DELIVERING 4G/LTE MOBILE BROADBAND FOR EMERGENCY SERVICES

TELSTRA WHITE PAPER
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EXECUTIVE SUMMARY

TELSTRA HAS SEEN THE EXCITING ADOPTION OF THE LATEST 3G AND 4G MOBILE BROADBAND TECHNOLOGY, UNDERPINNED BY TELSTRA'S WORLD LEADING NEXT G® NETWORK, AND AUSTRALIANS FROM ALL WALKS OF LIFE ARE REALISING THE BENEFITS THIS TECHNOLOGY CAN BRING TO BOTH THEIR PERSONAL LIVES AND THEIR BUSINESS AND PROFESSIONAL PURSUITS.

Increasingly, the availability of mobile broadband and voice services over an expansive coverage footprint is becoming not just a convenience, but a necessity.

The Australian emergency service organisations (ESOs) want to utilise this mobile broadband technology to enable their operations and enhance the services they provide to the Australian community.

Today, in addition to the myriad of private voice and narrowband data networks in use, the ESOs are increasingly using the public mobile telecommunications networks for broadband services to complement their operations. Given its extensive footprint in Australia, fast upload and download speeds and service reliability, the Telstra Next G® network is the service provider of choice.

However to support their business requirements, the ESOs are seeking greater certainty about service levels, especially in times of disaster or other disruptive events, before being prepared to migrate mission critical applications to public networks.

This paper discusses the options and presents an evolutionary path for ESOs to most effectively adopt 4G/LTE technology to deliver their mobile broadband data needs combined with the introduction of "quality of experience" functionality to give priority access and certainty of throughput for designated users.

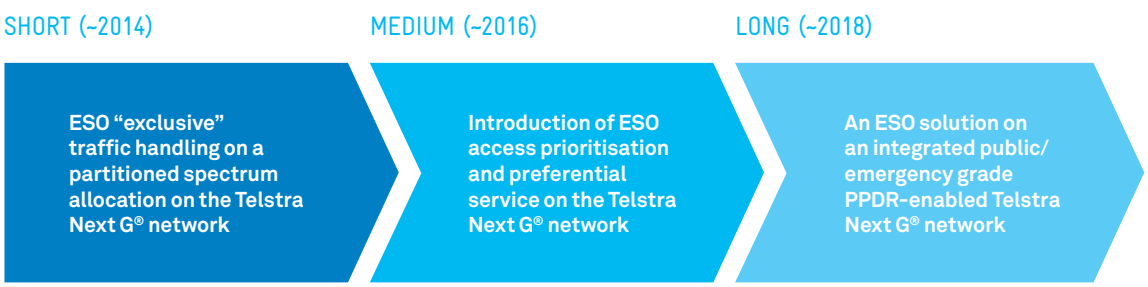
This paper promotes the parallel operation of 4G LTE technology not just in the Australian Digital Dividend (DD) 700MHz band for public network operations set down by Australian Communications and Media Authority (ACMA) , but also in the Public Protection and Disaster Relief (PPDR) spectrum for use by the ESOs. This PPDR spectrum at the low end of 800MHz, next to the DD band, has been earmarked across the Asia Pacific region for such use. Through this coordinated allocation of scarce and valuable radio spectrum, Telstra sees that utility will be maximised while achieving the stated need of the ESOs for "exclusive" spectrum.

The paper also discusses various business models, including ESO ownership or ESO leasing of network and spectrum assets, to deliver an emergency-service grade broadband network. Telstra suggests that building standalone broadband mobile network infrastructure solely for ESO use is prohibitively expensive and will ultimately not meet the coverage and reliability required for mission critical operation. Owing to the high costs and the absence of a government commitment to fund a standalone network, there is a risk that the spectrum would remain largely unused. This would be a waste of a valuable national resource.

If funds are allocated, a national emergency network could cost billions of dollars to build and hundreds of millions of dollars a year to operate. There would also be an opportunity cost to be considered, since funds would need to be redirected from other government programs.

Telstra suggests that having emergency broadband traffic on commercial infrastructure, with appropriate service levels, could be a more affordable option due to cost sharing and the use of existing infrastructure and resources.

