mentioned above, the implementation of Harmonised Government Spectrum (HGS) which will ultimately result in Government (including public safety) operations being nationally frequency-harmonised, consistent with the guiding principles of the Framework. The ACMA's 400 MHz implementation team works closely with stakeholders, including the NCCGR and individual capability managers, to assist with the transition process, including compliance with milestones under the implementation plan.

Public Safety Mobile Broadband (PSMB)

The Public Safety Mobile Broadband Steering Committee (PSMBSC) was established in 2011, with membership drawn from Commonwealth agencies, including the ACMA, and numerous peak bodies representing PSAs. Part of the function of the PSMBSC was to identify, through consultation with PSAs, industry and the ACMA, the operational and technical requirements of a PSMB capability.

The ACMA worked with the committee to examine the outcomes of a range of studies into the needs of PSAs against specific Terms of Reference that, among other things, stated that the committee would develop a national implementation plan (NIP) that would:

> *"… utilise a possible allocation of spectrum from the 800 MHz band for the deployment of an interoperable national mobile broadband capability for public safety agencies."*

These studies included consideration of a range of operational scenarios (informed by PSAs) to determine the quantum of spectrum required to support a mobile broadband capability out to the year 2020. These studies were taken as evidence to support identification of a quantum of spectrum in the 850 MHz expansion band (the same spectrum as the '800 MHz band' specified in the abovementioned ToRs, despite the difference in naming convention).

During this process it was envisioned that a dedicated PSMB network would provide coverage for PSAs in major population areas, on the States' and Territories' own advice that they could not afford to build infrastructure to provide coverage in most rural and remote areas. Outside these areas, coverage would be provided by commercial networks, through appropriate service-level agreements (SLAs). These assumptions underpinned the PSMBSC's technical and economic modelling and in response the ACMA announced (in the abovementioned public paper) an in-principle agreement to

set aside 10 MHz (5 MHz paired) from its review of the 803-960 MHz band to support a PSMB deployment, if required.

While the work of this committee was useful in giving the ACMA an empirical basis for determining PSA requirements, its ToRs were specific, not only in terms of the frequency band that the capability would use, but also how the capability would be delivered. For example, 'alternate' solutions (ie. commercially-based solutions) were confined under the ToRs to serving as:

> *"… a fallback option if, for any reason, the public safety agencies are not in a position to agree on an implementation plan or are unable to take up a possible allocation of spectrum."*

In that regard, the analysis undertaken by the PSMBSC was not 'first principles' in nature. In particular, there was a risk that a range of options for delivering a strong PSMB capability may have been excluded in adopting the abovementioned starting assumptions. While most of the studies undertaken during that process will no doubt serve as a valuable reference for the PC, it needs to be kept in mind that they were conducted against a range of specific, fixed inputs and parameters.

The ACMA therefore welcomes the 'ground up' approach of the PC in its consideration of how best to realise this vital capability, reaffirming that the end goal should ultimately be data capacity, with radio spectrum being one of a number of inputs. As previously stated, the ACMA has retained provisions for PSMB in its proposed plan for the 800 MHz band, but will await the outcomes of the PC's study before finalising any allocations.

Responses to specific questions in the Issues Paper

In this submission the ACMA has sought to address questions from the PC's Issues Paper that pertain directly to the ACMA's regulatory role. Questions for which answers have *not* been provided can be grouped into four broad categories, being governance (including interoperability), capability (including operational requirements and current arrangements), technology (including public safety-specified equipment availability and voice/data convergence) and business (including procurement and costing) matters. These matters are best left to those with relevant expertise.

The ACMA considers that the following questions relevant to its expertise and role:

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?

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?

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?

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?

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

As described in the previous chapter, the work of the PSMBSC was conducted under ToRs that were explicit in their identification of a specific frequency band to be considered for an allocation. The technical and cost modelling was undertaken against discrete delivery models consisting of various combinations of dedicated (within coverage area) and commercial (outside dedicated coverage area) solutions, with the distinction between each model being the amount of coverage provided by the dedicated component. The 'commercial only' option (ie. no dedicated coverage component) was only considered as a fallback under the ToRs. Capacity modelling was undertaken against a range of discrete scenarios, with specific operational presets that were agreed by the committee.

