



Response to Consultation

for

**Spectrum Review
Potential Reform Directions**

Australian Government
Department of Communications

November 30th, 2014

Rivada Networks

Response to Consultation - Spectrum Review, Potential Reform Directions

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30th November, 2014

Dear Project Manager,

Rivada Networks is pleased to offer our response to the Department of Communications' consultation paper on 'Spectrum Review, Potential Reform Directions.' Rivada Networks welcomes the opportunity to present herein what we believe is a compelling solution, meeting Australia's objectives of maximising the economic and social return from spectrum, while supporting its efficient allocation and use.

The popularity of smart phones, tablets, and other mobile devices has caused demand for wireless connectivity to skyrocket. The recent explosion of wireless data traffic is unprecedented, transforming the marketplace in just a few years. Demand will continue to grow for the foreseeable future as wireless systems become increasingly central to social, economic, and political life.

Technical improvements and network upgrades alone will not satisfy this accelerating demand; any sustainable solution will involve expanding access to spectrum for mobile data. Otherwise, limited wireless capacity could become a significant drag on Australian job creation, competitiveness, innovation, community development, and important advances in education, health care, and Public Safety.

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With the exponential increase in mobile data forcing carriers to rethink their network strategies, Rivada Networks' technology offers a solution to a looming broadband spectrum crisis. Our technology alleviates significant demand driven pressure on wireless broadband capacity through the creation of a dynamic, real-time market for additional bandwidth that benefits both suppliers and consumers alike.

Rivada Networks revolutionises the way bandwidth is consumed. By introducing dynamic allocation and pricing, Rivada is creating a new market that will easily increase the efficiency and value of wireless networks. Rivada's initial focus in the U.S. has been on providing service to the Public Safety market (Police, Fire, Emergency Medical Services, and other emergency services and first responders), thereby proving its technology in one of the most demanding user markets in the world. But our technology has the potential to revolutionize the way wireless bandwidth is allocated and used across the board. Australia's far-sighted decision to rethink spectrum policy positions it well to take advantage of this coming technological revolution.

In the United States, following the communications failures of 9/11 and Hurricane Katrina, Congress allocated dedicated radio spectrum to Public Safety in the prime 700 MHz band. The legislation allows commercial users to access the spectrum on a non-priority basis. Rivada's core technology, Dynamic Spectrum Arbitrage Tiered Priority Access (DSATPA), enables Public Safety agencies to retain absolute control over their own dedicated broadband networks, while enabling the generation of valuable revenues from unused capacity.

Rivada's unrivalled technology creates unique opportunities:

- It allows Public Safety spectrum to be monetised in real time, while our exclusive "ruthless pre-emption" technology enables Public Safety to maintain control of their dedicated spectrum;
- It creates a market-based platform through which spectrum capacity can be dynamically auctioned to commercial users.

The Australian Government might well consider the advantages of this approach in providing for next-generation communications technology to its own Public Safety personnel. But whether that particular application proves suitable or not, a dynamic wireless market represents a radical improvement over the current, static, monopoly-based systems that dominate the wireless market today.

Considerable interest has been generated internationally as understanding has grown of the opportunities our technology provides, especially from Governments that are either unconstrained by legacy issues or seeking to reduce the dependence, and therefore the cost to the consumer, of existing Mobile Network Operators (MNOs). Mexico is one country where reforms to the allocation of spectrum are creating the opportunity for the development of a wholesale spectrum market.

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Radio spectrum bandwidth is the world's next great commodity. DSATPA is a game changer, maximising the efficiency of the radio spectrum bandwidth resource, and unlocking the potential for more extensive and flexible high capacity broadband networks. We are eager to demonstrate to the Department of Communications that our approach presents the right solution to your requirements. We look forward to further discussions with the Department regarding Rivada's approach.

Yours sincerely,



Declan Ganley
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1.0 Executive Summary

Rivada Networks' approach supports a more efficient, responsive, sustainable and dynamic spectrum market. Rivada's technology provides a solution to rising consumer demand for spectrum, and more specifically, wireless broadband capacity - driven largely by mobile device usage and the emergence of applications in the burgeoning machine-to-machine sector.

Rivada Networks' innovative technologies meet the aims of the Spectrum Review. DSATPA commoditises bandwidth. It does so at all levels, including at the most granular - a specific allocation of bandwidth, for a specific time segment, in a grid as small as a subsector of an individual base station. DSATPA does all of this dynamically and competitively. In short, this is an industry game changer that will boost innovation and productivity, promote efficient allocation and use of spectrum in Australia, and be of immense benefit to both the consumer and to mobile network operators.

