COMMUNICATIONS ALLIANCE LTD

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Spectrum for broadband in the millimetre wave bands

COMMUNICATIONS ALLIANCE SATELLITE SERVICES WORKING GROUP SUBMISSION

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INTRODUCTION

The Communications Alliance Satellite Service Working Group (SSWG) welcomes the opportunity to provide this submission in response to the *Spectrum for broadband in the millimetre wave bands* Consultation by the Australian Communications and Media Authority, specifically addressing the *Questions for consultation* Document.

Executive Summary

The SSWG posits that the delivery of telecommunications services is at a critical juncture with the advent of 5G services. The SSWG argues that the traditional approach of considering successive generations of technologies is being replaced by a focus on addressing a growing number of demanding usage cases. A comprehensive picture of how the market demand (not just capacity forecasts) for broadband services is to be met into the future requires a holistic approach encompassing all complementary networks providing telecommunications services.

This submission builds on a growing concern that the 'highest value use' paradigm is becoming less applicable in today's environment, especially when considering the higher millimetre band spectrum and how services being delivered over these bands are to meet the needs of the Australian public.

The SSWG strongly recommends a wireless broadband Roadmap that takes into account satellite, fixed and mobile broadband services, providing clear policy and regulatory guidance, the prioritisation of bands being considered, technology advancements and the studies being undertaken by the ITU and national and international interests.

With respect to the timetable, the SSWG has not identified any issues where the ACMA cannot complete its normal spectrum planning process in time to meet equipment development cycles or to meet consumer demand once the outcomes of WRC-19 become clear.

This submission initially provides some general comments on a number of aspects concerning the review of spectrum for broadband in the millimetre wave bands, followed by specific responses to the questions posed in the ACMA *Questions for consultation* Document.

The submission represents the views of the majority of members of the SSWG. It does not represent the views of Telstra, which is lodging its own submission. Optus advises that, while it is in agreement with some elements of the positions advanced by the SSWG in this submission, it is not in a position to endorse the submission in its entirety. Optus is making an individual submission in response to this consultation paper.

The SSWG also understands that some other individual member organisations will be providing separate submissions to the ACMA in response to the *Questions for consultation* Document.

About Communications Alliance

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.

The Communications Alliance SSWG is a group of 20 companies active in the space sector in Australia and focused in particular on the commercial communications satellite industry. Membership of the SSWG includes commercial satellite operators, satellite manufacturers and equipment suppliers, ground infrastructure suppliers, installers and operators, consultants and independent experts. A list of SSWG members is at Attachment 1.

For more details about Communications Alliance, see http://www.commsalliance.com.au.

General comments

The Communications Alliance SSWG believes that 5G promises to be a transformative event in telecommunications history without parallel. The focus has now shifted from the traditional approach of successive generations of *technology* (2G, 3G, 4G/LTE) to *usage cases* involving appropriate solutions and combinations of services over the broadest possible scenarios covering (i) extreme broadband provision, (ii) massive machine communication including IoT, and (iii) critical communications needing immediate response and low latency characteristics.

Thus, a focus on the drivers of cellular mobile growth and data traffic on smart phones, for example, fails to comprehensively account for the future broadband environment demanded by 5G and will misdirect the appropriate and balanced reservation of spectrum to cater for service demand and the interactive nuances which are incapable of being properly addressed by terrestrial mobile networks alone. See the *Demand for 5G* section which expands on this concern.

The future demands a much broader acceptance of integrated delivery platforms which can be absorbed or integrated and which complement each other, through using satellite networks and point-to-multipoint or fixed wireless delivery along with mobile cellular.

The current attention by the ACMA is timely, but it is now appropriate to re-think the approach of going down the terrestrial mobile broadband (MBB) route, which is too narrowly confined and incremental and which appears to have clouded regulatory and policy directions. A pure broadband (BB) play is now much more relevant, taking into account the contributing virtues which new satellite technologies are promising. Prior to considering the raft of questions which follow there needs to be an overarching Broadband Road Map assembling a fresh vision of how 5G broadband is be achieved and which is not entirely captured by an incessant and exclusive drive towards terrestrial MBB.