While a significant, valuable body of work was assembled as a result, the ACMA is of the view that the specification of certain presets (in both the ToRs and elsewhere) did not adopt a first principles

approach. At a high level, the ACMA considers that a logical, first principles approach to efficiently planning and developing a fit-for-purpose capability would be to work through a number of steps that identify:

- What is the capability requirement, ie. in *operational* rather than spectrum or cost terms?
- What exists now and what is the capability gap?
- Is the current capability scalable or is a new approach needed?
- What are the options for delivering the capability?
- What are the costs and benefits of the competing options (taking into account the opportunity cost of the spectrum required to support each option)?

If spectrum is allocated for PSMB, there are costs imposed on alternative users of the spectrum. Therefore it is appropriate that a thorough cost-benefit analysis be applied to ensure that any reallocation is socially optimal.

Once the most cost effective option has been identified to meet the capability requirement, a specification can be derived, which may include spectrum requirements. By contrast, the PSMBSC sought to identify how much spectrum would be needed to support a specific option and then create an implementation plan, so ACMA sees significant merit in the approach proposed by the PC.

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

This question is answered from a spectrum management perspective, consistent with the ACMA's role. Examples of PSMB deployments in other countries are best contributed by PSA representatives who have a better grasp on the activities of their counterparts overseas. Broadly speaking, as far as the ACMA is aware, the most obvious examples of these are:

- Rollout of the FirstNet model in the US;
- Consideration of commercially-based solutions in the UK (to replace the ageing Airwave system); and
- Potentially a number of countries where PSAs access commercial broadband networks on a subscriber basis, on varying scales. A well-known example is in New Zealand, where Police have deployed more than 15,000 smartphones and tablets for use by frontline officers as part of a 10 year contract with Vodafone.

Relevant spectrum-related ITU-R publications include:

- Resolution **648 (WRC-12)** *Studies to support broadband public protection and disaster relief* itu.int/oth/login.aspx?ReturnUrl=%2foth%2ftiesonly%2fdownload.aspx%3ffile%3dR0C0A00000A0017PDFE.pdf&file=R0C0A00000A0017PDFE.pdf
- Resolution **646 (Rev.WRC-12)** *Public Protection and Disaster Relief* itu.int/oth/R0A0600001A/en
- Recommendation ITU-R M.1826, *Harmonized frequency channel plan for broadband public protection and disaster relief operations at 4 940-4 990 MHz in Regions 2 and 3* itu.int/rec/R-REC-M.1826/en

- Recommendation ITU-R M.2009, *Radio interface standards for use by public protection and disaster relief operations in some parts of UHF bands in accordance with Resolution **646 (Rev.WRC-12)*** Document http://www.itu.int/rec/R-REC-M.2009/en
- Recommendation ITU-R M.2015 – *Frequency arrangements for public protection and disaster relief operations in some parts of the UHF band in accordance with Resolution **646 (Rev.WRC-12)*** http://www.itu.int/rec/R-REC-M.2015-0-201203-I/en
- Report ITU-R M.2033 *Radiocommunication objectives and requirements for public protection and disaster relief* (note, intended to be superseded by M.[PPDR]) http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2033-2003-PDF-E.pdf
- Preliminary draft new Report ITU-R M.[PPDR] *Public Protection and Disaster Relief Communications.* Not yet finalised.

Relevant APT publications (all can be downloaded from http://www.apt.int/AWG-RECS-REPS) include:

- Recommendation APT/AWF/REC-01r1 *Use of the Band 4940-4990 MHz for Public Protection and Disaster Relief (PPDR) Applications*;
- Report APT/AWF/REP-08 *Possible Harmonized Use of Bands 406.1-430 MHz, 806-824/851-869 MHz, 4940-4990 MHz, 5850-5925 MHz for PPDR Application in some APT Countries*
- Report APT/AWG/REP-27 *PPDR Applications Using IMT Based Technologies and Networks*
- Report APT/AWG/REP-38 *Technical Requirements for Mission Critical Broadband PPDR Communications*

Question 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?