Should the Department of Communications adopt a 'Dynamic Spectrum Arbitrage - Tiered Priority Access' (DSATPA) model, Australia will achieve:

1. A solution that will maximise the economic and social return from spectrum, boost innovation and productivity, and benefit the broader community - thus complementing the Department of Communications overarching objectives.
2. Increased innovation and job creation in Australia. Trading of wireless bandwidth will lower barriers to entry and further catalyse new business models currently precluded by MNO/carrier dominance in the industry.
3. A more efficient, responsive and sustainable spectrum market.
4. A 'carrier agnostic' mobile broadband LTE footprint allowing for real-time competitive wholesale access which can reasonably be expected to benefit from the ever increasing 'scarcity' value of bandwidth, without surrendering that upside potential to an individual entity, or group of commercial entities.
5. A standards-based network that will be fully interoperable with nationwide and international LTE rollouts.

Please see link below to Rivada Networks' videos. Four key videos provide an overview of our solution, technology, and company.

<http://rivada.com/>

Rivada Networks meets Public Safety's requirements for a dedicated, high-quality, secure network for frontline workers and first responders, while our patented technology has the potential to utterly transform the way in which spectrum is prioritised, managed, shared, competitively priced, and used in Australia.

Rivada Networks' DSA model was initially developed for the Public Safety mission in order to provide for the best possible Public Safety communications networks, solutions and coverage

while also providing for the relief, and in cases, elimination of the requirement to tap taxpayer resources to fund the building and operation of those networks.

By enabling commercial carriers and others to buy blocks of bandwidth in a dynamic market, the Australian government can both increase the efficiency of its spectrum and generate a significant stream of revenue. While dynamic spectrum access, as outlined in Case Study 1 of the consultation paper, will play an important future role in enabling better quality of service and lowering barriers to spectrum access, handsets are not capable of routing packets through different gateways. Dynamic Spectrum Arbitrage, on the other hand, takes place at the network level, uses current off-the-shelf technology, and is readily controllable. Rivada Networks' solution creates the financial model and coordination necessary to enable aggregation of diverse carriers. Enabling DSA in the network offers an immediate solution to wireless broadband capacity demand pressures, leveraging existing specifications and standards, as opposed to waiting for solutions, capabilities and functionality at the device level, which may take up to a decade to emerge.

Access to dedicated spectrum is best realised through licensing as it creates an accountable 'broker' for spectrum supply and management, allowing for better frequency coordination while the associated economics drive better spectral efficiency. Unlicensed access creates a 'free for all' scenario, thus compromising quality of service.

Rivada Networks believe that the Australian Communications and Media Authority (ACMA) could play a significant role in supporting the development of DSA and relevant technologies by advocating the allocation of dedicated spectrum to a wholesale-only wireless-spectrum marketplace. Rivada Networks support Proposal 3 of the consultation paper regarding flexible spectrum allocation and believe that ACMA can further advance network sharing and equal access, encouraging new entrants into the market to aggregate capacity, thus enhancing the user experience, allowing for diversity, and driving down costs to the consumer.

2.0 Company Overview

Rivada Networks is a leading designer, integrator and operator of wireless, interoperable Public Safety communications networks. We provide advanced communications solutions to the Public Safety community. The Rivada offering is focused on delivering 4G voice, video and data through the latest in LTE infrastructure, delivering state of the art capabilities whilst meeting rapidly increasing demand for wireless broadband capacity.

Rivada Networks has the technology to realise the Australian Government's goals as outlined in the Spectrum Review, offering a solution that supports spectral efficiency via a transparent and dynamic market. Rivada's solution further augments Proposals 4 and 6 of the consultation paper by promoting transparent, flexible and efficient use of spectrum via a dynamic trading market for radio spectrum bandwidth.

Rivada Networks is a market leader in the provision of interoperable communications networks. It currently provides advanced communications solutions to the Public Safety community, as well as communications solutions to first responders in the aftermath of natural and man-made disasters, and terrorist threats. Rivada Networks' customers include a diverse range of federal, state, and local agencies in the United States, including U.S. Northern Command, the Department of Homeland Security, the Federal Emergency Management Agency, and the National Guard Bureau. Rivada Networks has provided communications solutions to almost every major disaster and civil emergency in the United States of America since 9/11. The expertise gathered during these experiences led to the development of the technology and solutions that are presented in our response to this consultation.

3.0 Additional Proposals

The core additional proposal that Rivada advocates is the allocation of dedicated spectrum for Public Safety. While the provision of a dedicated LTE public-safety network is not essential to the adoption of Rivada's technology, such a network would complement the approach outlined in the Spectrum Review. Our solution provides Australia with a reliable, fully interoperable, and cost-effective alternative to building expensive dedicated infrastructure for Public Safety without compromising the goal of increasing the commercial availability of spectrum for commercial 4G networks.

