AMTA and Communications Alliance Submission to ACMA

7 February 2017

ACMA Five Year Spectrum Outlook 2016-20

The ACMA's Spectrum Management Work Program

October 2016

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Executive Summary

AMTA and Communications Alliance (the Associations) welcome the ACMA's inclusion of the mobile broadband (MBB) work program and the ACMA's annual work plan priorities in the FYSO, which have greatly improved its usefulness and relevance as a planning tool for stakeholders.

5G – the next generation of mobile communications networks - promises to deliver significant technological improvements to mobile telecommunications as well as substantial social and economic benefits.

5G will be an evolution that builds on 4G/LTE mobile networks and continues the convergence of fixed and mobile services.

It is critical that sufficient spectrum is allocated to meet the associated growth in demand from the evolution to 5G networks – both in the mmW bands and below 6 GHz.

The Associations appreciate and support the ACMA's proactive approach and sense of urgency to planning for 5G.

Industry is already preparing for 5G and conducting technological trials. Certainty around the availability of spectrum resources is critical for the decision-making processes around substantial investments in both spectrum resources and physical infrastructure to roll-out 5G ready networks and services.

The Associations submit the following agreed industry positions for ACMA consideration:

- Below 6 GHz, both 3.6 GHz and 1.5 GHz need to be progressed from *initial investigation* to *preliminary planning*;
- In the mmW bands we believe the 25 GHz should be moved from *monitoring* to *initial investigation* immediately;
- Unsold lots in the 1800 and 2100 MHz bands should also be auctioned as a priority;
- The 850 MHz expansion band is important for making additional low-band spectrum available for mobile broadband. The ACMA should consider the timing of the allocation for the 850 MHz expansion band following the outcome of the unsold 700 MHz lots auction; and
- The ACMA needs to urgently review the charges it applies to scientific apparatus licences for technical trials. Current charges are excessive and risk stifling innovation. If there is no opportunity cost, the charge should be limited to the administrative costs of issuing the licence.

Finally, we note the ACMA has released a consultation paper, *Reconfiguring the 890–915/935–960 MHz band* [1]and we welcome the opportunity to respond to that paper separately.

[1] http://www.acma.gov.au/theACMA/reconfiguring-the-890-915-935-960-mhz-band

Background

The Australian Mobile Telecommunications Association (AMTA) is the peak industry body representing Australia's mobile telecommunications industry. Its mission is to promote an environmentally, socially and economically responsible, successful and sustainable mobile telecommunications industry in Australia, with members including the mobile Carriage Service Providers (CSPs), handset manufacturers, network equipment suppliers, retail outlets and other suppliers to the industry. For more details about AMTA, see www.amta.org.au.

Communications Alliance is the primary telecommunications industry body in Australia. Its membership is drawn from a wide cross-section of the communications industry, including carriers, carriage and internet service providers, content providers, equipment vendors, IT companies, consultants and business groups. Its vision is to provide a unified voice for the telecommunications industry and to lead it into the next generation of converging networks, technologies and services. The prime mission of Communications Alliance is to promote the growth of the Australian communications industry and the protection of consumer interests by fostering the highest standards of business ethics and behaviour through industry self-governance. For more details about Communications Alliance, see http://www.commsalliance.com.au.

Introduction

AMTA and Communications Alliance (the Associations) welcome the opportunity to comment on the ACMA's *Five Year Spectrum Outlook 2016-2020* (FYSO).

The Associations note that the ACMA has taken into consideration previous industry comments and suggestions and made substantive changes to the structure and format of the FYSO, specifically the inclusion of the mobile broadband work program and the ACMA's annual work plan priorities, which have greatly improved the usefulness and relevance of the FYSO as a planning tool for stakeholders.

We have provided responses to specific questions raised by the ACMA in the FYSO, as well as commentary on the mobile industry's position on spectrum requirements.

Preparing for 5G

5G is the next generation of mobile communications networks and it is anticipated to enable a fully and seamlessly connected society and economy. It will deliver substantial improvements in the speed, latency and reliability of mobile networks in order to meet the ever increasing demand for mobile broadband (MBB).

5G will be an evolution that builds on 4G/LTE mobile networks and continues the convergence between fixed and mobile services.

Up until late last decade, technologies tended to be purpose-built for particular applications so that various specific, often proprietary, technologies addressed the varying requirements of private mobile radio for business operations, public mobile phones for voice communications, fixed wireless access, etc. The advent of the smartphone and LTE technology has resulted in the lines between these applications becoming increasingly blurred, leading to technological convergence, in particular, between fixed and mobile services. For example, WiFi, previously used to communicate with fixed (or at best, nomadic) user devices only, can now connect to smartphones which are truly mobile devices. LTE is a cellular network technology that can be used to both connect mobile phones in motion, as well as fixed user terminals for broadband access, not to mention also satisfy the requirements of government radio communications previously completely reliant only on narrowband private land mobile radio networks for voice.