Finally, the paper considers the topic of network hardening and resiliency. With cooperation between the ESOs and the network operator, investment can be most effectively directed towards the duplication of critical network infrastructure, including the physical and electrical diversity of supporting services such as power and network interconnection. Improved power and battery backup systems will maximise survivability of the network under exceptional weather events or other adverse conditions.



Furthermore, with the introduction of access priority and preferential service levels, Telstra can make the most efficient use of its Telstra Next G® network, enabled with 3G and 4G technology, to deliver customers a service more closely aligned to the different applications in use, particularly in busy network times. Through this the best of both worlds – the extensive public network together with an "exclusive" ESO network – can be achieved at an affordable cost to government.

This paper describes a roadmap to deliver an emergency-grade mobile broadband network to meet the needs of ESOs and which can commence in advance of the 800 MHz PPDR spectrum identification and allocation processes being completed. Telstra believes this approach will meet the demanding requirements of emergency services, be far more affordable, and deliver a solution earlier than a standalone emergency network.

INTRODUCTION

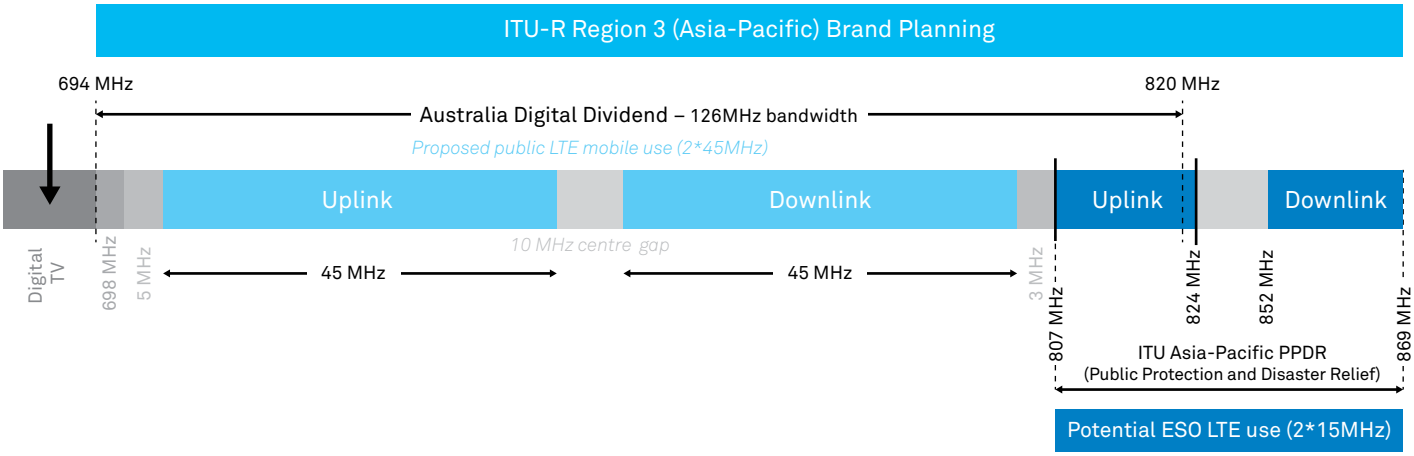
TODAY, EMERGENCY SERVICES MAINLY RELY ON GOVERNMENT AND PRIVATE NARROWBAND RADIO NETWORKS THAT DO NOT NECESSARILY INTERWORK BETWEEN AGENCIES OR STATES, HAVE LIMITED FOOTPRINT AND OFFER LITTLE BANDWIDTH.

Experience shows that the increased capabilities of an interoperable mobile broadband network will deliver significant benefits to emergency services through improved response capabilities, enhanced situational awareness, command, control and coordination. This is evident today in the extensive use made by ESO personnel of the public mobile broadband networks, particularly the Telstra Next G® network.

If spectrum is to be allocated for public safety mobile broadband, then it should be identified from within the frequency range identified by the ITU for Public Protection and Disaster Relief (PPDR) purposes and aligned with the 3GPP frequency plans for LTE technology.