The solutions and approach that we present provides Australia's Public Safety services and organisations with a state of the art, fully interoperable Long Term Evolution (LTE) broadband network, and also provides a recurring revenue stream that subsidises the ongoing cost of maintaining a Public Safety network. These core goals – the highest quality Public Safety network, flexibility, and a positive revenue outcome, are unlikely to be achieved in a more efficient way.

Rivada Networks welcome the opportunity to present our comments and share our thoughts. We would appreciate the opportunity to coordinate with the Department of Communications and with Australian Public Safety to define a future for Public Safety communications and place Australia at the forefront of the emerging global wireless standard for Public Safety communications, while addressing overarching demand related issues in wireless broadband capacity in Australia.

3.1 Summary of Rivada's Additional Proposals

- Rivada advocates the allocation of dedicated spectrum for Australian Public Safety

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- Rivada Networks' technologies enable Public Safety agencies to retain absolute control over their own dedicated broadband networks, while enabling the generation of valuable revenues from unused capacity, when available.
- Rivada's core technology, Dynamic Spectrum Arbitrage - Tiered Priority Access (DSATPA) works out to the very edge of the network, allowing Public Safety absolute priority access with instant (millisecond) pre-emption in the event of an emergency situation – thus guaranteeing first responders access to the highest quality bandwidth capacity at the moment they need it most.
- Meanwhile, during the extended periods in which the Public Safety broadband network has significant bandwidth to spare, DSATPA allows that capacity to be dynamically auctioned in a fully competitive 'on demand' process to competing commercial entities.
- DSATPA maximises the efficiency of the radio spectrum bandwidth resource and unlocks the potential for more extensive high capacity broadband networks.
- Rivada has served Public Safety for a decade, helping to meet their unique and critical communications challenges. Our work has been recognised for helping to save lives during times of severe crisis, such as Hurricane Katrina and multiple other emergencies and disasters.
- The expertise gathered during these experiences led to the development of Rivada's technology and solutions. Rivada's board members, many of whom formerly held senior positions in the Public Safety, defence and telecommunications sectors, provide broad experience at all levels of government, including;
 - General Richard B. Myers, USAF (ret), former Chairman of the US Joint Chiefs of Staff
 - Field Marshal, the Lord Guthrie, Former Chief of the Defence Staff, United Kingdom
 - Michael Jackson, Former Deputy Secretary, US Department of Homeland Security
 - George Foresman, Former Under Secretary, US Department of Homeland Security
 - Admiral James M. Loy, Former Deputy Secretary, US Department of Homeland Security
 - Chief Christopher M. Moore, Former Chief of Police of the San Jose Police Department and founding Chairman of the Public Safety Alliance (PSA) in the US
 - Don De Marino, Chairman of the National US-Arab Chamber of Commerce

Rivada's unique technology addresses an expanding market need in the face of a looming spectrum crisis and the stated goals of multiple governmental organisations internationally to

increase spectrum access. Whilst Rivada has focused our marketing and efforts on the potential users of Public Safety spectrum allocations, this represents a small percentage of Government controlled spectrum. DSATPA provides other Government agencies, Defence for example, with the ability to free up under-utilised spectrum without having to lose the rights to that spectrum entirely in a new round of Government auctions. Rural telecommunication providers, Public Safety agencies, industrial and enterprise users, and those who use unlicensed spectrum can use our products and services to create wireless networks without the significant capital outlays and delays required to licence spectrum.

Radio spectrum is, as the Spectrum Review states, a finite natural resource. The telecoms industry faces soaring demand for, yet a finite supply of, spectrum. The popularity of smart phones, tablets, and other mobile devices has caused demand for wireless connectivity to grow exponentially. Consumer and business demand for mobile data continues to increase rapidly and providers are struggling to deliver enough bandwidth.

Today, as more users embrace more devices and high-bandwidth services — such as video streaming — wireless network operators are running out of capacity, particularly during peak hours. In addition to demand driven by the proliferation of smartphones and tablets, further technological advancements could increase data usage beyond current forecasts. Connected cars, wearable devices and mobile healthcare are just three of the areas that may greatly accelerate the penetration of connected devices, thus further increasing spectrum demand.

As demand grows exponentially, regulators are recognizing the need to address the scarcity and inefficient use of wireless spectrum. The idea of spectrum sharing is developing rapidly, with the US regulator, the FCC, in particular voicing strong support for the concept. Inserting DSATPA into the spectrum ecosystem enables the market to better meet the demand challenges of the future. Enabling the dynamic expansion of spectrum with DSATPA significantly enhances supply of capacity for mobile broadband.

4.0 Value Proposition

Rivada Networks' solution addresses the very significant gap in the wireless telecoms market for the provision of additional capacity. Carriers and other service providers are struggling to counter the looming spectrum crisis. Rivada's DSATPA technology alleviates capacity constraints and improves spectrum efficiency and utilisation. DSATPA enables spectrum sharing between networks via the buying and selling of network bandwidth in near-real-time. Allowing capacity requirements to be addressed on an as-needed basis is a key differentiator.