In future 5G networks, the convergence of fixed and mobile services is expected to evolve further. For example, through technological advances such as network slicing—allowing a physical network to be divided into multiple virtual networks (slices), each tailored to support particular types of applications, and supported by 5G's envisioned scalable numerology—and adaptive antenna beamforming and tracking—which would support both stationary and moving devices. For this reason, the use of the term MBB covers both mobile and fixed wireless services for the purposes of this submission.

5G is more than just the Internet of Things (IoT) or faster download speeds – it is smart, connected communities – where transport systems, infrastructure and services such as health and education are all supported by mobile communications technology. Building such a fully connected 'mobile life' will require radical change to the way we use MBB and support applications not previously dependent upon mobile connectivity.

IoT is an evolution of Machine to Machine (M2M) applications that expands the interconnectivity from direct communication links to IP networks. IoT is an application that will be further enabled and expanded by 5G, according to 5G Americas:

> *"The vision of 5G is that the massive IoT market will explode with billions of devices and sensors that represent a digital representation of our real world, driven by low cost devices, long battery life, coverage everywhere, and innovative business applications. The promise of 5G is that it will be possible to realize critical IoT applications, which require real-time control and automation of dynamic processes in various fields such as vehicle-to-vehicle, vehicle-to-infrastructure, high-speed motion, and process control. Critical parameters to enable the performance required are network latency below milliseconds and*

ultra-high reliability and both are intrinsic components of the 3GPP work to define the new radio interface for 5G, NR. The 5G network architecture is being designed to cater for both IoT scenarios."[2]

5G promises to be a comprehensive advance in mobile technology – not just about mmW, antenna beamforming, massive machine-type communications (massive MTC), or super-high download speeds—it will need to be about all these features being provided in a flexible manner depending on service requirements.

ITU-R Working Party 5D is currently developing an ITU-R Report titled *Minimum requirements related to technical performance for IMT-2020 radio interface(s)*. Many of the key requirements proposed for 5G are the same as those presented in Recommendation ITU-R M.2083-0—*IMT Vision: Framework and overall objectives of the future development of IMT for 2020 and beyond*—and include [3]:

- extreme peak data rates (20 Gbps downlink, 10 Gbps uplink)
- extreme user experienced data rate (1 Gbps for hotspot, 0.1 Gbps for wide area coverage)
- massive connectivity (1,000,000 connections per square kilometre for massive MTC)
- ultra-low end-to-end latency (1 ms in the user plane)
- high reliability (99.999% for mission-critical "ultra-reliable" communications)
- mobility support for high-speed terminals (500 km/h)

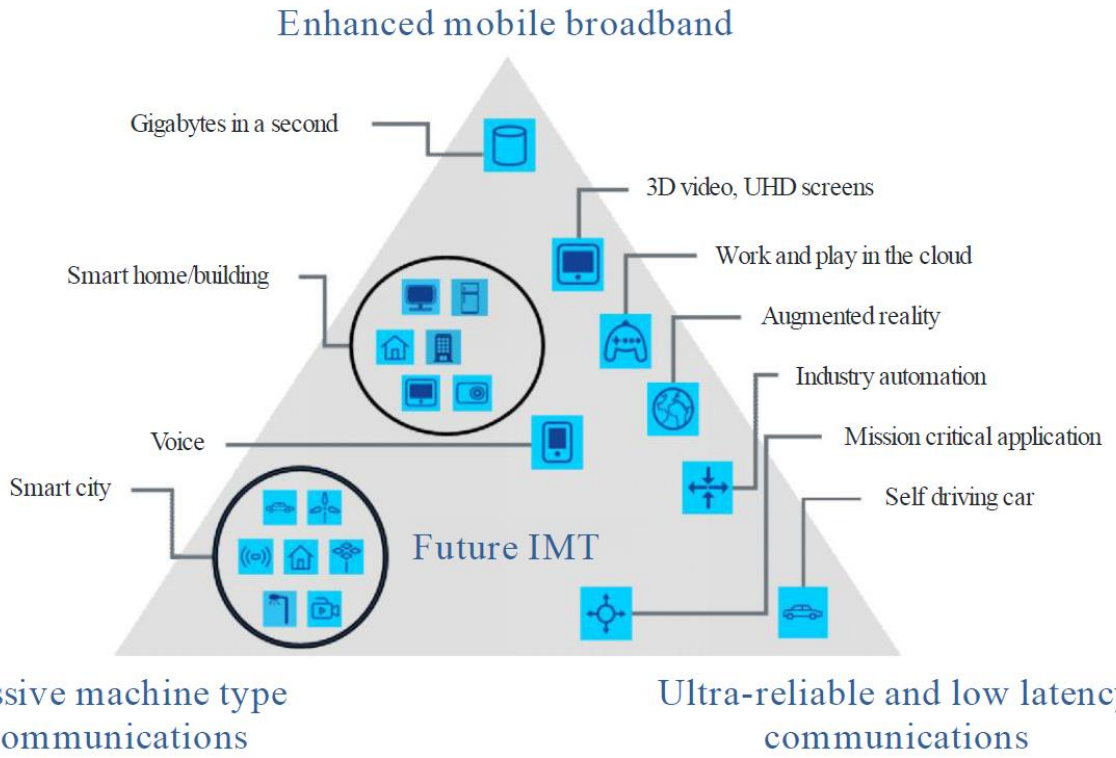
This broad range of requirements, particularly the massive connectivity and low latency requirements, make the step towards 5G more diverse compared to previous evolutions. For example, 3G to 4G primarily focused on higher data rates.