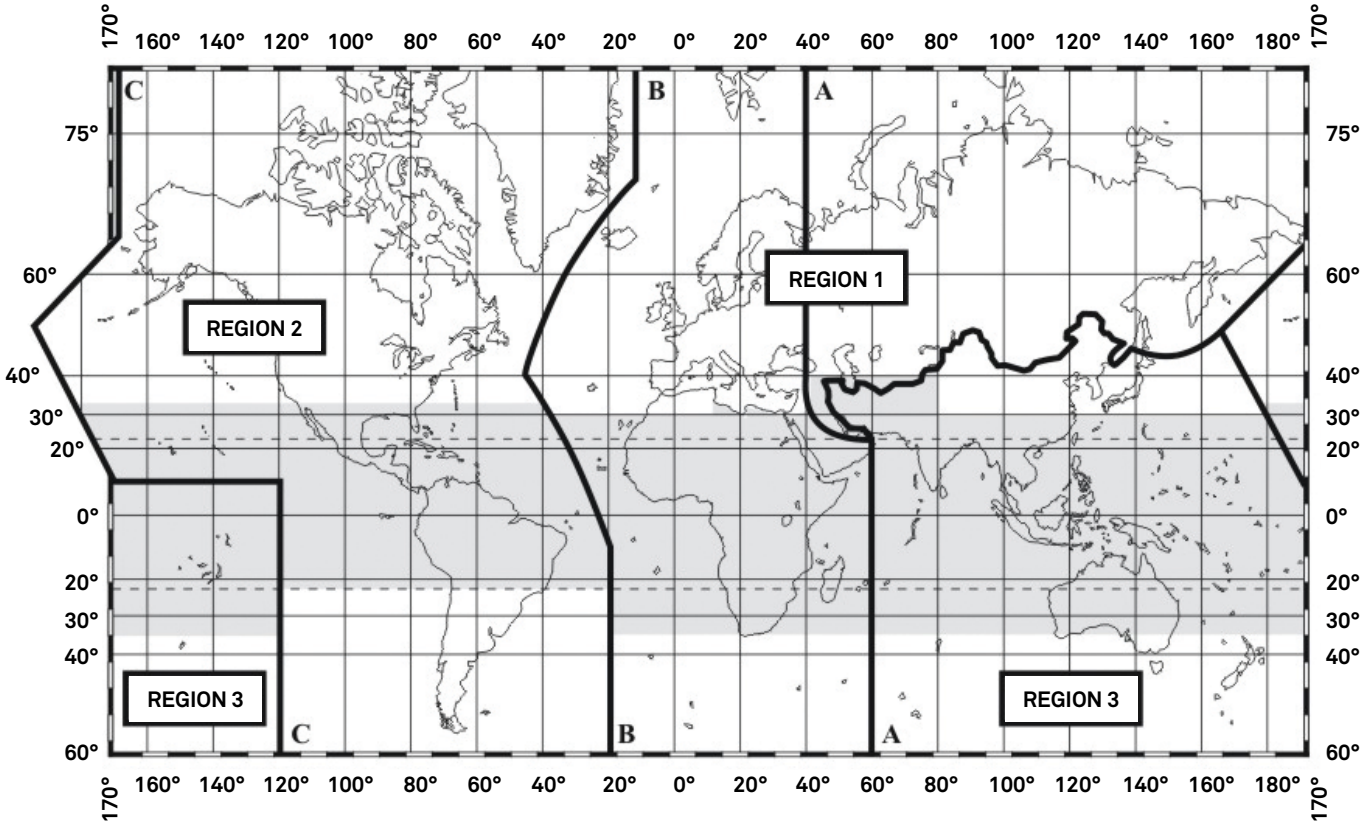
The 3GPP frequency band #27 has been proposed for this purpose. This band provides two 17 MHz paired bands: 807 MHz - 824 MHz for uplink and 852 MHz - 869 MHz for downlink transmission.

Figure 1: 800 MHz PPDR Frequency Plans



The 800 MHz band has been identified by the International Telecommunications Union for potential PPDR use in Region 3 which comprises most of the non-former-Soviet-Union Asia, east of and including Iran, and most of Oceania.

Figure 2: ITU Regions



Source : http://www.itu.int/ITU-R/information/docs/emergency-regions.jpg

The Third Generation Partnership Project (3GPP) standards body is also working on plans for 4G Long Term Evolution (LTE) deployment in PPDR frequencies.