The Terms of Reference of the spectrum review are wide-reaching, however the broad intent is to simplify the spectrum management framework by making arrangements "more efficient, effective and flexible, while continuing to appropriately manage interference and providing certainty for incumbents." This includes a first principles review of current licence types, which will ultimately affect all radiocommunications users, and development of a framework for determining how 'public interest' spectrum are considered, which could encompass issues such as PSMB.

In broad terms, the spectrum review is intended to create a future-looking toolkit for spectrum management in Australia. A strong emphasis is being placed on flexibility and opportunities are being explored for specific user groups to take on band management responsibilities where appropriate. These aspects will ultimately benefit Government radiocommunications users.

Regarding the Object of the Act, specifically the explicit provisions for public safety spectrum, the report of the Review states that

> *The objects of the Act would be reviewed during the development of the detailed legislative arrangements to make sure they are appropriate for the new framework, including encouraging efficiency, innovation and certainty of investment and ensuring regulation does not overly constrain spectrum use and reuse. The objective of providing adequate provision for public and community services would be retained.*

Question 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?

Any consideration of spectrum value must include option values, as they are likely to make up a material portion of the value parties place on spectrum. It should be noted that the relative size of option values may vary significantly across users, and particularly across sectors (i.e. non-commercial vs. commercial users).

The size of option values is likely to be driven by the amount of uncertainty in forecast market performance. A dynamic sector such as the commercial mobile broadband sector is likely to attach a relatively large option value to spectrum simply due to the large uncertainty of forecast demand for mobile services. Within the context of PSMB requirements, option value is of critical importance given the relevant spectrum (including, potentially, the 700 MHz or 800 MHz bands) would otherwise be allocated for use by commercial mobile broadband providers.

With regards to the commercial mobile broadband sector, there is significant uncertainty around mobile traffic forecasts, spectral efficiency improvements, and the timing and quantum of additional spectrum releases. In modern cellular networks, spectrum resources can be rapidly reallocated in the event that an MNO experiences unanticipated increases in mobile traffic, base station costs, or a slowdown in spectral efficiency, and this confers an option or insurance value to spectrum. In this way, even if spectrum is unused it is likely to have an economic value to its owner.

As such, any analysis that estimates the extent to which access to additional spectrum reduces the costs of network deployment (i.e. 'cost reduction analysis') will necessarily be an underestimate of the actual value MNOs may place on spectrum. The materiality of option values will depend upon the level of uncertainty around key factors in the sector, the risk profile of the MNO and many other factors.

In order to inform on the potential materiality of option values, Australian auction results are most relevant. The list of Australian spectrum auctions, including the results, is on the ACMA website.

Analysis of international spectrum auctions underlines the variability of spectrum auctions. Plum Consulting, in its *Valuation of public mobile spectrum at 825-845 MHz and 870-890 MHz* report, found a "mixed pattern of values" in its analysis of international 700 MHz, 800 MHz and 900 MHz auctions.[11] It is not surprising that international spectrum auction results vary widely. Unlike commodities like wheat and iron ore, spectrum cannot be shipped to different markets around the world – so trade does not equalise global prices. As a result, there is no direct reason to believe that prices in Australia should reflect prices in other countries. In addition, every auction has different characteristics which affect prices, such as quantity of spectrum offered, population covered, number of bidders, lot configurations, competition limits and/or rollout obligations.