[2] 5G Americas: LTE and 5G Technologies Enabling the Internet of Things, Dec 2016, p5

[3] Recommendation ITU-R M.2083-0, September 2015, IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond, available at: http://www.itu.int/rec/R-REC-M.2083/en
And ITU-R Working Party 5D, Doc. 5D/234, Report on the twenty-fourth meeting of Working Party 5D (Geneva, 14-22 June 2016), Chapter 5—Meeting Report of Working Group Technology Aspects, available at: http://www.itu.int/md/R15-WP5D-C-0234/en

FIGURE 2

Usage scenarios of IMT for 2020 and beyond



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Spectrum and deployment related policy and regulatory settings are critical inputs to support the implementation of 5G. Timely allocation and management of limited spectrum resources (including consideration of any incumbents), as well as efficient roll-out of physical infrastructure, requires thoughtful consideration and timely decision-making by policy makers to ensure that the benefits of 5G are fully realised.

Industry is already preparing for 5G[4] and investment decisions are being made now. It is imperative that there is certainty around the future availability of spectrum resources as well as the timing of spectrum allocations to provide certainty for the requisite long term investment decision-making processes.

The Associations therefore strongly support and agree with the ACMA's message of urgency, present throughout the FYSO, with respect to spectrum availability for MBB and future 5G services. The ACMA has consistently recognised that the demand for additional spectrum continues to grow and we note the ACMA's commitment to adapting to meet the associated spectrum management challenges this ongoing demand raises.[5]

We support the ACMA's willingness to press ahead with work on additional MBB spectrum, taking into consideration the long lead-times anticipated and the importance of international

[4] http://www.amta.org.au/amta/news/51183.mobile-nation-preparing-for-5g
[5] FYSO 2016-20 pages 17-24

harmonisation—among some of the factors that led to the creation of the Mobile Broadband Strategy and Work Program.

The Associations note that ACMA has commenced a program of preparatory work to facilitate access to spectrum for 5G and IoT technologies and has expressed its commitment to continuing to support industry in the development of 5G, including facilitating trials.

We also recognise that the ACMA—via its contingency planning model for consideration of additional spectrum for mobile broadband services—is prepared to monitor and respond to early 5G developments outside of the WRC-19 process, including rapid progression of bands to subsequent stages of the mobile broadband work program. Taking into account the increasing global interest in the 3.6 GHz band for early 5G deployment, the release of the discussion paper[6] on the band is an example of a near-term ACMA action supporting early consideration of spectrum for 5G in Australia.

The Associations are reassured and encouraged by the ACMA's statements in FYSO and support the proactive approach adopted by the ACMA.[7]

Economic benefits of Mobile Broadband

MBB continues to play a key role in stimulating Australia's economic growth and productivity. It is a driving force in connecting people and businesses, stimulating innovation and technological progress, and transforming industries. Future development of mobile and fixed wireless technologies, such as 5G, the Internet of Things (IoT) and Machine to Machine (M2M) applications will re-shape the Australian economy and drive productivity improvements.

Recent research by Deloitte Access Economics found that mobile telecommunications creates significant benefits in terms of productivity and workforce participation.[8]

Specifically, the research showed that Australia's economy was $42.9 billion (2.6% of GDP) bigger in 2015 than it would otherwise have been because of the benefits generated by mobile technology take-up with an increase in:

- long term productivity of $34 billion or 2% of GDP); and
- workforce participation of $8.9 billion, or 0.6% of GDP).[9]

The research also found that 65 000 full-time equivalent jobs were supported by the increased GDP attributable to workforce participation (equivalent to 1% of total employment in the Australian economy).[10]

6 ACMA Discussion paper - http://www.acma.gov.au/theACMA/future-use-of-the-1_5-ghz-and-3_6-ghz-bands
7 Ibid
8 Deloitte Access Economics, Mobile Nation: Driving workforce participation and productivity, 2016.
9 Ibid
10 Ibid

Demand for Mobile Broadband continues to grow

The global demand for MBB continues to grow and the evolution of 5G and IoT services will place even greater pressure on the capability of industry to meet growing demand without timely and sufficient spectrum allocations.