In looking at the roles of both terrestrial and satellite developments, the millimetre wave spectrum provides the following

- **Wide contiguous bandwidths:** for very high data rates in both terrestrial and satellite services
- **Less of an incumbency challenge:** the current relatively low utilisation makes the way forward for complementary terrestrial and satellite 5G an easier prospect
- **Emerging efficient technology solutions:** occurring in both terrestrial and satellite 5G advances – these include massive MIMO, antenna beam forming and phased arrays, switched beam access, coding efficiencies, high throughput networks, and lower orbit constellations
- **Reduced intra- and inter-service interference:** this is assisted by propagation characteristics at these frequencies
- **In-band and Out-of-band backhaul:** equally valid for 5G backhaul by terrestrial and satellite means
- **Distributed 5G network architecture**s: 5G satellites fit in especially well with the more distributed nature of 5G networks in areas of content/cached delivery closer to the user.

The broad picture of future spectrum demand

The ACMA needs to build up the assessment of future spectrum demand based on the broadest base of future requirements. This base relies on macroeconomic factors of financing and investment directions, and the drivers of public policy trends. It would be insufficient to project forward linearly based on a model of a finite number of telecommunications operators, mechanical projections of spectrum demand (where they exist), spectrum efficiency, and spectrum available.

By the time of arrival of 5G services (and IoT) financial markets believe the challenges of densification of networks will have stretched beyond the capacity to afford these networks to a point which is beyond the financial reach of current telco operators. Unfortunately, current forecast data growth in a marginal business is forcing EBITDA into marginal decline. However, significant restructuring of the asset base is nevertheless required by 5G.
This points to unsustainable levels of investment by operators. At the same time there are concomitant Opex demands which compound the situation for operators.
Given the poor outlook for monetisation from network investment, operators will temporarily be forced down a path of reinvestment of earnings. However this merely puts off the inevitable and is at the expense of shareholders.

Solutions available to operators include possible monetisation from added value of over-the-top service integration, and content provision. Neither of these have a happy history of successful monetisation of needed returns to telco operators.

This leads to the future of the industry moving significantly to enterprise models. There are three complementary options of enterprise model:

- Individual and discrete enterprise model: either in the private or public sector (e.g. the oil and gas industry, or the Govt health and other individual service sector sectors) where these sectors create their own telecommunications networks and spectrum needs.
- A second solution involves traditional (or new) telcos managing the disparate needs of some sectors, through enterprise divisions within the telco drawing together composite needs and spectrum demand. The full extent and diversity of 5G applications will be beyond the capabilities of most individual telcos, itself indicating the need for some form of specialisation.
- A third area is greater nationalisation within the industry of core facilities, e.g. in a substantial public move into mobile communications. Despite the potential inefficiency and less accountable financial discipline, one public highway is preferable and is more sensible to the investment community than three or four private highways, in prospect of the massive asset challenge ahead.

The last option recognises that Governments will face a very clear decision, possibly between inaction and structurally lower levels of economic growth; or significantly more regulatory intervention in telecom markets through the greater introduction of nationalised networks. In a public policy sense, Governments recognise that communications infrastructure is a key driver of GDP growth: the World Bank estimates that every 10% in broadband penetration drives over 1.38% of GDP growth[1]. Governments also have a mandated welfare to consumers, which is not reflected in private sector planning and responsibilities.

[1] J.P. Morgan, Asia Pacific Equity Research, 17 Mar 2017

These factors are necessary in arriving at a comprehensive picture of the future demand for spectrum which is a step down from understanding industry structure. Reliance on a traditional narrower sighted view of extrapolating existing industry structure and overbuilding with what is claimed to be future demand, using an approach of 'highest value use' of spectrum in defined circumstances is no longer acceptable when the overall industry model is about to change. It is necessary but not sufficient to assess claims – an assessment which the ACMA needs to satisfactorily present – but much more fundamental and broad ranging appraisal needs to be performed by the ACMA.

Balancing spectrum needs

The guarantee of successful spectrum management for future 5G communications comes from allocating or assigning spectrum in a balanced way and with co-existence and sharing strategies which account for complementarities in service development, recognising that both satellite and terrestrial techniques are converging to the same 5G delivery outcomes.

It would be a grave mistake to continue with an exclusive MBB focus which is centred on terrestrial mobile and not to engage in a comprehensive BB strategy. Satellite 5G solutions offer amongst other things the ubiquity and high bandwidth coverage which is a 'sweet spot' not otherwise easily attained by other technologies in the 5G ecosystem.