Shared use of spectrum via DSATPA enables multiple parties to benefit:

Customers

- Faster throughput of data — essential for high-bandwidth services such as video.
- Lower prices. DSATPA and the commoditisation of bandwidth fosters more fluid and competitive pricing to the end user.
- Improved service experience. DSATPA greatly alleviates carrier's Quality of Service issues, particularly in dense urban centres during peak hours.

Operators

- Efficient allocation of CapEx and OpEx. MNOs can forgo significant potential CapEx investment in utilizing DSATPA to meet growing subscriber demand.
- By providing a marketplace for wireless capacity, DSATPA alleviates the uncertainty that surrounds MNOs' network build-out plans, as excess capacity can always be sold into the market. Other things being equal, this will result in denser, higher-capacity networks with broader coverage than currently feasible.
- DSATPA offers a compelling solution to a number of obstacles faced by carriers, including site scarcity, build costs and complexity in urban areas, signal interference, zoning issues, ROI in rural locations, roaming interoperability issues.
- Allows operators to focus on sales, marketing and user experience.

Industry

- Spurs innovation among existing and new entrants to the marketplace.
- Enables more efficient use of the finite spectrum resource.
- Lowers the barriers to entry.

Government

- Fosters a more competitive landscape. Historically, spectrum was allocated to network operators for decades at a time through auctions or 'beauty contests'. DSATPA enables capacity increases without the risks associated with such 'winner-takes-all' awards of this scarce resource.
- Neutrality in resource allocation. A DSATPA enabled marketplace fosters neutrality and competition, by providing an open marketplace for bandwidth trading.
- In the case of Public Safety communications, DSATPA minimizes Government financial outlays. The whole roll-out of a designated Public Safety network can be privately financed using Rivada's model.

- Additional revenue streams. DSATPA provides a new revenue stream to the Government, allowing it to benefit from the increase in the value of spectrum over time, rather than surrendering that upside to spectrum licensees.

Dynamic allocation of bandwidth has the potential to utterly transform the way in which all spectrum is managed, shared, competitively priced, and used. DSATPA technology can enable sharing of resources across multiple blocks of spectrum. Considerable market opportunities lie in the opportunity to extend the approach to spectrum over which the Government cannot afford to relinquish full control—such as the spectrum currently used by the military and certain other government agencies.

4.1 Value Proposition to Public Safety

DSATPA was developed by Rivada following a decade of working with Public Safety officials to create a dedicated, high-quality, secure network for frontline Public Safety personnel and first responders. As Public Safety networks move from narrowband to 4G LTE, DSATPA technology enables spectrum sharing between Public Safety and commercial networks.

Rivada Networks' technology meets the mission requirements of Public Safety users while offering significant benefits to Public Safety agencies including the funding of Public Safety 4G LTE networks via a public private partnership model, and the generation of new revenue streams. DSATPA enables excess capacity not used by Public Safety to be sold commercially on a dynamic basis.

DSATPA for the first time allows bandwidth to be allocated on the basis of priority use — meaning that in an emergency, police, fire, and emergency medical services are guaranteed access to available bandwidth. By enabling commercial carriers and others to buy blocks of bandwidth during fallow periods when demand is low, Public Safety can both increase the efficiency of its spectrum and generate a significant stream of revenue to fund itself. Rivada's value proposition could be realised across a number of variations on the core business model, from building and operating the network, to licensing DSATPA technology.

4.2 The Model

Wireless capacity will be sold, via DSA, by location and by time: as a result, prices per gigabyte of capacity will vary dramatically as different customer segments utilise excess capacity in different ways. For example, suppose that a given MNO has a lack of bandwidth to meet subscriber demand in a particular location. Our service provides the opportunity to offer a better, more reliable service at peak times. The benefit to the MNO (or MVNO as the case may be) is that their customers are not throttled or frozen off their network; they can add capacity without costly infrastructure investment. Meanwhile electricity utilities, for example, could take advantage of a quiet period to backhaul meter readings from their customers. Despite those all-

too-familiar periods in which networks are badly overloaded, overall network usage today typically averages only about 60%. If that remaining 40% were made available in a dynamically priced market, the imagination is the only limit on the uses to which it could be put.

4.3 Other Spectrum Opportunities

The opportunity set for DSATPA technology is quite substantial. Inserting DSATPA into the spectrum ecosystem would enable the market to better meet the demand challenges of the future.

The Sharing Economy is widely regarded as one of the key emerging consumer trends of the early part of the 21st Century. The sharing economy — sometimes referred to as the peer-to-peer (P2P) economy, mesh, collaborative economy, or collaborative consumption — is a socio-economic system built around the sharing of resources. It includes the shared creation, production, distribution, trade and consumption of goods and services. These systems take a variety of forms, often leveraging information technology to empower individuals, corporations, non-profits and government with information that enables distribution, sharing and reuse of excess capacity in goods and services.