Ericsson's Mobility Report (Nov 2016) forecast:

- There will be 550 million 5G subscriptions by the end of 2022;
- 4.6 billion LTE subscriptions by the end of 2022;
- Mobile broadband will account for 90% of all subscriptions by end of 2022;
- VoLTE subscriptions will surpass 200 million by the end of 2016;
- Mobile data traffic grew by 50% from Q3 2015 to Q3 2016;
- Between 2016 and 2022 traffic generated by smartphones will increase by 10 times; and
- As the most populous region, Asia Pacific has the largest share of mobile data traffic. This is likely to continue into 2022, with a rapid growth in mobile broadband subscriptions expected in the region. China alone is set to add 440 million mobile broadband subscriptions between the end of 2016 and 2022.[11]

A recent report by Accenture Strategy forecast that in the USA, 5G deployment will create up to 3 million jobs and raise GDP by $500(USD) billion due to an expected investment of $275(USD) billion by industry over the next seven years. This investment in deployment will include the roll-out of hundreds of thousands of small cells.[12]

Sanjay Dhar, managing director at Accenture Strategy, said:

> "Full realization of the economic growth and cost savings will depend on how robustly 5G networks are deployed locally, and will require different approaches in local communities from those used in the past."[13]

As demand for MBB continues to grow, industry is required to continually address capacity issues and develop more innovative solutions to meet demand for mobile data with limited spectrum resources. The mobile industry has been upgrading and rolling-out new networks for 4G LTE and LTE-A as well as adopting new technologies that improve efficiency. For example, multiple input, multiple output (MIMO) antennae and carrier aggregation. However, there are inherent limits to efficiency gains. Limits to network efficiency gains combined with strong forecast demand for mobile broadband as the transition to 5G progresses create pressure network speed and performance, and therefore a need for additional spectrum to be allocated for MBB.

The Associations therefore welcome the ACMA's recognition of AMTA's position[14] that the three techniques to increase MBB capacity—technology spectral-efficiency, network densification and additional spectrum—are not fully substitutable, as there are different intricacies and costs, for example, public sensitivities, legal hurdles and expenses associated with network densification. As

[11] Ericsson Mobility Report, On the pulse of the networked society, November 2016
[12] Accenture Strategy - CTIA Report: 5G Deployment Will Create Jobs And Boost U.S. GDP
[13] Ibid
[14] Pg 8, AMTA Submission to ACMA 30/10/2015, in response to the ACMA discussion paper *Beyond 2020*

previously submitted by AMTA, mobile network operators are players in a competitive industry and therefore have a strong incentive to employ the most efficient combination of these three techniques to maximise the capacity that can be delivered from their existing spectrum assets to their respective customers.

It is imperative that the ACMA works with industry to identify more spectrum for MBB to meet strong forecast demand and enable industry to deliver the requisite speed and performance for 5G services and applications.

Spectrum Review

The Spectrum Review reform process is critical to the ACMA's work program and future strategies for spectrum planning in relation to MBB as well as other services. The Associations understand that the highest-priority work item under the *regulatory and service-planning work program* for 2017-2020 is the implementation of Spectrum Review outcomes, and agree with the ACMA designating it this level of priority.

The Associations believe that the reforms proposed as an outcome of the Spectrum Review should liberalise the licensing framework so that both existing and future spectrum licences are more flexible for licence holders.

For example, 5G mmW presents an opportunity for a new licensing approach (see response to question 7 below) and the Spectrum Review presents a further opportunity to consider licensing approaches in detail.

The reformed regulatory framework should also enable the opportunity cost of each spectrum band, in terms of MBB as well as other uses, to determine the ACMA's priorities in terms of its planning and work program.

The Associations look forward to the opportunity to participate in consultations on the anticipated Exposure Draft of a new Radiocommunications Bill in 2017.

Mobile Broadband Strategy

We have provided responses to the ACMA's specific questions from the FYSO below:

Issue for comment: 5G

1. ***When, or under what circumstances, would it be appropriate for potential 5G millimetre wave (mmW) bands to progress beyond 'monitoring' in the ACMA's mobile broadband work program?***

The Associations believe that the band 24.25-27.5 GHz has emerged as an early priority or 'pioneer' mmW band for 5G and should therefore be progressed to the *Initial investigation* stage immediately.

Although not supported by all, interest has also been expressed by one of our members (Intel) in 27.5-29.5 GHz Band (the 28 GHz Band) as a mmW band for 5G.

As shown in Table 14 of the FYSO, the ACMA recognises that there is a potential or evolving ecosystem in "bands announced internationally for early implementation of 5G"—namely parts of the frequency range 27.5-29.5 GHz referred to as the "28 GHz band". The emergence of devices supporting 28 GHz band spectrum extends to a potential device ecosystem in the band 24.25-27.5 GHz band also. The relative maturity of the band 24.25-27.5 GHz and its link to the 28 GHz band is explained further in the response to Question 4.

More generally for all mmW bands, the Associations offer the following criteria for progressing bands beyond the *Monitoring* stage. On page 56 of the FYSO, the ACMA has listed factors that have led to the inclusion of various bands in the *Monitoring* stage of the mobile broadband work program, and the applicability of each of these factors against the various bands is summarised in Table 14 of the FYSO. For the WRC-19 Agenda item 1.13 bands, the ACMA notes that there is domestic interest, significant interest worldwide—including by regional groups, as shown by the common proposals developed under WRC-15 Agenda item 10—and the potential for international harmonisation, as is being worked towards under WRC-19 Agenda item 1.13. The "missing pieces" are therefore:

- technology standardisation—currently being worked on by 3GPP under the development of 3GPP Release 15, which is likely to include mmW up to 40 GHz; and
- potential or evolving device ecosystem.

The Associations therefore believe that it would be appropriate to progress a mmW band to the *Initial investigation* stage as soon as there is progress of either of these two factors. .