The unique qualities of satellite delivery bring international connectivity, broad, instant and ubiquitous coverage, facilitate aeronautical and maritime communications and reach into areas that are otherwise uneconomic to serve.

Demand for 5G

Other than various capacity forecasts made by 5G proponents, there is no measurable indication of demand for 5G services. While the ACMA has released a Mobile Broadband Strategy, we note this is to 'address the growth in mobile broadband capacity' rather than demand.

The ACMA has recently decided to release the band around 3.6 GHz ostensibly for 5G services and is moving towards the allocation of the 26 GHz band. Prior to considering any other bands or supporting other bands through the ITU-R processes the ACMA should monitor demand in these bands and from that develop a strategy to address the growth in mobile broadband demand, specifically 5G services.

Within the Mobile Broadband Strategy there is a section entitled '*Holistic approach to mobile broadband capacity growth*'. If only it were a truly 'holistic' approach that took into account the spectrum requirements of the entire communications ecosystem, as opposed to just the mobile component. Sadly, this section again focusses on capacity and not demand, but the title at least is promising. This section discusses meeting demand in current bands which is a strategy we broadly support. A more detailed and realistic assessment of future demand, and the ability to meet that demand, in the current bands is required before the ACMA embarks on re-farming or proposing 5G services in any other band.

Within the section that discusses 'Stages and considerations for band refarming' we note the ACMA still clings to an old economic paradigm 'highest value use' which from experience has meant in the past the exclusion of other services in the geographic areas where the band is re-farmed. We submit that the quarter of a century old paradigm of spectrum

licensing no longer applies and is particularly inapplicable to modern systems, millimetre wave bands or 5G services.

Unfortunately in Strategy 4 of the paper this mindset seems to be restated 'In effect, in a specific geography and frequency band, mobile broadband has been provided exclusive access to the spectrum'. We hold the view that this mindset is harmful to the communications industry as a whole.

Highest value use must be the greatest value for the whole community from the use of a band. It is obvious that the inclusion of a second service along with mobile broadband will provide more value than a simple single service model. Often regional and remote areas in Australia are deprived of services under this model as are people living in the 'dead zones' between spectrum licenced geographical areas.

Considering the above there are a number of processes that need to be put in place before the ACMA considers supporting or re-farming any other bands beyond the 26 GHz band.

These are:

- determining *market demand* for 5G broadband services not simply *capacity demand*, which notably could be influenced by a desire to minimise spectrum fees.
- investigating better methods of sharing between services in a 'smart system' world where massive MIMO, service cooperation and the physical ability to share greatly enhance the ability for multiple services in the same geographic area and thus greatly increase 'the highest value' from the use of a band beyond the simple single use concept. We note the 3.6 GHz and 26 GHz bands provide an excellent opportunity to seek the input of sharing experts to explore these issues.
- coordinate with other services, particularly FSS, who have been displaced from parts of the C-Band and now naturally seek other bands to operate in, before following the lead of 5G vendors towards their preferred bands.
- use all of this information to develop a true roadmap for all services beyond 2020.

Exclusive vs permissive spectrum management

The traditional approach to spectrum planning in contested bands is to package up spectrum in geographic blocks of band segments and auction these segments on an exclusive basis to those willing to pay the highest price. While it is doubtful that this approach has led to optimal spectrum usage outcomes in lower bands, it is quite certain that such an approach is not suitable to the higher bands such as Ka, Q, and V bands under discussion in this consultation. Under consideration here is the ACMA's questionable principle which promotes the 'highest value use' of the spectrum. In practice, this principle can better be described as 'highest obtainable price' which is achieved by granting access to one user at the expense of all others – although this may not be the goal of the planning process, it is the inevitable result, as experience indicates.

Due to higher propagation losses and with the ability to use directional antenna technologies across the full range of space and terrestrial services, the radiofrequency interference environment in millimetre wave bands is fundamentally different to any other that ACMA has previously considered in its spectrum management work. Depending on the usage scenarios, the technical characteristics of these services may allow coexistence between terrestrial and space services, or between users of differing terrestrial technologies, in the same or immediately adjacent areas. This is being studied at the ITU as part of the work on WRC Agenda Item 1.13. Depending on the outcome of those studies, the possibility of

implementing a permissive spectrum management regime allowing a mix of highly compatible services sharing spectrum and geography in close proximity could be opened up. Such a regime would depart from the idea that large geographic blocks of spectrum can be allocated on an exclusive basis to a single operator, who may choose not to use it. Although the lack of exclusivity may lower the price of the spectrum, the overall value to the end users of spectrum would be substantially increased by the greater degree of spectrum utilisation.

