Public Safety Mobile Broadband

A submission to the Productivity Commission Issues Paper

June 2015

Alcatel-Lucent welcomes the opportunity to respond to the Productivity Commission Issues Paper, *'Public Safety Mobile Broadband'*. As a leading player in the global communications sector, Alcatel-Lucent is well placed to provide insight on technology and market trends and how they apply to the various considerations encompassed by the terms of reference.

Mobile broadband has rapidly become a significant and increasingly important feature of everyday life, for consumers, businesses and other organisations across the community. As such, mobile broadband is a key enabler for Public Safety Agencies (PSAs), providing access to emerging features such as real-time imagery, video, geo-localisation and always-on connectivity to private cloud-based applications and databases, all of which have the potential to enhance public safety outcomes.

Consistent with the unique reliability requirements of PSAs, and technology evolution, it is appropriate that the Australian Government via the Productivity Commission to consider how best to meet the need for Public Safety Mobile Broadband (PSMB) in the future. In this paper we will seek to provide constructive insight in response to the questions put forward in the Productivity Commission Issues Paper.

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Introduction

Society has developed an insatiable thirst for connected services, including those for public safety — police, fire and emergency medical services. And while governments wish to improve public safety, they face a dilemma in meeting this need without increasing taxes or cutting infrastructure spending. Governments around the world are looking at how they can utilise modern networks to enhance operational effectiveness, collaboration among agencies, and improve service while reducing cost.

Public safety communications are at a turning point. The most urgent planned and unplanned events now require the highest level of reliable, integrated mobile communications. In today's world, this means not only mission-critical voice, but also real-time imagery, video, geo-localisation, and high-speed access to private cloud-based information and applications. These demands must also be matched with dependable, real-time coordination between multiple government agencies.

Public safety networks were born in an era where technology was primarily used for dispatch — sending a police car, fire truck or ambulance in response to a call. Funded from individual budgets within functional areas, each department reacted to technology rather than investing in it as a means to better accomplish their mission. This model was acceptable when communications technology was primarily limited to telephone lines connecting the public to a dispatcher and radio using specialised narrowband technologies such as P25, TETRA or TETRAPOL connecting that dispatcher to various public safety personnel.

Because communications networks have evolved at different government levels and funded by isolated budgets, separated service networks emerged to meet the needs of each. Separate networks do not foster collaboration among agencies. Interoperability is difficult if these systems are not designed to share files, situational status or other information. Perhaps the most visible example of poor interoperability is the 2005 response to hurricane Katrina in the United States. Days after the storm, essential services were in disarray, people were stranded on roof tops, hospitals were without power and the government was out of control. Seven years later, the US government established FirstNet, an initiative to build a unified national broadband wireless network dedicated to public safety. Interoperability and breaking down silos are among its top objectives. A growing number of countries are now also taking this route.

When evolving to mobile broadband, a public safety agency may choose from numerous business models that will support its specific needs, taking into account existing Professional Mobile Radio (PMR) network operations, available spectrum, regulatory environment and financial resources. It may contract services provided by a commercial mobile network operator, operate or use a service from a dedicated virtual network over a mobile operator's infrastructure, build a wholly owned and operated dedicated network, or use a mix of different approaches.

One size doesn't fit all. Adding Long Term Evolution (LTE) mobile broadband capabilities to existing PMR networks in a non-disruptive and cost-effective way can be complex, with many factors to consider. Fortunately, proven roadmaps exist for a smooth migration that leverages existing infrastructure and investments.

About Alcatel-Lucent

Alcatel-Lucent (Euronext Paris and NYSE: ALU) is the leading IP networking, ultra-broadband access and cloud technology specialist. We are dedicated to making global communications more innovative, sustainable and accessible for people, businesses and governments worldwide. Our mission is to invent and deliver trusted networks to help our customers unleash their value. Every success has its network.

Alcatel-Lucent plays a leading role and brings unique perspective in transforming public safety communications through the use of commercial broadband technologies. Our engagements include active participation in the 3GPP standardisation body to standardise features specific to support of public safety communications, working in the United States to transform the public safety spectrum band for commercial broadband technologies, and the operation of public safety wireless networks in countries such as Germany and Austria.

For more information, visit Alcatel-Lucent on: http://www.alcatel-lucent.com, read the latest posts on the Alcatel-Lucent blog http://www.alcatel-lucent.com/blog and follow the Company on Twitter: http://twitter.com/Alcatel_Lucent

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Detailed Responses

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

Alcatel-Lucent is supportive of the first principles approach to analyse efficiencies, effectiveness and economics in delivering a PSMB capability, with reference to the broad stated deployment options of establishing a dedicated PSMB network, relying fully on commercial networks, or some combination of the two. Strong analysis should be made of the specific requirements of PSA communications requirements.