The Associations also believe that it is appropriate to progress the consideration of bands based on these two factors, considering that waiting until the outcomes of WRC-19—i.e. confirmation of the "international spectrum harmonisation" factor—may leave the Australian government and industry rushing to prepare suitable spectrum allocations and licensing arrangements straight after WRC-19, which concludes in November 2019. This is explained further in the response to Question 3.

2. What is the relative priority of investigation of mmW bands versus other potential mobile broadband bands below 6 GHz?

The Associations believe that spectrum bands below 6 GHZ should remain a priority for the ACMA.

Both sub-6 GHz spectrum and mmW can and should be progressed without delay.

3. What disposition should the ACMA adopt in progressing possible 5G mmW bands? Specifically, is a traditional approach appropriate, where Australia would wait until there were clear signs of a harmonised, widespread ecosystem developing in a band before it was seriously considered domestically? Or should a more proactive approach be adopted that would potentially make available bands very early in a more speculative manner? What are the benefits and risks to each approach?

Work on a 5G NR standard that could cover mmW up to 40 GHz in support of the eMBB use case is expected to be completed by mid-2018. This leaves a window of 18 months between technical standardisation and potential official international spectrum harmonisation expected at WRC-19.

Around the world, carriers and vendors are preparing for pilots, pre-commercial deployments—and in some cases even commercial networks—prior to 2020. Much of this activity towards 'early' releases is driven by the attractive opportunity to delivering new user experiences to large crowds at major sporting events—including the World Cup in Russia and Winter Olympics in PyeongChang in 2018, and the Olympic Games in Tokyo in 2020. Such experiences are likely to require support for high-traffic, low-latency applications that can only be supported by 5G.

The above developments show that the international mobile telecommunications industry is not waiting for the establishment of harmonised spectrum bands likely to result from WRC-19; it is seeking to develop its own internationally harmonised spectrum bands. While there is a danger of discordance emerging among early-adopters' choice of 5G frequency, the economic and social benefits of 5G technology are such that Australia cannot wait for WRC-19 to conclude before it begins planning for 5G. It must start now.

Australia must be at the forefront of international 5G technology and spectrum standardisation processes. As such, the Associations support the adoption of a proactive approach to the ACMA's spectrum planning for 5G. We note the ACMA's introduction of Embargo 69, and from this we infer that the ACMA shares the Associations' view that the band 24.25-27.5 GHz is of high potential value for future 5G mmW services.

The benefits of this approach are that spectrum policy and regulatory settings will be ready to facilitate the deployment of new and innovative services as soon as technology permits. In addition to increasing the potential speed-to-market of these services, it also helps to increase certainty for those entities needing to make huge investments in infrastructure and spectrum to provide them to consumers.

The main risk of the more proactive approach is principally that the spectrum remains unused for a number of years prior to the future rollout of 5G mmW services. However, we believe that the risks are relatively low considering that demand for spectrum in this range from alternative uses has been low for a far longer period—the band below 27 GHz is unused in Australia except

for body scanners within international airports, and science service downlinks at isolated locations.

4. What bands are the most mature in terms of possible early moves on 5G mmW bands?

As outlined in question 2, the Associations believe that spectrum bands below 6 GHZ should remain a priority for the ACMA. Both sub-6 GHz spectrum and mmW can and should be progressed without delay. The Associations believe that the 24.25-27.5 GHz band has emerged as a 'pioneer' mmW band for 5G. The main considerations behind this are connected to international spectrum harmonisation.

At this point, AMTA wishes to highlight the European Commission (EC) Radio Spectrum Policy Group (RSPG) recommending that work on 5G spectrum above 6 GHz be focussed on the bands 24.25-27.5 GHz, along with a couple of others, as also referred to in the FYSO. In line with this recommendation, the administrations of Norway, France, Russia, the UK and the GSA Spectrum Group also identified the band 24.25-27.5 GHz as a high priority band under WRC-19 Agenda item 1.13, in response to the CEPT Questionnaire on *Use and future plans for frequency bands in relation to studies in CEPT on WRC-19 Agenda item 1.13*. The GSA Spectrum Group has highlighted 24.25-27.5 GHz as a short-term 'pioneering' band among the WRC-19 Agenda item 1.13 bands. As pointed out by the ACMA, parts of this band are also included in the FCC's Further Notice of Proposed Rule Making, and in October 2016, major US carrier Verizon called for the FCC to "open up" the bands around 24 GHz.

This shows considerable support for the band 24.25-27.5 GHz within Europe, which we note is a large market where the opportunity for economies of scale exists for devices supporting 24.25-27.5 GHz. This opportunity increases if devices also support the 28 GHz band with an extended tuning range covering both bands. We note that Qualcomm and Intel have both launched pre-standard '5G' modems that support the 28 GHz band, while Ericsson, Nokia, Samsung have all developed their own test platforms to perform trials in the 28 GHz band in conjunction with US and Korean carriers, providing strong evidence for an emerging device market.

Another technical reason for supporting this band is the lower propagation and building penetration losses (relative to higher mmW bands) that make this band favourable for minimising path losses, particularly for outdoor-to-indoor communications compared to higher mmW bands.