The combination of harmonisation of PPDR across countries such as China, India and possibly Africa, as well as Australia, New Zealand and the Pacific, together with 3GPP proposals for 4G/LTE standardised in PPDR frequencies offers enormous benefits which come from scale. These benefits include lower equipment and device costs as well as a potentially large and diverse range of devices and functionalities.

Some Australian proponents of an emergency services mobile broadband network are suggesting that the ESOs should build their own mobile broadband network using the 800 MHz spectrum and specifically for emergency response. As justification, issues with commercial networks' availability of service, capacity, redundancy, resiliency and security during major emergencies have been cited.

Hardened 3G and 4G networks can provide the performance and reliability needed for emergency use

We believe commercial 3G and 4G networks with appropriate hardening can provide the performance and reliability sought by ESOs.

Moreover, this approach makes better use of spectrum, and is a far more cost-effective way to support emergency services.

In Telstra's case, the Telstra Next G® network enabled with 4G LTE technology (available in 4G coverage areas) can meet the reliability and accessibility requirements through a staged approach to introducing spectrum partitioning, priority access and preferential service level introduction for emergency communications.

Telstra also has a proven history of network performance and fast restoration by our national field force during natural disasters.

NETWORK OPTIONS FOR EMERGENCY SERVICES

TO EXPLOIT THE CAPABILITIES OF MOBILE BROADBAND SPECTRUM, EMERGENCY ORGANISATIONS HAVE THREE OPTIONS FOR ACCESSING NETWORK INFRASTRUCTURE:

1. **Utilise an exclusive spectrum allocation, build and maintain their own mobile broadband networks**

   This would deliver highly available communications and potentially enough headroom for disaster response. Emergency Services would also have ownership and control to manage their service levels and ensure appropriate network availability.

   The major disadvantage of this method is cost – both initial network investment (estimated at several billions of dollars) and ongoing lifecycle management, operations and maintenance (estimated at several hundreds of millions of dollars per annum).

2. **Utilise exclusive spectrum allocation. Lease back a network built and maintained by a commercial network operator such as Telstra**

   Like option 1, emergency services would have exclusive use of a section of spectrum to ensure communications. While they would no longer build or manage the network, they could set service level agreements to ensure high availability.

   The advantage of this option is defraying the significant cost incurred to build a network. Management and maintenance costs may be lower if emergency services can leverage the operator's economies of scale. Administration would also be simpler since the only people required are those who manage the relationship with the provider.

   While this approach may appear the most attractive in the short term it does not consider the cost of maintaining exclusive access to a portion of the network, and would also involve emergency services potentially paying for the portion of spectrum which is allocated to them.

3. **Integrate ESO spectrum allocation and network operations with the existing mobile broadband capabilities of commercial network providers**

   We believe this option is the most affordable and effective strategy over time to deliver emergency-grade mobile broadband for the following reasons.

   Emergency mobile broadband coverage must be broad
   Emergency mobile broadband coverage has to be national and broad to be effective. As witnessed by natural disasters over the past decade, the majority of these events like Cyclone Larry, Black Saturday, the Queensland floods and Cyclone Yasi occur in regional Australia. Impact is often over a wide geographical area requiring significant mobile broadband coverage.

   The cost of a new 4G network could be billions of dollars
   The cost of building such an expansive network from scratch (not an augmentation of existing infrastructure) with high availability, fast upload and download speeds, and the necessary infrastructure diversity, runs into many billions of dollars. Furthermore, to maintain and operate such a network requires significant annual operating expenses to cover site leases and for repair, maintenance and contracts with utilities.

   Mobile broadband networks are extremely expensive to build and operate
   As an example of cost, our investment in the 3G High Speed Packet Access (HSPA) Telstra Next G® network was more than three and a half billion dollars with an ongoing yearly capital investment in the order of hundreds of millions of dollars and a similar level of expense for operations and maintenance.

   Considering the size of these expenses, and noting that existing commercial networks have already been consolidated from four to three (through the merger of Hutchison 3 and Vodafone), it is unlikely that Australia could justify, on economic grounds, building a fourth mobile broadband network for emergency use.