Highly disruptive and successful sharing economy business models have emerged across a range of industries and in a range of different formats, from P2P marketplaces such as Airbnb, to crowdfunding platforms such as Kickstarter. Ridesharing service Uber's business strategy is adaptable and such a strategy could lead to lower prices in other areas such as the wireless industry. Forbes magazine has described the 'unstoppable rise' of the sharing economy and have defined it as one 'where asset owners use digital clearinghouses to capitalize the unused capacity of things they already have.' Spectrum Sharing is an inevitable next step in this movement, where a limited and perishable resource, for which there is exploding demand, becomes commoditised and much more efficiently utilised.

DSATPA technology provides an optimum solution to feed the growth in demand for wireless spectrum: Airbnb has increased the effective supply of short-term housing through the creation of an online marketplace, and Uber maintains a supply-demand balance through dynamic pricing enabled by wireless technology. Similarly, Rivada's technology will leverage the efficiency of an online marketplace and the benefits of dynamic pricing to improve the mobile-communications experience for all involved.

5.0 Funding

Australian Public Safety has an unprecedented opportunity for an historic improvement and modernisation of its communications solutions through the allocation of dedicated spectrum for Public Safety use, coupled with a proposed deployment of a nationwide Public Safety broadband network. In order to benefit from this opportunity, the broadband communications

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solution must affordably meet the needs of Australia's first responders. In an era where government budgets are contracting, it is critical that we aim to do more with less. It is also critical that Public Safety organisations across the country become an integral partner in the planning and development of this nationwide network.

The prohibitive cost of building Public Safety networks that leverage heavily on existing commercial infrastructure or building all new, dedicated nationwide Public Safety networks is forcing Governments across the world to look to innovative business models to accomplish their objectives. Public Safety in Australia has the opportunity to circumvent economic challenges and to leverage a \$2 trillion (USD) per annum global wireless ecosystem. This unique opportunity will place Australia at the forefront of what we expect will be a global paradigm shift for Public Safety communications. Rivada Networks has an innovative approach to this opportunity, one that addresses all of the fundamental success criteria.

Australian Public Safety will need access to dedicated spectrum to ensure they have sufficient bandwidth for the capabilities they need to respond to emergencies and incidents. Public Safety services and organisations also need to have absolute control of the networks they use for mission-critical communications. However, it is also widely accepted that the Public Safety community will not use all of that spectrum all of the time.

In addition to state of the art technology, and sufficient spectrum to use those networks, Australia's Public Safety services require access to funding to build, operate and maintain the necessary capabilities. In order to reduce the overall cost of the project to Government, Rivada proposes an innovative approach whereby the cost of network development is privately financed and all costs, including build and ongoing operation, are subsidised by allowing fee-paying commercial users to access the Public Safety network. In this scenario, Public Safety will have absolute priority on the network, and will have permanent access to the entire allocation of spectrum and network capacity when needed. However, when the entire capacity of the network is not required by Public Safety, the network will allow commercial subscribers to use the network by dynamically leasing any excess capacity on a wholesale basis to carriers and other broadband capacity purchasers. The revenue generated by the selling of capacity to wholesale buyers will be used to pay for the build out and the annual operational costs associated with the network. Rivada will not be a competitor to the carriers, but will instead be a service provider for all carriers, as well as providing capacity for new entrants who can now compete as a result of the decreased barriers to entry.

A Public Safety broadband network should re-use existing communications assets owned by Public Safety services and organisations wherever and whenever possible, including tower sites, backhaul capacity, network operations centres, human resources, and other relevant assets. These Public Safety infrastructure assets generally come with the additional benefit of hardened attributes such as the ability to support substantial generator power, high wind loads, and other important features. Where Public Safety assets are not available, the network should utilise commercial assets to speed deployment and minimise capital costs.

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Rivada will provide the funds to build and operate the network, with no repayments being made until the network is complete and commercial services have begun to flow from the project. Revenues generated from Australia's Public Safety network will essentially pay for the network with the net effect that Government does not commit any taxpayers' money to the network.

Civilian commercial communications networks are built for peacetime and periods of calm – they are designed to handle a steady volume of commercial civilian traffic, and rely heavily on the availability of electricity, a lack of network congestion, and conditions of normality that frankly do not exist in those moments when Public Safety services and organisations are called into action en masse. Although there is an essential role to be played by civilian commercial carriers and networks in interacting with the Public Safety network, it would be unwise to become overly reliant on them.

Rivada Networks has been involved in Public Safety communications for more than a decade. In that time we have provided assistance in the United States during Hurricanes Katrina, Gustav, and Ike, as well as during disasters such as the California Wildfires and the collapse of the Mississippi River Bridge in Minnesota. In all of these disasters we have seen the same pattern.