As technical field trials and standardisation work continue, the relative priority of bands may change. For example, despite the higher propagation losses at higher mmW bands, smaller, more efficient antennas with higher gains could be produced at these higher bands, presenting a more favourable spectrum option. For now, it seems that the lower mmW bands are generating the most interest, as demonstrated by the launch of the Qualcomm and Intel modems as mentioned earlier.

5. What technical considerations are relevant to possible early moves on 5G mmW bands? For example, what is the minimum contiguous bandwidth considered suitable for individual licences and the industry as a whole? Are some of these considerations flexible in order to support an early move?

In the responses to Questions 1 and 4 supporting progression of the band 24.25-27.5 GHz, it has already been highlighted that a broad device ecosystem enabling economies of scale is very

important. Notably, the market for devices supporting the band 24.25-27.5 GHz is greatly expanded with an extended device tuning range covering both this range and the 28 GHz band. This concept could be applicable to other bands. For example, it should be noted that the potential to support 31.8-33.4 GHz, as part of a further extension of this broader tuning range, is still under study. A broader tuning range could also apply across 37-43.5 GHz, which would support both potential future 5G operations in 37-40 GHz in the USA—as recently allocated by the FCC as part of the "Spectrum Frontiers" Ruling—as well as in Europe, in which the band 40.5-43.5 GHz is gathering significant support.

There are also other technical considerations relevant to early moves on higher mmW bands. For example, the need for, or attractiveness of, particular bands to support particular applications or aspects of 5G for which other bands are not ideal. The bands 71-76 GHz and 81-86 GHz are currently used for mmW links, and therefore (or, in spite of this) could be very useful for accommodating the expected increased requirement for 5G backhaul/fronthaul.

With respect to the minimum contiguous bandwidth (MCB), work on the 5G NR mmW air interface is converging on the use of OFDM-based waveforms, with component carriers (CC) 100 MHz wide. In the same way that the MCB is 5 MHz is used in current spectrum licences supporting LTE networks, an MCB value mirroring a CC width of 100 MHz may be appropriate.

With respect to the width of the band allocated to broadband services for use by 5G, it is generally agreed that the desirable amount of contiguous spectrum for a 5G band is considerably higher—at least around 1 GHz—especially in the mmW bands. In Korea for example, the regulator is considering three licences of 1 GHz each (e.g. 26.5-29.5 GHz).

6. What spectrum sharing and incumbency considerations will be most relevant to 5G mmW bands (acknowledging that the answer will depend on the specific band under consideration)?

The main considerations that affect the ability for spectrum sharing are:

- Type of incumbent service
- Area of deployment of incumbent service
- Density/extent of deployment of incumbent service

Because of high propagation losses in mmW bands, sharing between future 5G mmW systems and incumbent terrestrial services can be facilitated through the application of minimum required separation distances that are typically quite modest.

Therefore, sharing between 5G mmW and incumbent terrestrial services only presents a problem if the incumbent services are deployed to a great extent—i.e. many systems in operation creating an aggregate spectrum denial covering wide areas—and/or if the incumbent services are deployed in the same area in which 5G mmW systems are sought to be deployed. For example, challenges with respect to sharing and compatibility may be presented by existing 38 GHz microwave fixed links and 75/85 GHz mmW fixed links that have considerable deployments in capital city areas. Adaptive beamforming antenna techniques, which are expected to be a key technology for mmW 5G, may result a very useful tool in minimising interference in such scenarios.

The types of service that may present sharing and compatibility challenges are mainly those services involving spaceborne transmitters and particularly, spaceborne receivers, since the separation distances cannot be increased if so required. It should be noted that this is a general observation and that these issues will be the subject of details sharing and compatibility studies that need to be carried out by the ITU Task Group 5/1 under WRC-19 Agenda item 1.13. It should also be noted that the US FCC concluded that sharing between 5G and spaceborne receivers was unlikely to cause harmful interference under the US rules. AMTA and some of its members will be participating in this work through the Australian WRC-19 preparatory process.

7. Do the mmW bands offer opportunities for new spectrum sharing and/or licensing approaches? If so, what opportunities should be investigated?

The Associations note that the Spectrum Review reforms are still pending and that the impact of those reforms on the licensing framework remains unknown. The Associations believe spectrum sharing in spectrum licenced spectrum should be approached with great caution. Spectrum sharing risks undermining property rights and deterring innovation, especially considering that the potential widespread proliferation of spectrum sharing devices may result in unacceptable interference that cannot subsequently be controlled. The Associations therefore submit that as a principle, spectrum-sharing arrangements must not be introduced without the agreement of the spectrum licence holder. The spectrum licence holder must be the only one able to decide if their spectrum assets can be shared.

The Associations suggest that when a licensee is agreeable to share use of the spectrum they hold; they should have the ability to make arrangements to share with other users, either by a sub-leasing or direct authorisation process. Such a process or arrangement would not need to involve the ACMA.