   Sharing commercial infrastructure would be more cost-effective
   Telstra believes sharing the 4G infrastructure of a commercial operator would be more cost-effective by sharing costs and using existing infrastructure and resources and costs defrayed across a much greater user base.

   A unified approach to a dedicated emergency network may be hard to achieve
   Timely delivery is also a consideration. For example, the emergency services plan to deploy a national interoperable network for narrowband voice communications will not be fully realised until 2020. The reason is explained in the report that was presented to COAG by the Natural Disaster Arrangements Working Group in 2009[1]. The extended timeline appears to be mainly due to budget constraints and difficulties in coordinating a common approach across various organisations and states.

A commercial solution would be faster to deploy

A national emergency mobile broadband network, which is significantly more complex and costly, would most likely suffer the same challenges but on a larger scale. Commercial solutions, on the other hand, can be delivered faster due to much of the network infrastructure and operational systems already being in place.

In addition, building and operating broadband networks is not the core business of emergency services, but it is for mobile network operators. It would be more appropriate to use the skills of commercial operators and let emergency services focus on what they do best.

It also means that the network providers take on the risk of technology obsolescence and future upgrades that will be necessary to ensure that the network continues to be fit-for-purpose and meets the evolving needs of ESOs, stakeholders and customers.

Commercial networks can also be hardened to meet specific requirements such as operating without mains power via the use of next generation fuel cells that might offer days of reserve at selected sites to be hardened, or surviving equipment failures through backup systems. Capabilities can also be enhanced through different levels of prioritised access for voice and data.

Independent findings confirm the advantage of using commercial networks

The use of commercial infrastructure is further supported by the findings of the report Radiofrequency Spectrum Options for Public Safety Agencies in September 2010[2]. The report considers various spectrum and implementation options and concludes that:

"Based on economic considerations, the optimal outcome for PSAs (Public Safety Agencies), the government, network carriers, and the economy as a whole would be a commercial arrangement with PSAs negotiating access to a carrier's network."

In the United States, the First Responders Network Authority recently summarised (in September 2012) that building a stand-alone network for ESOs would be the "most expensive to build and operate" and would take "the longest to build" when compared with engaging with one or more established wireless operators[3].

Given the growth of commercial services, the opportunity to leverage commercial assets promises to make the development and deployment of an LTE wireless broadband network for public safety far more economic than it would if ESOs were to own and operate the network.

MAKING THE STRATEGY WORK

TO DELIVER EMERGENCY-GRADE MOBILE BROADBAND ON COMMERCIAL INFRASTRUCTURE, TELSTRA ADVOCATES AN INITIAL SOLUTION USING SPECTRUM PARTITIONING ON THE TELSTRA COMMERCIAL LTE NETWORK, FOLLOWED LATER BY INTRODUCING PRIORITY ACCESS AND PREFERENTIAL SERVICES LEVELS ONCE SUCH CAPABILITY IS DEVELOPED ON THE LTE QUALITY OF SERVICE STANDARDS.

In formulating this solution, we have assumed that ESOs require emergency-service voice to take priority over emergency-service broadband data, and that both have priority over commercial voice and data.

Parallel operation of a commercial LTE network (e.g. on 700MHz Digital Dividend spectrum) and an ESO network using, for example, the 800 MHz PPDR spectrum on a common base station and core network can be likened to a freeway with a multi-lane thoroughfare for the majority of traffic (the commercial network) and an additional or reserved transit lane for emergency traffic (the PPDR channel).

By way of analogy, imagine an eight-lane highway, with six lanes for public traffic and two lanes for public safety agencies (see Figure 3):

- The six public network lanes (three each way) can be likened to the 700MHz Digital Dividend spectrum allocation each 15MHz wide†; and
- Two emergency services lanes (one each way) which can be likened to the Public Protection and Disaster Relief spectrum allocation each 5MHz wide.

Such spectral separation or partitioning (i.e. the separation of the public and private transit lanes) would provide the ESOs with the necessary certainty to conduct their operations in times of emergency or special events in much the same way dedicated transit lanes provide preferential access for emergency service/public transport vehicles.