Depending on the outcomes of the Productivity Commission's considerations and resulting policy discussions, it will be important to recognise a range of additional issues that may have bearing on the outcome. These may include:

On the issue of whether a PSMB can be contracted from a commercial network

The analysis should consider whether there is a competitive market for carrier services or whether there is only a single supplier able to meet the PSMB coverage requirements. Analysis should consider factors including costs for network hardening (including towers, redundant backhaul, back-up power and physical security), how the arrangement could be transferred to a new carrier with no impact to public safety communications at the time of contract renewal, differences in Service Level Agreements (SLAs) and how liability might be handled in case of mishap.

On the issue of competition policy

In the case of a single commercial provider for PSMB requirements, analysis should consider possible implications for the competitive carrier market. In some European markets there are emerging examples of Mobile Virtual Network Operators (MVNOs) for the purpose of PSMB with the goal of preferable competition, governance, network redundancy and security outcomes as compared to a single commercial provider.

On the issue of traffic and cost

Mobile broadband is an evolving market characterised by rapid device, service and application innovation with consequential impacts on traffic and network capabilities. While it is possible to envisage many of the potential uses and benefits of PSMB, and assume significant growth over time, it may not be possible to entirely predict future applications, use patterns and data traffic. This unknown may impact on the ability to build an adequate cost model for a commercial PSMB arrangement.

Network diversity and redundancy

In general terms, telecommunications network design should factor consideration for redundancy. That is, the ability for service continuity in the case that the primary network infrastructure is disabled or impaired. This may have heightened importance for various stakeholders, including government, in the development of PSMB. Consideration of PSMB may therefore take account for opportunities of network diversity.

Operational transition

It should be recognised that upgrading PSA communications capability to PSMB is likely to raise a range of associated operational issues for PSAs including the creation of new tools and practices, training and new modes for conducting PSA activities in line with the enhanced communications capabilities.

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

International reference may provide important context and insight for the benefit of the Productivity Commission's analysis. Some key international developments are:

United States

FirstNet (First Responder Network Authority) has been obligated by the United States Congress to "take all actions necessary to ensure the building, deployment and operation of the nationwide public safety broadband network FirstNet."

Further information on FirstNet is available online: http://www.firstnet.gov/

South Korea

In July 2014, the South Korean government adopted plans to build a broadband network dedicated to public safety using LTE technology to be deployed nationwide by 2017.

Article links: http://bit.ly/1JiqWSo http://bit.ly/1FNPzE8

European Commission

The European Commission produced '*Is Commercial Cellular Suitable for Mission Critical Broadband?*', a 2013 study into the use of commercial mobile networks and equipment for 'mission-critical' high-speed broadband communications in specific sectors.

PDF link: http://bit.ly/1FWe6II

Belgium

Blue Light Mobile in Belgium is an example of a MVNO servicing the needs of PSAs. Blue Light Mobile consolidates the services of the nation's three mobile carriers.

Further information on Blue Light Mobile is available online: http://bluelightmobile.be/en

Alcatel-Lucent

Alcatel-Lucent has a range of relevant resources available for consideration.

Strategic whitepaper, '*Is your network ready for public safety in 2020?*'.

PDF link: http://bit.ly/1GhZYvg

Strategic whitepaper, '*Ultra-Broadband PMR: Five Business Models for Enhanced Mission Critical Operations*'.

PDF link: http://bit.ly/1I3fOas

Strategic whitepaper, '*Mission-Critical Communications Networks for Public Safety*'.

PDF link: http://bit.ly/1KGGFgg

Web page: http://www2.alcatel-lucent.com/public-safety/

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?

Alcatel-Lucent is of the understanding that allocation of spectrum for the purposes of PSMB should be able to occur within the existing framework for allocations as defined by the

Australian Communications and Media Authority (ACMA). To leverage economies of scale for devices and infrastructure, bands used for the PSMB network should align with bands used by commercial operators.

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?

Alcatel-Lucent recommends a wide view be taken of the PSA definition. This may extend the definition from the Issues Paper to consider functionality for ground-to-air services such as Police Helicopter and the Royal Flying Doctor Service. It may also be possible to include critical infrastructure operators and military that may support in disaster recovery operations.

Current operations may not generally class PSA-to-community communications as mission critical, although applications such as contacting a resident on arrival are common practice. However, it is possible to anticipate that community expectation and also PSA strategies for crisis management may create future demand in this area.

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?

No response for this item.

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?

Alcatel-Lucent would favour a definition of 'mission critical' to encompass: "a system where failure of any part of the system compromises an organisation's ability to perform its function or puts people in jeopardy."