The catastrophic physical damage suffered by the network, combined with a surge in civilian mobile phone usage during the incident, as concerned people attempted to call their loved ones, meant that Public Safety officials could not access mobile networks, leading to sub-optimal performance and confusion between agencies and responding units. In other cases, disasters affected rural or remote areas with limited commercial network coverage to begin with.

In all of these cases, the limitations of relying on a commercially provided mobile communications network, designed for mass public use, became distressingly apparent.

Commercial mobile companies are simply not programmed to respond to major civil emergencies and as such cannot be relied upon to immediately restore access to the networks in the immediate aftermath of a major incident:

- In Hurricane Gustav, it took the commercial networks over a week to get repair teams on the ground before they could begin to restore the networks. In Katrina, it took considerably longer.
- During superstorm Sandy, almost 25% of the entire commercial network was unavailable, and was not restored for several weeks in some places.

The first minutes and hours after a disastrous incident of this nature are absolutely critical to emergency response teams, and it is during this period that they most urgently require access to a telecommunications infrastructure built on hardened sites and supported by backup power

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in the event of electricity becoming unavailable. As such, reliance on commercial carriers for this kind of emergency situation is not a valid option for Public Safety, as they are simply not designed to provide for the unique requirements of modern Public Safety.



Self Sustaining Model: *Rivada Networks' approach provides a unique operating and funding model.*

6.0 Rivada Technology

During Hurricane Katrina, Rivada Networks deployed emergency cellular base stations in Louisiana with satellite backup. While able to provide emergency communications to first responders, we found that when usage capacity was at maximum, we were unable to provide prioritised access to key users who needed it.

As a result of that experience, Rivada spent a number of years developing Tiered Priority Access (TPA), allowing us to allocate access to bandwidth based on prioritisation of the user. Having developed TPA, we realised that if we could tier priority access at a local level, we could do it at any scale, allowing bandwidth to be commoditised and allocated to users based on real time valuation, dynamic allocation of, and access to, that bandwidth.

TPA allows Public Safety control over its own permanent, dedicated network, granting full and absolute priority when needed through a throttling mechanism, while making the surplus

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bandwidth dynamically available to wholesale commercial users during the significant periods of fallow time when the Public Safety bandwidth is not being used by emergency services and other first responders.

Rivada's patented Dynamic Spectrum Arbitrage-Tiered Priority Access (DSATPA) enables spectrum sharing across frequency bands. This will pave the way for more effective load-balancing on commercial networks at peak times and better use of commercial networks off-peak. Rivada's technology can also facilitate sharing between underutilised government wireless broadband networks, such as Public Safety networks, and commercial networks, thus alleviating wireless broadband capacity constraints for the commercial operator and improving overall spectrum efficiency and utilisation. Rivada Networks' DSATPA technology leverages existing LTE specifications and standards to offer an immediate solution to wireless broadband capacity demand pressures across the entire range of cellular spectrum from 600 MHz to 3600 MHz.

With our technology, the marketplace operator does not act as a competitor to commercial carriers. Instead it operates as a licensed service provider to all carriers, offering bandwidth to existing carriers and new entrants who will now be able to compete as a result of reduced barriers to entry. Our technology works across the entire cellular spectrum range and beyond, enabling fuller utilization of this valuable resource.

DSATPA is the world's first technology that seamlessly allocates excess spectrum on disparate networks to where it is most needed.

DSA is a form of spectrum sharing that makes radio resources or network capacity dynamically available to secondary users, as opposed to apportioning the spectrum itself.

The key emerging technologies in spectrum sharing are Rivada's Dynamic Spectrum Arbitrage and Cognitive Radio (an enabling technology for Dynamic Spectrum Access, as outlined in Case Study 1 of the consultation paper). While theoretical research for Cognitive Radio is on the rise, because of the complexities involved, both hardware implementation and system development are progressing at a much slower pace.

While cognitive radio is an admirable concept in the area of spectrum sharing and allocation, Rivada Networks' DSATPA technology holds several key advantages over this nascent technology:

	Rivada DSATPA	Cognitive Radio
Standards Based	<ul style="list-style-type: none">• 3GPP standards compliant.	<ul style="list-style-type: none">• Not compliant with standards.• Still in project phase.
Network	<ul style="list-style-type: none">• Uses LTE networks.• DSATPA overlays on to 4G and 5G networks.	<ul style="list-style-type: none">• Requires a complete network rip out.• Network technology is many years away from market availability.