The exact form a new spectrum management regime in millimetre wave bands would take is a subject for discussion and detailed technical planning work. However, it may be worth exploring alternative approaches to spectrum management that foster the coexistence of multiple services, if feasible, rather than an approach which seeks to grant exclusivity and maximise price.

5G road map

A pre-requisite to considering the Questions in this consultation should be a Road Map which provides a clear policy and regulatory guide to the support of harmonised and complementary services. Part of that Road Map would be a prioritisation of bands which are under consideration and the justification of those priorities. Otherwise we are blindly stumbling down the road. A Road Map would lead to planning certainty of access for national (and international) needs.

Such a Road Map should also integrate satellite solutions, which will play an important role in the future 5G ecosystem, not least of which would be ensure that the benefits of 5G are extended beyond urban areas into more remote and sparsely populated areas.[2] GEO and MEO satellites today can already support 3G and 4G networks, and the latest High Throughput Satellites (HTS) designs will be able to scale to support the multi-gigabit speeds envisaged in 5G networks. Satellites today already support many machine-to-machine (M2M) and Internet-of-Things (IoT) networks (e.g. for SCADA and asset tracking applications), and can scale to support the M2M and IoT networks of tomorrow. Indeed, the satellite industry is making significant investments in advanced ground antenna technologies to enable ubiquitous IoT via satellite. Satellites can even support the ultra-low latency requirements of new 5G applications. Meeting sub-one millisecond latencies in terrestrial 5G networks will require the content to be stored at every base station for immediate delivery, and satellites would be extraordinarily efficient in providing such 'broadcast-like', point-to-multipoint distribution of commonly accessed content.

Whilst there is a significant emphasis being placed on the development of the suite of terrestrial mobile 5G standards with intense activity and investment across the globe, the timeframes being contemplated are somewhat ambitious and the demand assessments are questionable. As such we anticipate that it will be some years before 5G based communication systems are widely available and adopted in the 26 GHz band.[3]

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[2] *See, e.g.*, Daniel Mah, SES, *Integrating Satellites into 5G*, *presented at* ACMA Spectrum Tune-up: Spectrum for 5G Broadband in millimetre wave Bands (5 Sep. 2017); EMEA Satellite Operators Association, White Paper, *Satellite Communications Services: An Integral Part of the 5G Ecosystem*, *at* https://www.esoa.net/cms-data/positions/ESOA%205G%20Ecosystem%20white%20paper.pdf (last accessed 4 Oct. 2017).

[3] ETSI CTO Adrian Scrase said the 'extremes' of 5G performance targets, particularly ultra-reliable low latency and massive machine-type communication 'will not really be addressed maybe until the mid-20s. So this is quite a long-term play'. From Policy Tracker, 21 Feb 2017.

Having said that, there appears to be a case for initial pioneer consideration of 26 GHz for IMT services, by an emerging common consent and priority amongst ITU Members. Other bands are still under study and it would seem premature to outguess those studies and also implicitly obvious to not first learn the pioneer lessons and then apply them. This would therefore countenance against expanding efforts into other millimetre wave bands at this point in time.

5G standardisation for terrestrial IMT is under way, as are efforts to integrate satellite solutions into 5G standards and specifications.[4] New satellite services bringing high bandwidth GSO services and NGSO innovations are also under way and planned for launch or are already in existence. All this adds urgency to the need for a more appropriate policy framework and Road Map to encapsulate a blueprint for early benefits to Australia.

Future terrestrial spectrum needs for IMT are based on highest density usage areas. It is therefore quite unacceptable to broadly interpret this demand to all areas. In addition, network densification in high density areas will benefit from interworking with satellite networks for efficient content delivery at the base station level.