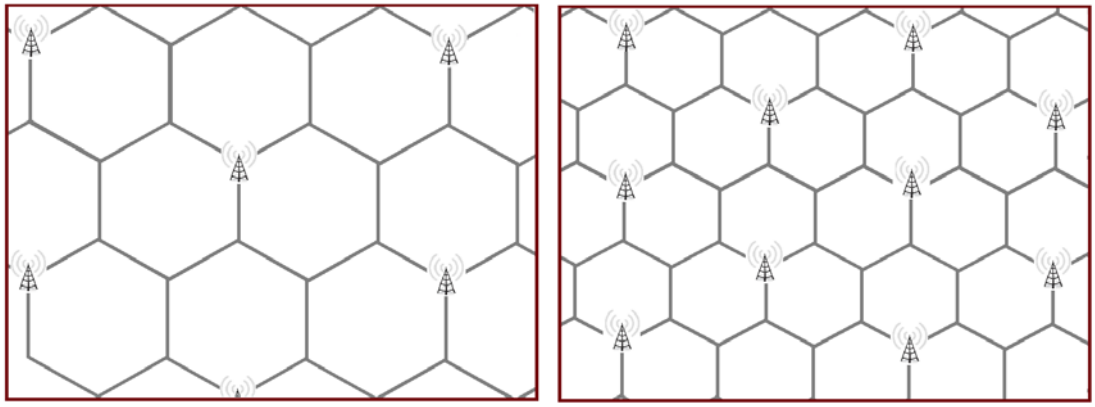
Question 55: What network cost components are interdependent with other costs, or other parameters (such as assumptions about the amount of spectrum allocated)? What is the nature of these interdependencies?

In delivering a required amount of mobile broadband network capacity, there is a well-established three-way trade-off between investment in spectrum, infrastructure and efficient technologies. Assuming the most spectrum-efficient available technology is adopted (which in the PSMB case, would be the latest 3GPP release), this collapses to a trade-off between spectrum and infrastructure – specifically the peak bandwidth used in a sector/cell (which given that in LTE these frequencies are reused in adjacent sectors, would also represent the overall allocated bandwidth for the network) and the number of eNodeBs (LTE base stations) deployed within a given coverage area.

[11] Plum Consulting, Valuation of public mobile spectrum at 825-845 MHz and 870-890 MHz, pp 6-7

This is illustrated in the example below, drawn from the ACMA's submission to the Parliamentary Joint Committee on Law Enforcement's 2013 Inquiry into Spectrum for PSMB:

> *Within the depicted notional coverage area, the same capacity could be achieved in both the left (which uses a certain spectrum bandwidth) and right (half that bandwidth) scenarios. Note that as more spectrum is provided less base stations are needed (and therefore lower deployment costs).*



> *This argument no longer holds once cell sizes increase towards their maximum limit (limited by radio propagation factors and maximum allowable power settings), where any increase in spectrum will directly add to the capacity, but the number of base stations cannot be decreased any further. In general terms, while additional spectrum for a 'thin' network can reduce capital expenditure, more conventional, 'denser' networks are more scalable (ie. can tailor capacity to meet varying needs), more robust (network can better recover if a base station cease to operate) and more capable of handling spikes in data traffic (eg. due to an incident).*
>
> *High value spectrum below 1 GHz is scarce, thus a trade-off where spectrum is sacrificed to save on infrastructure should be avoided. From a whole-of-economy perspective, the conventional density approach both frees up the additional spectrum for other uses and maximises the efficiency in use of the spectrum provided to PSAs. The infrastructure density is scalable; however the bandwidth provided is not – once provided it cannot be used by other services.*

Question 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?

The ACMA has provided the PC with the Analysys Mason Mobile network infrastructure model, which was created for the ACMA to further our understanding of the relationship between the amount of mobile infrastructure required and the amount of mobile spectrum made available. The model makes projections about the infrastructure requirements for the mobile sector, with results presented in terms of the number of sites that are required for a mobile operator to satisfy forecast data demand, given a range of assumptions including:

- the geographic area to be covered by each mobile technology (2G, 3G, 4G)
- the volume of mobile traffic to be carried by each mobile technology
- the spectrum available for each mobile technology
- the spectral efficiency of each mobile technology.

Sensitivity analysis can also be undertaken by changing assumptions about a range of inputs including traffic projections, spectrum allocations and spectral efficiency.

To help gain an appreciation of the number of base stations required to achieve a specific level of coverage, the ACMA's Register of Radiocommunications Licences can be used to find the numbers and locations of all of the base stations deployed by the three main mobile telecommunications carriers, across all of the commercial mobile frequency bands. The carriers themselves have stated coverage areas, generally expressed in terms of percentage of population coverage, which can be combined with this data to estimate the number of base stations required to provide the required amount of coverage.

Question 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?