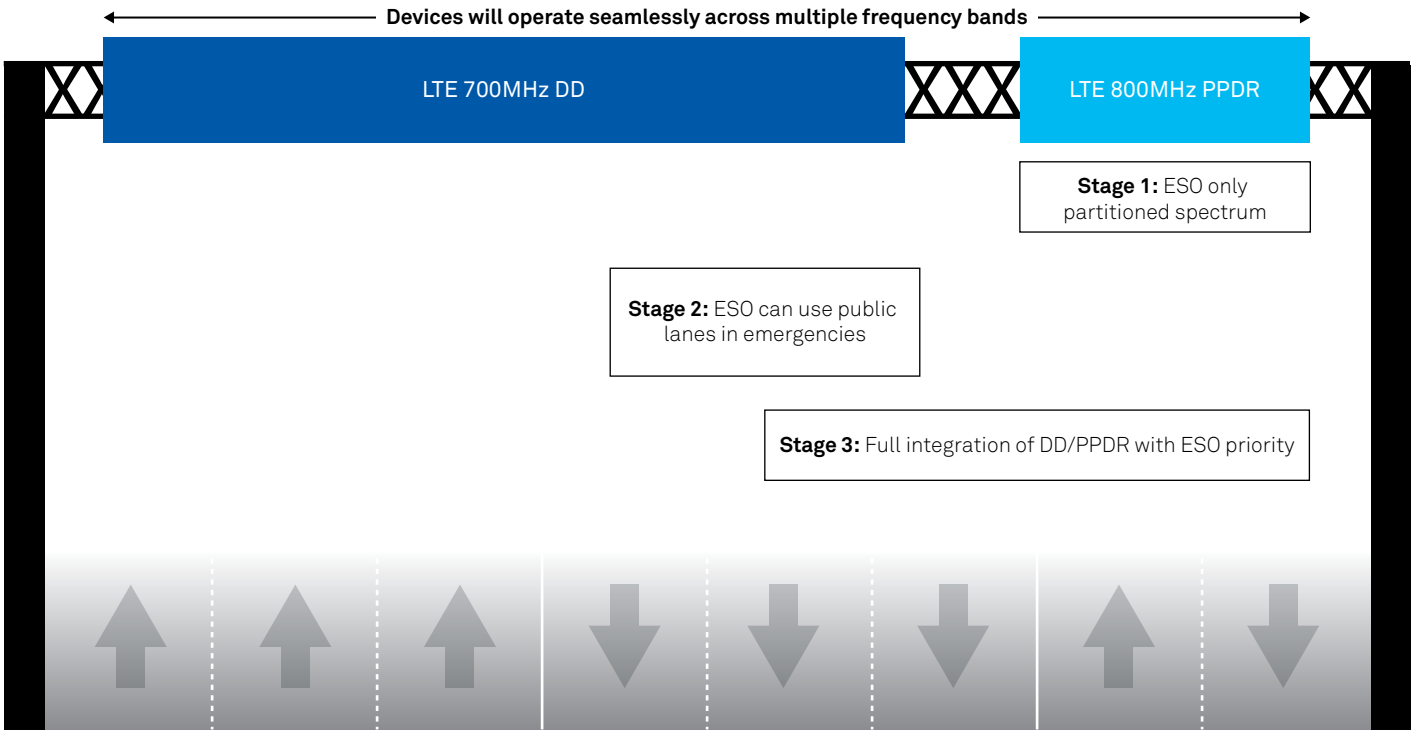
Whilst this is a beneficial first step to addressing the needs of ESOs, the approach can be further enhanced to overcome the shortfalls of a dedicated transit lane. (For example, what happens if the PPDR spectrum lane fails due to a breakdown blocking the lane ?) By taking the PPDR spectrum allocation together with the Telstra Next G® LTE enabled network, LTE standard Quality of Service capability, once commercialised, can be utilised to allow ESO traffic to work across both spectrum bands – DD and PPDR – or to continue with the analogy utilise the public traffic lanes when the private transit lanes are unavailable or running at full capacity.

Ultimately the use of QoS to provide ESO traffic access to public spectrum can be complemented by also allowing public traffic to have unprioritised access to the PPDR spectrum – essentially allow public traffic managed access to the transit lane when not required by the ESO. This fully integrated approach to use of spectrum allocations in totality not only represents the most efficient use of this valuable and scarce resource but consequently leads to the lowest cost solution and hence the most attractive option for ESOs both from a cost and also a flexibility and functionality point of view.