International and domestic processes – 24.25 to 27.5 GHz Band

With WRC Agenda Item 1.13[5], it is important for Australia to be pro-active and support complementary studies, together with harmonisation where possible and a flexibility to adapt as quickly as possible. However, the ACMA should be cautious not to get too far ahead of the WRC process. Indeed, given the likely pace of development in the 5G ecosystem, and the uncertain pace of demand growth, there is no need for the ACMA to rush its selection of a pioneer 5G millimetre wave band.

Australia's interest in anticipating the designation of the 24.25 to 27.5 GHz band as a pioneer IMT band is recognised. However, there is no reason to think that the ACMA could not wait until after WRC-19 and still complete its normal spectrum planning process in time to meet anticipated market supply or demand. At the same time, there are significant risks to moving too quickly. Early earmarked spectrum may lie fallow for a long time because of a slow-to-develop 5G ecosystem, investment and/or market demand. It could also become costly to replan the spectrum if WRC-19 turns out differently from what the ACMA expected. In the meantime, investments by other radio services in the band will be deterred. The ACMA should learn from its premature decisions to earmark the 3.6 GHz band for Wireless Access Services and the 27 GHz and 28 GHz bands for LMDS, which resulted in underutilisation of those bands for extended periods of time.

The ACMA should also recognise that the 27.0 to 27.5 GHz is already being used by NBN Coo's two satellites to provide broadband service to rural Australia. In addition, the 24.65 to 25.25 GHz band was recently expanded at World Radio Conference 2012 (WRC-12) to serve as feeder link band for a newly allocated Broadcasting Satellite Service (BSS) band at 21.4 to 22.0 GHz. Satellite operators are only now beginning to deploy in this band in other parts of the world. The loss of the 24.65 to 25.25 GHz feeder link band would make the new BSS

The most optimistic vendors acknowledge that 5G will not be in consumer's hands before 2023-2025

[4] *See* European Commission, *Satellite and Terrestrial Network for 5G* (SaT5G), http://cordis.europa.eu/project/rcn/211060_en.html.

[5] Agenda item 1.13: *Work plan and proposed liaison to Task Group 5/1 on spectrum needs for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz* at the World Radio Conference in 2019 (WRC-19).

allocation difficult to use. Given the actual use of 27.0 to 27.5 GHz today, and the potential use of BSS bands to support content distribution in future 5G networks, the ACMA should exclude these portions of the 24.25 to 27.5 GHz band from consideration as a pioneer IMT band. At the very least, for these band segments, the ACMA should await the outcome of the relevant WRC Agenda Item 1.13 compatibility studies.

The emerging argument of the increased tuning range of terrestrial mobile is purely an argument of convenience which should not be distracting. In addition, the ACMA should not endorse the term 'tuning range' being used as though it were an obvious, 'win-win' solution for all. In fact, we believe that equipment built with a wider range than necessary for its purpose will effectively prohibit the use of other services anywhere in the equipment's entire 'tuning range,' even if part of that 'range' was not meant to be used for that service in that country. Therefore, International harmonisation of the satellite band is a more compelling argument. The proposed minimum IMT identification targets of 24.5 to 27.5 GHz and 37 to 43.5 GHz are noted. Higher frequency bands are also available. The 32 GHz band also appears to be favourable for IMT harmonisation.

Other millimetre wave Bands

Regarding other millimetre wave bands being considered for terrestrial mobile 5G, the SSWG would like to note the following:

1. WRC-19 Agenda Item 1.13 identifies over 31 GHz of millimetre wave spectrum as candidates for 5G spectrum. The focus should be on these bands. There is simply no need to examine bands not included in Agenda Item 1.13. However, developments in these bands are not sufficiently mature for early action by the ACMA prior to WRC-19. Nor is such early action necessary, given the likely ecosystem development, network investment and demand growth timelines for 5G in the millimetre wave bands.
2. The 27.5 to 29.5 GHz band is not included in WRC-19 Agenda Item 1.13 as it is already being used extensively as an uplink band for GEO and MEO satellites, including the latest- and next-generation HTS satellites (such as the NBN Co satellites and the O3b constellation). As a result, early moves by a few countries to identify this band as a pioneer 5G band are unlikely to be followed by the rest of the world. The ACMA has rightly decided not to consider this band for 5G mobile services.
3. The 32 GHz band (31.8 to 33.4 GHz) may be a prospect for international harmonisation, given that it had the support of all three ITU regions at WRC-15 as a 5G candidate band. However, a mobile allocation would need to be added and compatibility with existing services would need to be studied.
4. The Q and V bands (parts of the 37 to 52 GHz band) will likely be contended, given the incorporation of these bands into the next-generation of Very High Throughput Satellites (VHTS). For example, no fewer than six global constellations of VHTS non-geostationary satellites have been announced by companies such as Boeing, O3b, OneWeb, SpaceX and Telesat and Theia. A careful review of the IMT and satellite spectrum requirements will be required to determine whether there is enough spectrum available to accommodate both. Compatibility studies are also underway at the ITU to determine the conditions under which IMT and satellite can share the same spectrum in these bands.
5. The 66 GHz (66 to 76 GHz) and 81 GHz (81 to 86 GHz) bands may also be good prospects of harmonisation because of limited existing and planned uses. About 15 GHz of spectrum in contiguous blocks of at least 5 GHz may be available at these bands, and their propagation characteristics make them suitable for high-density indoor and outdoor 5G deployment scenarios, e.g. in stadiums, campuses, and