There are a range of approaches to estimating opportunity cost in the spectrum context. The ACMA undertook a consultation process on the use of opportunity cost pricing for spectrum in 2009, which was informed by a consultation report (by Plum Consulting) on the methods of estimating opportunity cost. See the relevant section of the ACMA website.

In its report, Plum Consulting recommends the following:

> *The … choice of approach to deriving opportunity cost estimates is contingent on the objectives the regulator is seeking to achieve, the frequency band being considered and the quality of the information available. In some circumstances multiple approaches may need to be used and reconciled.*
>
> *The recommended approach is given by the following multi-step process:*
>
> 1. *What services or applications could potentially use the frequency band? Are they to provide a service offering (i.e. public) or to support internal business processes (i.e. private)?*
> 2. *If they are to provide a service offering (i.e. public services) then for each use derive the value of spectrum as follows:*
>   a. *Are there market values derived from spectrum transactions in comparable market and spectrum use situations? If yes, then use these data to provide an estimate of value for the service in question.*
>   b. *If there are some uncertainties over the reliability of the value derived from market data or such values cannot be derived, then directly calculate the value as follows.*
>   i. *Generally calculate value based on the NPV of future cash flows with all inputs (including capital) valued at their market price.*
>   ii. *But if in some circumstances it is reasonable to assume that spectrum holdings change to achieve cost reductions while service output and revenues are constant, then estimate value based on the least cost alternative approach.*
>   c. *Where market and directly calculated spectrum values are obtained, make choice of value based on the direction of bias that seems likely to best promote welfare.*

3. *If they support internal business processes (i.e. private services) then for each service derive estimate the opportunity cost of spectrum based on the least cost alternative approach*
4. *If there is a use with an estimated value greater than that for the current use then set the AIP between the two values – generally towards the bottom end of the range but depending on the shape of spectrum demand curves there may be circumstances where a value towards the middle of the range will be appropriate.*

Generally, an increase in the amount of spectrum sharing will reduce the number of alternative users that are denied access to this spectrum, and will therefore reduce the opportunity cost of a given spectrum band.

Question 59: What data sources could be used to estimate the opportunity costs of spectrum under different deployment options for PSMB?

See the *Recommendations* section, pp 35-36 of Plum Consulting's report on Administrative Incentive Pricing of Radiofrequency Spectrum.

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

The opportunity cost of any administrative allocation of spectrum identified to support a PSMB capability should be taken into account. Spectrum that is standardised by 3GPP for mobile broadband, particularly below 1 GHz, is an extremely valuable commodity. Any administrative allocation would represent a significant amount of revenue directly foregone to the Commonwealth, and indirectly a non-realisation of the various economic and social flow-on benefits that may otherwise be realised from the spectrum being allocated for commercial mobile broadband deployments.

Discussions around spectrum valuation in a public interest context often raise questions about whether 'special' prices are justified or appropriate. The ACMA's approach to these matters is to set prices on a market basis and to respond to directions from the Government on public interest pricing matters. For example, under the previous work of the PSMBSC the then Attorney-General Nicola Roxon announced that the spectrum set aside for PSMB would be subject to a 50% public interest discount for PSAs.

As a general rule, it is preferred that operators are subject to a spectrum pricing regime, regardless of the extent to which the public interest is served by their use. The reason for this is primarily as it promotes efficient use, and is consistent with a key message from the report of the PC's 2002 Review of Radiocommunications Acts:

> *Regulatory measures will still be needed to meet the spectrum needs of defence, safety-of-life and essential services, but, as far as possible, these services should also be subject to price disciplines, with budget support to meet spectrum costs.*

This efficiency-based reasoning is also reflected in the PC's report:

> *Charging fees that do not reflect the opportunity cost of the spectrum, and granting fee exemptions or concessions, reduces users' incentives to use spectrum efficiently.*

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

While this is not a question for the ACMA and will depend on the expected system lifecycle, among other factors, it is worth mentioning that under the current licencing framework, Spectrum Licences

are issued on a 15 year basis (payed up front) and apparatus licences up to 5 years, with fees payable yearly (note that the report of the spectrum review recommends a change to these frameworks, but it can be assumed that they will remain in place for (at least) the near term). This may need to be factored into the amortisation of costs for the various options.