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

Alcatel-Lucent's experience is that PSAs use applications over existing Land Mobile Radio (LMR) networks including voice calling, emergency and distress calling, location information, status messaging (man-down, on-site). This is very similar for different jurisdictions. Standard LMR networks struggle and are not generally suitable for data applications.

It should be noted that in some cases PSA voice services are carried on regular public telephony networks while commercial networks are also used for non-critical data exchanges such as mobile data access and identification.

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?

In Alcatel-Lucent's experience, European PSA narrowband networks, such as LMR networks, are typically renewed or upgraded approximately every 15-20 years for network hardware and every 2-3 years for network software.

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?

PSA communications networks will typically demonstrate a significantly greater discrepancy between average everyday demand and peak demand than in a commercial network. In Alcatel-Lucent's experience, current peak PSA communications traffic in times of crisis and emergency is typically 10-to-20 times larger than average demand as PSAs focus their attention on a particular location and/or event.

Another significant factor for managing PSA communications is that the significant traffic peaks are unpredictable in timing and location, as is the nature of crisis and emergency. On the other hand, commercial networks can generally plan for times and locations of peak demand, such as mass gatherings for New Years Eve of football finals, or various calendar events that have traditionally resulted in traffic spikes.

Figure 1. Different network capacity requirements for commonly used PSA communications applications

Application	Key Capacity Requirements						
	Bandwidth	**Latency**	**Usage**	**Coverage**	**Mobility**	**Reliability**	**Power**
Smart meter	-	Moderate except for control	Infrequent	High (Area)	-	High	-
Patient monitor	Moderate	Moderate except for emergency	Regular	Moderate	Low	High	Moderate
Police car	High (DL)	Moderate		High	High	High	-
Private car	Moderate	-		Moderate	High	-	-
Security camera	High (UL)	Low	Continuous	-	-	High	-
Point of sale	-	Moderate		High (Area)	-	Moderate	Moderate
Intrusion alarm	-	Low	Infrequent	High (Area)	-	High	Low

Source: Alcatel-Lucent

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?

No response for this item.

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?

Very few large organisations view mobile networks as 'mission critical'. The more common definition might be 'business critical' where consumer users employ enhanced features such as Virtual Private Networks (VPNs), corporate data and applications. Additionally, very few large organisations operate in a field force environment in the same way as PSAs.

Alcatel-Lucent's deployment of private LTE networks for Rio Tinto mine operations may provide some insight for PSMB. The private network deployment model has been key to providing Rio Tinto with its desired levels of flexibility and control. Insight for PSMB may be found in regards to:

- Significant use of prioritisation to manage traffic.
- Significant non-voice machine-to-machine (M2M) traffic.
- Criticality for worker safety.
- Use of mobile CCTV operations.

A potential future application for Rio Tinto is group calling using an all-inform structure, as often used by PSAs.

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?

Alcatel-Lucent is of the understanding that Telstra achieved a positive outcome for its LANES trial; however there was no significant public safety or congestion incident to put the system to critical test during the trial period. We understand there was no SLA in place for the trial.

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?

While interoperability testing would be required, roaming between different LTE networks and to 3G and 2G networks (although with more limited functionality) is technically

possible. Such interoperability would also require appropriate commercial arrangements and regulatory approvals.

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

The most urgent planned and unplanned events now require the highest level of reliable, integrated mobile communications. In today's world, this means not only mission-critical voice, but also real-time imagery, video, geo-localisation, and high-speed access to private cloud-based information and applications. These demands must also be matched with dependable, real-time coordination between multiple government agencies.

One area supported by emerging network capability and growing in particular significance for PSAs is enhanced situational awareness. In this environment, PSAs gain 360° situational awareness. Command and control officers can obtain and immediately share essential data with officers in the field. This includes high-definition video (including drone surveillance), social media, advanced analytics and accurate multimedia information such as object and person identification, gunshot detection and crime scene views. Additionally, vital signs from first responders and injured people can be transmitted to the appropriate command and control centres to improve personal safety and save lives.

Alcatel-Lucent's ng Connect innovation program has demonstrated these types of applications in an LTE public safety trial in Las Vegas.

PDF link: http://bit.ly/1LWrpcm

Further valuable material reporting the value of PSMB from the perspective of may be obtained from various fact sheets produced by FirstNet in the United States, including *'FirstNet EMS Fact Sheet'*, *'FirstNet Law Enforcement Fact Sheet'* and *'FirstNet Fire Services Fact Sheet'*.

Web page: http://www.firstnet.gov/resources

While many applications will be transferable across PSAs, it is likely that some specific innovation will occur to meet the unique needs of individual agencies. For example, ambulances may employ greater connectivity for on-board equipment and integration with other e-health applications that emerge across the healthcare sector. Fire services may adopt a greater range of 'life-vest' applications that monitor the health and safety of workers operating in hazardous conditions.