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		<ul style="list-style-type: none"> • Cognitive radio doesn't work unless the network is in place to accept handsets. • Authentication issues between separate networks, from LTE to UMTS to GSM — where all have to act like one network — is a key challenge. • Analogue-to-digital and digital-to-analogue interfaces are still a key bottleneck in CR development.
Regulation & Licensing	<ul style="list-style-type: none"> • Minimal licensing and regulatory challenges. • Spectrum is licensed and the established order remains. • Compliments the existing regulatory framework. 	<ul style="list-style-type: none"> • Immense licensing and regulatory challenges, which may lead to years of delay. • Cognitive radio requires a revolution in the regulatory framework. Without licensing there is a risk of radio transmission anarchy and a possible descent into spectral 'warlordism' where the entity with the strongest transmitter wins.
Carriers	<ul style="list-style-type: none"> • DSATPA compliments carriers' approach, providing a complimentary solution to looming spectrum crunch issues. • With DSATPA's network gateway approach, carriers retain complete control of customer interaction. 	<ul style="list-style-type: none"> • Breaking commercial carriers' licensing and operating model is a significant challenge. • CR technology raises many inter-carrier issues — scanning available carrier networks and coordinate ahead with that network to inform that the subscriber will be landing there.
Handsets	<ul style="list-style-type: none"> • Available now. 	<ul style="list-style-type: none"> • Estimated minimum of 5 years from market availability. • There is no individual transmitter known to cover everything across multiple frequency bands — which necessitates multiple transmitters from 700-2300MHz. • Battery life is a key challenge when enabling power-hungry multi-transmitter scanning technology. • The technology has no consistency in modulation. Getting handset technology to work in saturated radio spectrum is a critical challenge.
Shared Economy	<ul style="list-style-type: none"> • With DSATPA, Rivada addresses the needs of the sharing economy. • Spectrum utilisation is easier to manage and monitor accurately — providing for monetisation 	<ul style="list-style-type: none"> • CR has not yet contemplated these needs. • No function for the market to determine allocation of resources.

	opportunities to owners of the physical space where bandwidth is made available and used. <ul style="list-style-type: none">• DSATPA enables the market to determine allocation of resources.	
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6.1 DSATPA Summary

DSATPA enables spectrum leasing or capacity leasing on a short-term basis. This will increase competition in the wireless market and improve spectrum efficiency without negatively impacting the primary carriers' ability to deliver service.

DSATPA is unique in that it enables spectrum or radio resources to be leased for an entire license area or for a defined sub-license area. DSATPA is a policy driven governance and bidding process that enables spectrum and capacity to be geographically targeted for use and resale, providing a continuous source of revenue.

By employing DSATPA, both existing licensed and virtual wireless operators can enhance their service offerings by securing wireless resources in a dynamic fashion. Therefore existing wireless networks and virtual network operators utilising fixed spectrum bands can be enhanced with capacity on-demand services in a given geographic area, and/or region through assignment of short term spectrum leases, de facto leases, or dynamic roaming for complementary or competing wireless service providers and/or end users. DSATPA can enable spectrum and resources leases that are for small regions (e.g. per user, per sector, per base station, per cell cluster, per license county, per license area or any sub multiple or multiple thereof).

Spectrum and radio resources can be made available on the basis of time, usage, geography or any combination of the three as defined by the arbitrage process. DSATPA enables quasi just-in-time allocation of spectrum and radio resources thereby improving the overall spectrum utilization for a given market and providing a revenue source for the spectrum owner.

- The technology enables a spectrum holder to dynamically lease radio spectrum to the highest competitive bidder, while retaining complete control of the network and the ability to instantly take capacity back as and when needed.
- The spectrum holder can retain the ability to pre-empt spectrum as needed (e.g. public safety spectrum).
- The competitive nature of this approach levels the playing field and means that carriers and non-traditional players have the same opportunity to access the network. There is no "gatekeeper" since use is mediated by a transparent, open market.

- DSA technology unlocks the potential for supply and demand economics to bolster the quality, quantity and coverage of wireless broadband services.

The Department of Communications could play a significant role in supporting the development of spectrum sharing and relevant technologies by establishing a dynamic wholesale market for wireless bandwidth as an alternative to the current exclusive licensing arrangements. In Australia, the Department of Communications can encourage network sharing and equal access, encouraging new entrants into the market to aggregate capacity, thus enhancing the user experience, allowing for diversity, and driving down costs to the consumer.

Under a traditional spectrum licence, the carrier pays the government up front for exclusive use of a frequency band or bands for a specified period of time, subject to renewal. Using Rivada's DSATPA technology, one possible arrangement would entail forgoing the traditional licence cost in exchange for a continuing stream of revenue from a newly created Telecoms Commodity Exchange, using Rivada's technology. Rivada proposes to take a percentage of the commercial revenue generated in that marketplace, and to remit the remainder, after paying for network build-out costs and maintenance, to the Government in lieu of the up-front licence fee. Over time, we expect this excess to become quite substantial. And because network utilisation will almost certainly be much higher than under current arrangements, the value of the spectrum sold on the exchange, and the revenue to the Government, would likely be greater than under a traditional licence.