One of the biggest challenges associated with the use of mmW bands is the very high propagation loss, comprising a combination of high free space loss due smaller antenna aperture at higher frequencies, little diffraction, high penetration loss by building materials, vegetation and even people, gaseous absorption and rain fade. While this causes difficulties in trying to generate a sufficiently high *wanted* signal level at the intended receiver—particularly in non-line-of-sight (NLOS) conditions—it certainly alleviates the challenges of reducing *unwanted* signal levels at the receivers of potential 'victim' services.

The mmW bands do offer opportunities for spectrum sharing. The separation distances in the order of 100 kilometres between co-channel services required at UHF and microwave bands are very likely to be reduced to single-digit figures in km at mmW bands. As such, it could technically be possible to have 5G services and other services like earth stations operating within the same city, something which is much more difficult at UHF and microwave frequencies. For example, in the US, the FCC has adopted a variety of measures including:

- The bands 27.5-28.35 GHz and 37.6-40 GHz are allocated exclusively for fixed and mobile services nationwide, with limited satellite use permitted in each county away from population centres. The ACMA itself has investigated Earth station siting policies over the past decade.

- In the band 37.0-37.6 GHz, a new framework is under development to facilitate sharing between fixed and mobile services with federal users.
- The frequency range 64-71 GHz is allocated for unlicensed use, which in practice is likely to be facilitated by contention-based protocols and modern dynamic spectrum sharing techniques.

However, these types of measures will require much more investigation before the ACMA considers experimenting with novel licencing and/or administrative arrangements to facilitate spectrum sharing.

Issue for comment: IoT

8. Are there any spectrum bands that should be further investigated by the ACMA for potential future use for IoT applications? Why? The ACMA in particular seeks views on possible opportunities in the VHF band for IoT.

The ACMA should be extremely cautious about setting aside spectrum for specific purposes such as IoT. The Associations' main concern regarding IoT is that regulations and licence conditions support cellular-based IoT technologies like LTE Cat-M and NB-IoT. No issues with existing licensing frameworks have been identified to date, but the ability to support cellular IoT will have to be considered in upcoming activities like the review of spurious emissions listed in Schedule 2 of the projected work program 2017-20, and primarily, the Spectrum Review.

IoT applications supported by 5G are likely to rely on low band 5G spectrum, but by that stage it is likely that IoT will be able to be incorporated in 5G networks with non-IoT applications (like eMBB) through *network slicing*. Low band 5G spectrum is emphasised here considering that IoT applications (both consumer and industrial) are likely to have high reliability and availability requirements, and so favourable propagation conditions are critical to ensure that long path lengths, vegetation and man-made obstructions do not compromise these. Therefore, requirements for low band spectrum for 5G are likely to continue to grow into the future.

The Associations, however, are not in favour of additional dedicated spectrum for IoT applications because IoT solutions entail a mix of technologies and spectrum bands depending on the use case. For example, we do not agree with the allocation of the band 928-935 MHz to narrowband machine-to-machine (M2M) technologies as this could potentially lead to inefficient use of spectrum. The Associations support flexible use applications and are in favour of class-licensed use that is less prescriptive and remains available for generic uses.

9. Are there any sectors of industry that require increased engagement from the ACMA regarding spectrum for IoT applications?

The Associations believe that the ACMA's participation in the IoTAA[15] provides suitable mechanism for engagement with the IoT community, covering a wide range of industries such as health, transport, government and environmental services.

[15] Internet of Things Alliance Australia http://www.iot.org.au/

Issue for comment: DSA

10. When, or under what circumstances, would it be appropriate to move beyond monitoring international regulatory and technical developments and consider implementation of arrangements in Australia?

The Associations do not support the ex-post replacement of tried-and-tested spectrum licensing and coordination methodologies with a sharing-based spectrum management approach. DSA should not be used in spectrum licensed bands as spectrum licensees have acquired their licences on the basis that they have an exclusive right to use that spectrum.

That said, we recognise, that in certain scenarios, DSA may present opportunities to use the spectrum where it may have otherwise been fallow under traditional approaches. While a lower priority than the spectrum matters we have raised in this submission, the ACMA may wish to consider more policy and technical research into the implications of DSA on incumbent services.

Proposed Work Plan for 2016- 2017

The Associations note that on pg 32 of the FYSO, under the section *Implementation of the mobile broadband strategy and work program*, the work plan for 2016-2017 focuses on the 1.5/3.6 GHz discussion paper, consultation on re-farming the GSM900 band, and consideration of bands in the *Monitoring* stage. We note that other activities related to mobile broadband to be carried out in H1 2017 include the auction of 700 MHz unsold lots, and consultation on 2 GHz and 3.4 GHz unsold lots. As such, these should also be reflected in the 12-month work plan, along with other work items currently in the 2017-20 work program that will be worked on from H2 2017—i.e. 2 GHz 'expansion band' and 1.9 GHz reversion to apparatus licensing.

Mobile broadband work program: October 2016 update

In reviewing the existing 12-month mobile broadband work program proposed in FYSO, the Associations wish to express support for the current stages at which bands are classified in the work program. That is to say, at this stage, we would be opposed to any proposals to remove any bands from the work program or to 'demote' any bands to a less-progressed stage.