A common feature of these applications is that the uplink traffic requirements will be higher than for many applications that generally run on commercial networks where downlink is the dominant mode.

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

There will be features in LTE (3GPP release 12 and 13) that will mimic the current features used by PSAs on their existing networks. We can anticipate that PSMB to enhance and expand PSA features significantly, opening PSAs to a broader innovation ecosystem. A similar transition has occurred for commercial services where applications and data services are gradually overtaking the use of some traditional voice services.

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

Current operations may not generally class PSA-to-community communications as mission critical, although applications such as contacting a resident on arrival are common practice. It is possible to anticipate that community expectation and also PSA strategies for crisis management may create future demand in this area. While it may not be essential that this functionality occur within the operational PSMB network, it is possible that there may need to be some form of integration between the internal PSA platform and the broader external platform. One example is the evolution of the '000' emergency service (Next-Generation 911) where dispatchers will have access to video and images from the public and will require PSMB capacity to share this information with first responders.

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

The most urgent planned and unplanned events now require the highest level of reliable, integrated mobile communications. In today's world, this means not only mission-critical voice, but also real-time imagery, video, geo-localization, and high-speed access to private cloud-based information and applications. These demands must also be matched with dependable, real-time coordination between multiple government agencies.

Alcatel-Lucent is supportive of moves to ensure Australian PSAs are best served to access these emerging applications. Such analysis should pay regard to emerging PSA capability requirements for enhanced situational awareness and future applications, enhanced interoperability and collaboration, as well as affordable flexibility and evolution.

Specific considerations for this analysis may include definitions for 'mission critical' and how to apply SLAs in that regard; spectrum availability and allocation, bandwidth requirements (5+5 MHz or 10+10 MHz) and value for money. Further, consideration may be given to the liabilities and responsibilities of a commercial carrier given PSMB responsibilities.

It is worth noting that certain public safety features are being standardised in 3GPP and functionality will be phased in over time.

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)?

Standards-based LTE – the global mobile broadband technology – has the potential to dramatically enhance PSA operational effectiveness and coordination within a secure infrastructure shared by cooperating agencies. The operational benefits include enhanced interoperability and collaboration made possible by LTE's inherent interoperability and roaming capabilities. By means of gateways, it is also possible to enable communication interworking with the legacy PMR systems. The collaboration capabilities are then enhanced, strengthening a key aspect for successfully conducting life-critical operations.

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

Yes. Alcatel-Lucent is of the understanding that there are currently different systems used by different Australian PSAs and that some agencies require users to carry multiple radio devices to access different networks in certain circumstances. Given its reliance on open standards and the level of interoperability testing already done to support commercial services, LTE-based PSMB would help alleviate this problem and deliver new opportunities for national interoperability. However, a PSMB operator would need to be vigilant to prevent the future introduction of proprietary user features that compromise interoperability. By means of gateways, it is also possible with LTE to enable communication interworking with the legacy PMR systems.

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

It is unlikely that the benefits, costs and risks of achieving national interoperability would significantly change under the different deployment options as long as the relevant PSA user equipment was designed to support the different LTE frequency bands being used across the different deployment options and that the PSMB have processes in place to support testing, backward compatibility and related aspects.

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

No substantive response for this item, however Alcatel-Lucent is aware that where a multi-agency emergency response is required the response is based on (regional) disaster plans.

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?

No response for this item.

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

Public safety professionals require the highest level of reliable mobile communications, including broadband data services that deliver real-time imagery, video, geo-localisation and always-on connectivity to private cloud-based applications and databases. The most urgent planned and unplanned events now require the highest level of reliable, integrated mobile communications. In these cases, cells on wheels or rapidly deployable systems on wheels may help to provide the additional required coverage and/or capacity at the required location and time. In the Australian context, coverage needs to support a very high level of availability wherever a PSA is operating.

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

Alcatel-Lucent has typically used the cell edge rate to measure network coverage while additionally defining user equipment antenna heights and user equipment transmission power.

For public safety purposes, network coverage should be based on percentage of land area and road distances rather than by population alone. In building coverage is an important consideration for some agencies. It should also be declared whether the target is for an individual person or vehicle.

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

The coverage of commercial mobile networks is generally a product of commercial interest and investment capacity. Technically, there is potential to increase coverage through the deployment of additional mobile antenna sites and associated infrastructure and (pending commercial considerations of carriers), Radio Access Network (RAN) sharing through concepts such as Multi-Operator Radio Access Network (MORAN) are also possible.

In areas where coverage or capacity is particularly problematic, cells on wheels or rapidly deployable systems on wheels can help to provide additional required coverage and/or capacity to meet the needs of specific events.

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?