† In order to provide an easily understandable example, Telstra has made assumptions regarding a possible outcome of the 700 MHz spectrum auction to be held in April 2013 being a hypothetical operator acquiring the allocation of three lots of 2 X 15MHz. This does not necessarily indicate Telstra's preferred outcome in the auction nor any of Telstra's intentions in participating in the auction.

These public and private lanes will cater for all traffic types in normal periods, with a dedicated allocation immediately limiting usage of a lane of the PPDR spectrum for ESO use only during natural disasters and other incident scenarios. During these periods, public safety agencies could also be given priority on the Telstra Next G® network, as required, to provide capacity beyond the PPDR allocation.

Figure 3 : Transit lane analogy for complementary use of DD/PPDR spectrum



The diagram above shows that under congestion or emergency conditions, one lane will be instantly allocated to public safety agencies with both uplink and downlink capability, with a further option of a second lane purely for use by public safety agencies. The 3G capability of the Telstra Next G® network can also be used by emergency services outside of the 4G LTE coverage area to provide national and ubiquitous coverage.

NETWORK CAPABILITY AND RESILIENCE

IN DELIVERING AN EMERGENCY SERVICES SOLUTION, THE TELSTRA NEXT G® NETWORK, CAN PROVIDE THE REACH, AVAILABILITY AND RESILIENCE REQUIRED BY ESOs.

The Telstra Next G® network offers faster speeds in more places, is more responsive, and has the lowest call drop rate and high availability, based on an architecture that provides:

- Sites optimised to deliver maximum radio resources that offer the best possible user experience at all times
- Core network systems designed with redundancy to mitigate a single point of failure
- 24/7 network health monitoring and proactive capacity management helps to ensure that network issues are addressed before they impact performance.

In addition to this world class architecture, the Telstra Next G® offering includes mobile transmitters like Cells-On-Wheels (COWs), Satellite Cells-On-Wheels (Sat COWs) or Mobile Exchanges On-Wheels (MEOWs) that may be required in times of natural disasters and can be deployed and integrated quickly when needed.

Self Organised Networks capability will enhance network tuning in emergencies

The ability to manage coverage and capacity for emergency services is expected to be further enhanced by the Self Organised Networks (SON) capability that is part of the LTE 3GPP Release 10 standard, also known as LTE Advanced. SON can optimise the network in geographic locations without the need to physically send people there.

BACKHAUL TRANSMISSION LINKS

Telstra's backhaul can provide better performance than private networks

The Telstra Next G® network includes redundant and resilient backhaul capability that can meet emergency requirements and provide a more superior performance than a purpose-built private network for the following reasons:

- Optical fibre fed, ethernet-enabled backhaul to the vast majority of sites which enable superior speeds and minimises bottlenecks
- Telstra's multi-gigabit ethernet backhaul capability can meet current and future traffic and technology needs.

If the ESO requirements warrant it, Telstra may be able to harden selected sites with satellite backhaul links on standby.

QUALITY OF SERVICE ON LTE

4G LTE standards have a more complete and mature QoS framework

Incorporating the lessons from 3G networks has allowed the 4G LTE standards to describe a more complete and mature underlying QoS framework. Future LTE software deployments are expected to facilitate QoS solutions to satisfy ESO requirements to provide priority on the Telstra Next G® network as required and thus providing capacity beyond that available on the infrastructure using the 800 MHz PPDR spectrum.

DEVICE AND TERMINAL CONSIDERATIONS

LTE OFFERS A RICH ECOSYSTEM OF DEVICES WITH REDUCED EQUIPMENT COSTS.

By using a globally standardised solution such as LTE, ESO devices supporting the PPDR band can be used on overseas networks regionally which have also adopted PPDR.

This is of additional benefit in times of natural disasters when public safety responders from the global community often help local personnel.

Device interoperability will allow regional visiting officers to assist from the moment they arrive.