Rivada Networks can provide a full operating demonstration of DSATPA enabled LTE on request.

6.2 Four key points about Rivada's Technology

Addresses Ever Increasing Demand

- Wireless bandwidth has a high market value, because demand for it is growing faster than new supply can be added.

Maximizes Bandwidth Efficiency

- Rivada has worked out how to sell this bandwidth – in specific locations for fixed durations at variable, market-determined prices.

Reduces Barriers to Entry

- A dynamic market for wireless bandwidth allows new entrants to get started without massive infrastructure investments.

Eliminates Unused Bandwidth

- There is a massive amount of unused bandwidth on cellular networks at certain times of day.

Commercial wireless operators are currently in the process of deploying 4G LTE networks to meet increasing bandwidth requirements for their customers. However, as demand for bandwidth continues to increase, further pressure will be applied to operators to provide the necessary radio capacity.

Dynamic Spectrum Arbitrage (DSA) enables existing licence holders — and the Government, in the case of unallocated or repurposed spectrum — to lease excess capacity on a temporary basis to other network operators or to non-operators who have a need for spectrum. These new users of spectrum could include handset makers, content providers, auto makers, or almost any business that wants access to wireless bandwidth, but has no desire to build or operate their own network.

7.0 Conclusions

Traditional spectrum licensing regimes are rigid, exclusionary and economically inefficient. Long-term licence auctions often see spectrum going to those with the deepest pockets, rather than those who will make the best use of it. Beauty contests, on the other hand, are prone to corruption, and even when conducted cleanly, require regulators to know more about the future uses of spectrum than anyone can possibly know.

The Government's Consultation Paper makes it clear that the Department of Communications understands these limitations. The good news is that with the advent of Dynamic Spectrum Arbitrage, these compromises are no longer necessary. Rather than making a single, long-term choice about the control and use of blocks of spectrum, Australia has the opportunity to show the way forward through the creation of a dynamic, near-real-time, permanent marketplace for network capacity.

New spectrum could be brought into this marketplace through a public-private partnership that would return a continuing stream of money back to the Government as the new network's capacity is bought and sold. Rivada is confident that the initial funding for network build out could be raised from private investors, minimizing the up-front cost and risk to the government of adopting this approach. Given the flexibility of DSA, the envisioned Telecoms Commodity Exchange could make available for trading any existing licence-holders' spare LTE capacity as well, should they so desire.

The bidders in this marketplace will be able to request resources based on the following criteria:

- Capacity/bandwidth desired;
- Treatment (desired services, including QoS);
- Geographic boundary (as granular as sub-sector);
- Time of day;

- Duration.

In the US, Rivada is working to deploy its technology first in 20MHz of spectrum that the US federal government has made available to Public Safety nationwide. While Australia would also benefit from a dedicated 4G Public Safety Broadband network, it is not necessary for the deployment of Rivada's technology, which is fully compatible with the latest 3GPP LTE specifications.

MNOs face a bandwidth crunch in prime locations at peak times, and thus would be interested in purchasing any capacity that is made available to them, especially if the incremental cost is less than their cost to supply bandwidth on their own. For areas/times of peak demand, market forces will drive the pricing up to premium levels. A large portion of the revenue from the leasing of capacity that reverts to the Government will be from this premium peak traffic. Bandwidth at prime locations during off-peak time or peak time and non-prime locations should be sold at market price, where the anticipated buyer would be MNOs, MVNOs, and other heavy bandwidth users. Lower demand, and thus lower priced, off-peak capacity is more attractive to wholesale customers looking for inexpensive alternatives to existing agreements, ways to save money, or ways to solve growing demands in areas like security monitoring, transmission of large data sets that can occur at off-peak hours, and the growth in machine-to-machine communications.

Rivada's approach pays for the network's build-out and operation. It provides an ongoing revenue stream to the Government that will grow with the expansion of market demand for wireless bandwidth. The potential upside for this growth is left where it belongs, on the Government balance sheet, for the public's benefit.

By reducing the barriers to entry to the commercial market, the Rivada approach allows new market entrants to purchase bandwidth as needed without investing in a nationwide mobile network. This proposal fosters the creation of an entirely new marketplace that will result in countless innovations and thousands of jobs in broadband communications and beyond.

8.0 Further responses to Stakeholders Questions

What additional proposals should be considered?

We believe that Department of Communications should advocate the allocation of dedicated spectrum for Public Safety for the several reasons detailed earlier in this document. The Department of Communications should promote network sharing and provision to allow equal access to spectrum, thus encouraging new entrants into the market to aggregate capacity and enhance user experience. Allowing for diversity drives telecoms costs down and encourages fair market pricing.

Rivada Networks

Response to Consultation - Spectrum Review, Potential Reform Directions

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