There will be a range of challenges to overcome to achieve PSMB, regardless of the selected deployment option. In the case of deploying PSMB using a commercial network, challenges may relate to securing SLA, investment for network hardening and provision for coverage extension. For a dedicated network, challenges will include time to deploy and initial investments.

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?

There will be features in LTE (3GPP release 12 and 13) that will mimic the current features supported by narrowband networks. We anticipate standardisation work (supported by the international community) to conclude mid-2016 and that the features can be mapped for application in Australia. However, if any proprietary feature has been deployed by PSAs in Australia, some investigation will be required to determine whether the standard solutions being developed will provide it with support.

In the interim there are voice technologies available that operate Over-The-Top (OTT). This means that they operate without the quality and latency enhancements of the standardised features, but may be suitable for non-mission critical operations.

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?

It is expected that such challenges will be addressed in the standardisation process. Testing would also be required.

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?

There are a range of commercially sensitive factors that inform the availability of new applications and technical features. As a rule of thumb, however, Alcatel-Lucent has generally observed feature availability some 18 months after the standards have been finalised. We expect standardisation on Push-To-Talk (PTT) to conclude for 3GPP R13 mid-2016. As a result, PTT voice service applications could become available as early as 2018.

Article link: http://bit.ly/1IiUiSj

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?

We anticipate that this will be similar for all relevant PSAs; however there may be certain specific requirements in specific cases. For example, police covert operations may require a higher level of integrity and security than fire and ambulance. However, all will require a similar level of availability.

In general terms, telecommunications network design should factor consideration for redundancy. That is, the ability for service continuity in the case that the primary network infrastructure is disabled or impaired. This may have heightened importance for various stakeholders, including government, in the development of PSMB. Consideration of PSMB should therefore take account for opportunities of network diversity.

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?

In general terms, a commercial network would require a process of 'network hardening' to make it suitable for the requirements of a mission critical PSMB network.

Commercial networks tend to be built to a commercial standard (~3hrs battery backup, low site redundancy, no radio overlap (in low density areas), and little diverse path backhaul) and commercial grade integrity and security. In a mission critical network you

would expect all of these standards to be enhanced. Further, legacy PSA networks typically have additional features (such as call logging), which would need to be added to the PSMB network. .

In the United States we have seen the requirement for Internet Protocol Security (IPSec) on all public safety linking infrastructure.

Another consideration is exposure of commercial networks to (Internet-like) attacks (eg. DDoS). In this regard, the security and resilience of the commercial network would need to be reviewed.

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?

PSMB networks are required to assure availability, identity and access controls, confidentiality, message integrity, communication security, seamless and easy to use security controls and privacy. For insight on defining and measuring security requirements, Alcatel-Lucent suggests an examination of the Federal Communications Commission (FCC) Communications Security, Reliability and Interoperability Council (CSRIC) report of March 2015.

The report notes how the National Institute of Standards and Technology (NIST) cyber security framework can be applied to wireless networks. The document also mentions some of the public safety services.

The NIST cyber security framework operates on identify, protect, detect, respond and recover principles for security. Alcatel-Lucent notes that the methodology and attributes described in the CSIRC report are applicable to PSMB and that the analysis and measurement principles described in the FCC CSRIC report may be leveraged for PSMB in Australia.

PDF link: http://bit.ly/1JuAlqd

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

PSAs will have intimate insight on this topic. In general terms, a commercial network would require a process of 'network hardening' to make it suitable for the requirements of a mission critical PSMB network. This would include user authentication, data access and storage, the certification of personnel to access equipment, exposure to attacks (eg. DDoS). In this regard, the security and resilience of the commercial network would need to be reviewed.

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

The enhanced situational awareness made possible by future PSMB applications envisages capabilities including database access and file sharing, high-definition video (including drone surveillance), social media, advanced analytics and accurate multimedia information such as object and person identification, gunshot detection and crime scene views.

Additionally, vital signs from first responders and injured people can be transmitted to the appropriate command and control centres to improve personal safety and save lives.

In a regular capability modelling exercise, network traffic would be estimated according to each application and user, as well as distribution across PSA sites (potentially based on existing traffic).

A common feature of PSA applications is that the uplink traffic requirements will be higher than for many applications that generally run on commercial networks where downlink is the dominant mode. Further, PSAs may increasingly adopt a new set of applications covered under the emerging market for the Internet of Things (IoT), which may influence how PSMB capability should be measured.

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

Measurement for the level of service capacity provided to PSAs would need to be modelled. Some parameters such as coverage availability, throughput availability at cell edge (uplink and downlink) and capacity per cell could be considered.

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?

There is strong indication across industry and market studies that 10+10 MHz is the minimum required spectrum allocation to support PSMB. This is demonstrated in adoption of the 10+10 MHz plan in nations including the United States, Canada and Korea.