The Associations consider it timely and appropriate to progress some bands to the respective next stage in the mobile broadband work plan, namely we support:

- The progression of the 1.5 GHz and 3.6 GHz bands to the *Preliminary Replanning* stage as proposed in the 1.5/3.6 GHz band discussion paper.
- The progression of the band 24.25-27.5 GHz to the *Initial investigation* stage, as explained in its responses to Questions 1 through 4 in the FYSO.

As mentioned, the Associations support the progression of the 3.6 GHz band to the *Preliminary Replanning* stage, but believes that the corresponding replanning work should be conducted in parallel with the consideration of "options to review arrangements in the broader 3400-3700 MHz band", as listed in Table 13 of the FYSO. There is implicit support from the ACMA for this work to be undertaken, noting its statement that it "sees benefit in pursuing a review of the arrangements in the broader 3400-3700 MHz band to improve its utility, contingent on progress in the 3.6 GHz band" [pg 68]. AMTA's response to the 1.5/3.6 GHz discussion paper included the following position:

> *"To the extent that it does not lead to a significant delay in the allocation of 3575-3700 MHz to IMT use, AMTA urges the ACMA to commence its review of the spectrum below 3575 MHz with a view to making part of the same reallocation procedure as spectrum in the 3575-3700 MHz frequency range".*

This review of the mobile broadband work program in the FYSO presents an opportune moment to incorporate the 3.4 GHz and 3.5 GHz bands—those parts of the frequency range 3400-3575 MHz range subject to apparatus licensed arrangements—in the *Preliminary Replanning* stage, along with the 3.6 GHz band, if the ACMA adopts this approach as an outcome of the 1.5/3.6 GHz band consultation.

Finally, the Associations emphasise the importance of continuing to make progress on bands in the *Re-farming* stage. For the bands currently listed in the *Re-farming* stage, we suggest the following list of band should be considered more closely for further study and work:

- ***900 MHz band***—we note and appreciates that the ACMA is undertaking work in this area with the release of the consultation *IFC 35/2016—Reconfiguring the 890-915/935-960 MHz*.
- ***700 MHz unsold lots***—we note that the ACMA has commenced the auction process for the unsold lots by opening the application process on 16 January 2017.
- ***1800 MHz and 2 GHz unsold lots***—the unsold spectrum blocks in the 1800 MHz and 2 GHz bands can be quickly used to enhance existing LTE capacity and coverage. They should be brought to market as soon as possible. The Associations understand that some necessary groundwork is being done by the ACMA through its consultation on the designation of the 2 GHz band for spectrum licensing—*IFC 34/2016—Spectrum licensing in the 2 GHz and 3.4 GHz bands*.
- ***850 MHz expansion band***—The 850 MHz expansion band presents another very attractive low-band spectrum option for mobile broadband networks. The ACMA should reconsider the timing of the allocation for the 850 MHz expansion band following the outcome of the unsold 700 MHz lots auction.

Projected Work Program 2017-20

The Associations offer the following brief comments on Part 4 of the FYSO:

- We note and support the ACMA's expectation that further work on the 1.5 GHz and 3.6 GHz bands will be carried out under the *Preliminary Replanning* stage of the mobile broadband work program.
- We understand that the ACMA intends to consider further work on the 2 GHz 'extension band' (1980-2010 MHz and 2170-2200 MHz) towards the second half of 2017, and so this work item is expected to be incorporated in the updated 12-month work plan.
- Considering the expiry of 2 GHz spectrum licences in October 2017, it is expected that some work on the reversion of the band 1900-1920 MHz to apparatus licensing would be undertaken as part of the next 12-month work plan, even if to place an embargo on the band.

Scientific Apparatus Licence Fees

We note that AMTA has asked the ACMA[16] to urgently review the scientific apparatus licence fees (by June 2017) as they are currently prohibitively expensive for the technical trialling of 5G and other new wireless technologies. We strongly believe that the access charge for such trials should be based on opportunity cost pricing. And we suggest that if no opportunity cost is imposed, the charge should be limited to the administrative costs of issuing and managing the licences.

[16] AMTA Letter to David Brumfield, ACMA sent 19 Sept 2016

Conclusion

A robust spectrum strategy for MBB needs to encompass more than just a consideration of spectrum bands. We need a spectrum strategy that is based on a flexible and responsive domestic regulatory framework and that adopts a proactive approach to international engagement. The ACMA should be proactive in its work so that can make timely informed decisions in response to international activities. The Associations believe that liberalising the licensing framework under the Spectrum Review and assessing the opportunity costs for each band will enable more efficient spectrum use (for MBB as well as other uses) and improve Australia's ability to realise the potential social and economic benefits of MBB.

The Associations support the ACMA's commitment to delivering spectrum in a timely manner to the highest value use and looks forward to continued engagement on the ACMA's work program and MBB strategy in order to meet the demand for spectrum for MBB.

Any questions about the above comments can be directed to Lisa Brown, Policy Manager, AMTA at 02 6239 6555 or lisa.brown@amta.org.au or Juan Pablo Casetta, AMTA Spectrum Consultant at juanpablo@openspec.com.au .