CONCLUSION

TELSTRA BELIEVES A STAGED, INTEGRATED APPROACH ACROSS SPECTRUM AND NETWORK INFRASTRUCTURE INVOLVING COMPLEMENTARY USE OF PUBLIC 700MHz DIGITAL DIVIDEND AND 800MHz PPDR SPECTRUM FOR 4G/LTE BROADBAND FUNCTIONALITY PROMISES THE BEST OF BOTH WORLDS FOR DELIVERING ON ESO MOBILE BROADBAND SERVICE.

This approach delivers the benefits of prioritised service, economies of scale derived from an integrated network approach which removes duplication, a reduced total cost of ownership, and allows funds to be directed to network hardening and development of new and innovative services which can be delivered over an expansive network footprint that Telstra delivers.

The International Telecommunications Union has identified Public Protection and Disaster Relief (PPDR) spectrum in the 800 MHz band for use by emergency service authorities across the Asia-Pacific region. The 3GPP standards body is also working on plans for LTE deployment in this frequency band. A coordinated approach involving network infrastructure and device vendors, Telstra and ESOs across the region could hasten the availability of suitable LTE equipment to operate within this spectrum.

A new standalone emergency network, or potentially multiple networks, will add substantial capital and operational costs to public spending budgets already under strain. Furthermore, this will quite possibly not provide equal service to urban, regional, and rural Australia and result in significant delays for the deployment and introduction of the service.

Telstra suggests that the long term goal of using existing public infrastructure of commercial providers, preceded by a staged approach first using spectrum partitioning followed by QoS introduction to build ESO confidence, would be a far better option. Expense would be significantly reduced, and the skills and resources of the network operator could be leveraged. Availability of service could also be guaranteed by directing funds to hardening the network and priority access on PPDR spectrum can be provided in emergency situations to ESOs, and prioritising of emergency traffic on the commercial network can be achieved via Quality of Service. In this way, the reliable, available and secure communications vital for emergency traffic could be assured for less cost, and with fewer complications and delays.

ABOUT THE AUTHORS

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Alex Stefan is the National General Manager for Government and Public Safety & Security. Based in Brisbane, Alex is responsible for overseeing Telstra's customers in the Federal, State, and Local Government including justice and emergency services. An industry veteran with over 24 years' experience, Alex has worked with several government and state departments and his expertise is in the provision of 24/7 ICT systems in support of mission critical operations.

Prior to joining the Telstra Corporation, Alex spent eight years as the Chief Information Officer for the Department of Emergency Services (DES) Queensland, which includes the Queensland Ambulance Services (QAS), the Queensland Fire and Rescue Service (QFRS) and Emergency Management Queensland (EMQ). In this role, Alex managed a team of 230 professionals on a state-wide level and coordinated the Department's information management and ICT strategies in line with its business goals. Earlier, Alex spent 15 years in senior management roles at the Queensland Police Service.

Alex holds a Bachelor of Science from Griffith University. He is also an Associate Fellow of the Australian Institute of Management and a Senior Member of the Australian Computer Society. He has been part of many national and state government committees and forums.

Anthony Goonan
Director, Network & Commercial Planning

Anthony Goonan is responsible for Telstra's long term network technology roadmap and associated investment plan.

Anthony is a graduate of Sydney University with a Bachelor of Science in Pure Mathematics and Bachelor of Electrical Engineering with Honours. Anthony also possesses a Graduate Diploma in Education. He is a Governor on the Electrical and Information Engineering Foundation Board of Sydney University.

Joining Telstra as a cadet engineer in 1982, Anthony has more than 25 years experience deploying first, second, third and now fourth generation mobile networks. Anthony was also responsible for the design, deployment and operations of Telstra's mobile networks provided for the Sydney 2000 Olympic and Paralympic Games – the first ever "mobile" Olympics. He has held senior management positions in mobile planning, product and device development & verification, infrastructure deployment and network operations.

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ABOUT TELSTRA

Telstra provides network services and solutions to more than 200 of the world's top 500 companies. They rely on us to do business across 240 countries and territories and to enable greater productivity, efficiency and growth.

Telstra solutions offer the best of all worlds – skilled people and a rich portfolio of services delivered on our world-class Telstra Next IP® network and Next G® network. To ensure reliable performance, they're monitored and maintained from our dedicated centres using advanced management and operational systems. And they're backed by Telstra Enterprise-grade Customer Service® and one of Australia's largest and most qualified field and technical workforce.