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?

Differing PSA capability and demand would require modelling. In general terms, LTE supports prioritisation of users and applications and how these features are deployed is a matter of policy. Prioritisation may need to be changed dynamically based on the requirement of the incident response.

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

For the sake of analysis it may be useful to consider the establishment of a dedicated PSMB network as a baseline. In this case, there are a range of factors related to a commercial network that may influence sufficient PSMB capacity. These potentially include:

- Unknown or undefined SLAs.
- Unknown cost structure.
- Commercially-oriented deployment strategy.

- Less responsive capacity forecasting and positioning.
- Carrier operations separate from PSMB operations.
- Required network hardening.

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

There is a significant difference in resilience between PSA narrowband networks and current commercial mobile broadband networks.

Commercial networks tend to be built to a commercial standard (~3hrs battery backup, low site redundancy, no radio overlap in low density areas, little diverse path backhaul). In a mission critical network you would expect all of these standards to be enhanced. For example; we have seen requirements for 10hrs battery backup, duplication at critical sites and geographically diverse backhaul.

PSA narrowband networks employ direct mode, repeater mode model for resilience.

In general terms, a commercial network would require a process of network hardening to make it suitable for the requirements of a mission critical PSMB network.

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?

Network resilience is usually measured in terms of availability.

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?

Alcatel-Lucent is of the view that consideration of a replacement service is both appropriate and high priority. While it may not be cost effective to deploy an extreme high depth of LTE coverage for PSMB, alternatives for replacement or augmentation should be explored. One option may be for the first (or second) responder PSA to bring additional capacity to a particular incident including by means of a cell or system on wheels.

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?

Alcatel-Lucent is not aware of specific barriers to creating a resilient PSMB capability assuming adequate spectrum and funding allocations. However, it should be noted that most PSAs are agencies of state or territory governments and that implementation of a PSMB capability by 2020 may require certain institutional or policy changes within the PSA ecosystem.

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?

Mobile broadband is an evolving market characterised by rapid device, service and application innovation with consequential impacts on traffic and network capabilities. While it is possible to envisage many of the potential uses and benefits of PSMB, and assume significant growth over time, it may not be possible to entirely predict future applications, use patterns and data traffic. This unknown may impact on the ability to build an adequate cost model for a commercial PSMB arrangement.

LTE-based solutions use an all-IP architecture that, combined with geographic redundancy, reduces potential points of failure and provides the high availability required by public safety users. LTE technology is perfectly suited for efficiently handling any mix of applications. It boasts guaranteed and differentiated end-to-end Quality of Service (QoS) and priority/pre-emption mechanisms to ensure that the most critical applications and users always get serviced. LTE systems also offer extensive self-optimising network capabilities for simplified network operations, maintenance and self-healing. These capabilities make it easier to rearrange networks when needed, such as when adding deployable units for disaster scenarios.

LTE Release 10, approved in 2011, and subsequent planned specifications, have been designated as LTE Advanced, or LTE-A. These enhancements are already producing major benefits, including the potential for ultra-wide bandwidth – up to 100 MHz of spectrum, if available – with ultra-high data rates and greater capacity to support more sophisticated applications. LTE-A includes additional advanced Multiple Input Multiple Output (MIMO) capabilities, enhanced support for heterogeneous networks and machine-type communications. More importantly, starting from 3GPP Release 12, LTE integrates public safety features mimicking the most demanding mission-critical capabilities of existing PMR systems. These include support of efficient group communications, including PTT, direct communications between terminals and fallback mode for the base stations.

The essential set of mission-critical communication functionality previously developed for TETRA and other PMR technologies is projected to be available in LTE standards mid-2016 (3GPP Release 13). A fully developed ecosystem of standards-compliant devices and infrastructure is therefore not expected to develop much before 2018. Nevertheless, existing LTE standards and solutions already meet first-responder requirements for augmenting and complementing legacy PSA systems with broadband data-based capabilities. All new features can be included in subsequent software releases for the relevant network equipment.

Forthcoming 5G standardisation is expected to be built around and upon 4G technology making disruption in upgrades unlikely.

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

There are not anticipated to be any specific issues related to the convergence of voice and data services under the different deployment options. PSMB traffic has been historically different to commercial traffic in the following ways:

- In PSMB nearly all traffic is internal e.g. data from databases. In commercial networks most traffic is sourced externally e.g. data from the internet.

- In PSMB there are generally equal amounts of uplink (UL) and downlink (DL) traffic. In Commercial networks it is heavily dominated by downlink traffic.

As the network traffic evolves this may impact how security is managed, the balance between uplink and downlink and the impact on uplink bandwidth performance.

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

There are not anticipated to be any specific technical challenges involved with delivering a mobile broadband capability to PSAs by 2020 according to the alternative deployment options. However it should be noted that in the case of working with commercial operators, PSMB would require effective management of the range of commercial, network and roaming issues put forward in this paper.

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?

Given its standard-based development, there are no specific obstacles to a mobile broadband network being fully compatible with a range of end-user devices. It should be noted that spectrum allocations should be aligned with other emergency service networks globally to the extent possible. However, it is advisable to run interoperability testing of devices with the infrastructure vendor to ensure the devices will operate with their best performance. Alcatel-Lucent has interoperability testing labs for this purpose.

The assumption here is that the network upgraded to the latest standard. Generally speaking, handsets supporting 3GPP Release 12 and 13 features will not be able to use those Release 12 and 13 features on a network only supporting Rel10. The standardisation process however to date has ensured that Release 10 handsets will work on a more advanced networks eg. 3GPP R12.

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

Networks generally need to be kept up to date to ensure the latest security enhancements are added and support for newer handsets. Outside of this there is minimal impact on the cost of the system to PSAs from the method of ensuring interoperability.

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

Specific considerations for this analysis may include definitions for ‘mission critical’ and how to apply SLAs in that regard; spectrum availability and allocation, bandwidth requirements (5+5 MHz or 10+10 MHz), value for money and competitive market. Further, consideration may be given to the liabilities and responsibilities of a commercial carrier given PSMB responsibilities.

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

On the assumption that the question refers to different coverage options in potentially different regions, then to ensure interoperability the following elements should be amongst those considered common:

- User Equipment should be capable of operating in all the applicable bands.
- Traffic estimates would be identical across solution types in the same area provided bandwidths are identical.
- Application costs should be identical.
- SLAs should be identical.

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

There are a range of sources for the costs relevant to this study. These include technology vendors, carriers, (radio) site owners, site maintenance organisations, emergency service organisations (for applications) and existing documented costs.

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?

There are at least two aspects to this.

- The PSMB has the potential to materially impact competition in the carrier market. For example if one carrier is awarded public funds to extend and/or harden its network, it could be perceived to be receiving a commercial advantage. Alternatively, as per the FirstNet model, a PSMB can provide new or non dominant carriers with additional coverage in time of low PSMB usage increasing competition via wholesale access. In the FirstNet case, this wholesale revenue stream is used to completely fund the maintenance and operating costs of the PSMB. These commercial users would have limited access to the network in the case of emergencies.
- There is a potential issue of sharing network between commercial and PSA users. In that case and depending on SLAs, commercial users might have limited access to the network in case of emergency.

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?

No response for this item.

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?

The network elements in Box 4 are appropriate but LMR-oriented. We would suggest using models such as eTom as a framework to review whether all costs have been addressed (eg. billing and charging or cross charging infrastructure, provisioning etc).

Additionally; there are cost categories such as 'other' that may be worth consideration. For example the additional costs of logging public safety networks.

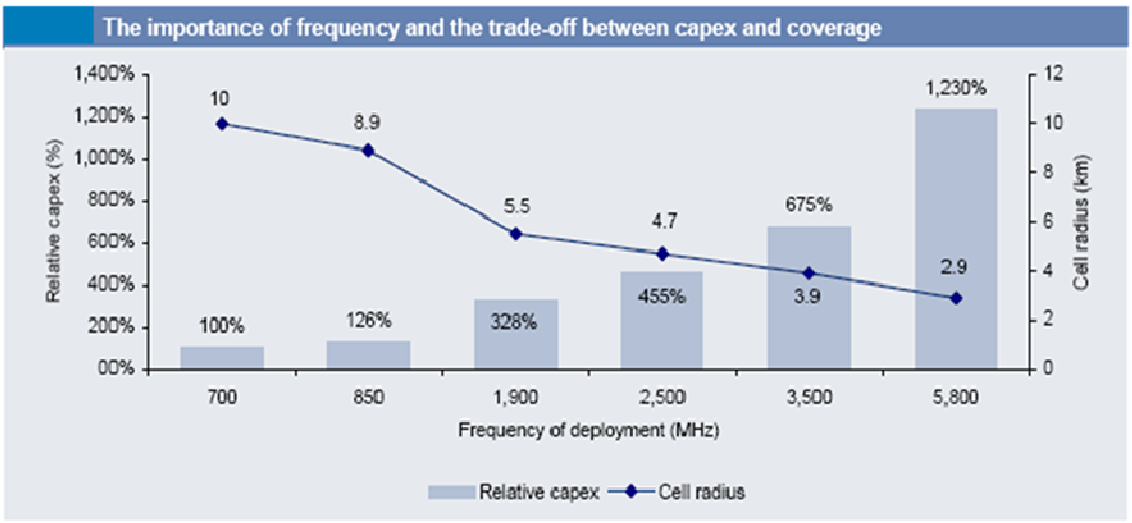
54. What method(s) should be used to estimate the network costs of different deployment options for delivering PSMB? What studies should inform the Commission's thinking in this area?

A coverage study would be required to estimate the network costs of different deployment options for delivering PSMB.

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?

Site count is strongly related to the cell edge rate and capacity. Spectrum (700MHz vs 2600MHz) is strongly related to the range you get from each site. See Figure 2.

Figure 2. Trade-off between CAPEX and Coverage



Source: Intel Analysis

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?

The best traffic estimates are based on the existing P25 network.

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?

For a build option the costs will be dominated by the need to achieve the coverage. This will need to be calculated using a radio network planning tool. This can then be translated in site count and costs. Capacity will then need to be added where it is insufficient using the existing P25 radio networks as a guide. Actual cost elements and architecture may be obtained from vendors. Most network planners use the eTom network to develop operational costs.

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?

No response for this item.

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

No response for this item.

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

No response for this item.

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

Alcatel-Lucent is of the view that costs and benefits for a PSMB network should pay regard to current rates and timeframes for network upgrade and replacement. In Alcatel-Lucent's experience, European PSA narrowband networks, such as LMR networks, are typically renewed or upgraded approximately every 15-20 years for network hardware and every 2-3 years for network software.

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

Analysis of the PSMB benefits should pay regards to both cost savings and the service value of new and emerging applications.

Cost savings

We expect cost savings on the network as follows:

- Handset costs.
- Reduction in P25 network maintenance costs.
- Database costs (licences, registration, warrant).
- We are also expecting general cost reduction due to the higher volumes and standardisation of this technology overseas (vs the alternative of using a non standard technology).

New applications / benefits

We expect benefits from:

- Better utilisation of existing staff:
    - Cameras and video will make it safer. Staff may ultimately be reduced with the video verification of suspects (reduced trips) and where multiple people are used to verify evidence.
    - Increased integrity with video verification.
    - Increased control in emergency situations via improved situational awareness.
- New applications:
    - Telemedicine.
    - Facial/identity recognition.
    - Hazard identification.
    - Personal safety (life vest) for field staff reducing workplace costs.
    - Internet of Things (IoT).
    - Potentially, Bring Your Own Device (BYOD) for particular users.

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?

The potential benefits of PSMB (in terms of PSA outcomes) would require modelling.

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)?

See above resources at Question 2. Useful references may include FirstNet in the United States, South Korea's current activity and various MVNO-oriented initiatives in Europe.

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

The enhanced situational awareness made possible by future PSMB envisages capabilities including database access and file sharing, high-definition video (including drone surveillance), social media, advanced analytics and accurate multimedia information such as object and person identification, gunshot detection and crime scene views. Additionally, vital signs from first responders and injured people can be transmitted to the appropriate command and control centres to improve personal safety and save lives.

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

Alcatel-Lucent understands that the FirstNet benefits analysis in the United States was completed using spreadsheet coverage analysis and modelling to estimate the costs under different scenarios. The same approach could be used in this case.

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?

There are a number of research papers on PSMB however it should be noted that the outcomes are very much dependant on the starting point, inputs, assumptions, costs included and baseline etc. Nonetheless, these studies may prove valuable insight for Productivity Commission consideration:

- *'Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the EU: 2x10 MHz in 700 MHz in 10 European Countries'*. Dr Alexander Grous, London School of Economics Dec 2013.
  PDF link: http://bit.ly/1QjFpOm
- 'Quantifying the Costs of a Nationwide Broadband Public Safety Wireless Network'. Ryan Hallahan, Jon Peha Carnegie Mellon University.
  PDF link: http://bit.ly/1EN5SNI

Acronyms

3GPP	3rd Generation Partnership Project
BYOD	Bring Your Own Device
CCTV	Closed Circuit Television
CSRIC	Communications Security, Reliability and Interoperability Council
DDoS	Distributed Denial of Service
FCC	Federal Communications Commission
IoT	Internet of Things
IPSec	Internet Protocol Security
ITU	International Telecommunications Union
LMR	Land Mobile Radio
LTE	Long Term Evolution
M2M	Machine To Machine
MIMO	Multiple Input Multiple Output
MVNO	Mobile Virtual Network Operator
NIST	National Institute of Standards and Technology
OTT	Over The Top
PMR	Professional Mobile Radio
PSA	Public Safety Agency
PSMB	Public Safety Mobile Broadband
PTT	Push To Talk
QoS	Quality of Service
RAN	Radio Access Network
SLA	Service Level Agreement
VPN	Virtual Private Network