shopping malls. There may also be potential synergies with Wi-Gig developments in the 60 to 70 GHz range.

Next steps

The process being proposed by the ACMA going forward appears reasonable and logical except that it is the SSWG's view that the Mobile Broadband Strategy is now becoming dated and questionable in the context of 5G. The time has come for a re-evaluation of the strategy.

The SSWG welcomes the recently released Government's 5G Directions Paper[6] which considers that 5G 'is more than an incremental change for mobile communications' and that it 'provides the underlying architecture that will enable the next wave of productivity and innovation across different sectors of the Australian economy'. It is unfortunate that the Paper omits satellite communications as a part of the 5G ecosystem, nevertheless the SSWG takes up the offer in that the Government 'will work collaboratively with industry to foster an ongoing dialogue on 5G beyond the launch of this paper to identify and remove sectoral barriers to its successful and timely rollout'.

[6] Department of Communications and the Arts Direction Paper: *5G—Enabling the future economy paper*, October 2017. https://www.communications.gov.au/documents/5g-enabling-future-economy

Responses to specific questions

The following table provides responses from our members on the specific questions posed in the *Questions for consultation* Document.

No.	Question	SSWG responses
1	What disposition should the ACMA adopt in progressing possible 5G mmWave bands? 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 bands available very early in a more speculative manner? What are the benefits and risks to each approach?	The ACMA should adopt a proactive approach to the extent of developing and embracing a clear Road Map for wireless broadband (whether delivered by satellite, terrestrial fixed, or terrestrial mobile means) of the way ahead and take into account developing studies and pioneer lessons as they are learned. Truncation of normal spectrum planning processes should be reserved for special cases, and there is nothing here to suggest that special circumstances exist for truncation of the process for the 26 GHz or any other millimetre wave bands under consideration at the ITU. Deliberations on WRC-19 Agenda Item 1.13 are ongoing, with sharing studies between mobile broadband and other services are underway but not yet complete. Equipment and applications for 5G in the 26 GHz or other millimetre wave bands are also fairly nascent, as companies will likely await the outcome of WRC-19 before scaling up production. Thus, there is nothing to suggest that the ACMA cannot complete its normal spectrum planning process in time to match equipment development cycles or to meet consumer demand, once WRC-19 outcomes become clear. At the same time, there are significant risks of moving too fast. Early earmarked spectrum may lie fallow for a long time because of a slow-to-develop 5G ecosystem and/or demand. It could also become costly to replan the spectrum if WRC-19 turns out differently from what the ACMA expected. In the meantime, investments by other radio services in the band will be deterred.
2	When, or under what circumstances, would it be appropriate for potential 5G mmWave bands to progress beyond monitoring in the ACMA's mobile broadband work program?	When markets have developed to the extent that existing mobile bands can no longer support traffic demand in Australia and when there are 'clear signs of a harmonised, widespread ecosystem developing in a band,' which is necessarily a fact-intensive discovery process that should not be pre-empted by pre-conceived notions of the future. As noted above, there are significant risks of moving too fast. Early earmarked spectrum may lie fallow for a long time because of slow-to-develop demand and/or equipment ecosystem. Arguably, the ACMA's decision over a decade ago to embargo the extended C-band was one that was too far ahead of demand, resulting in extended underutilisation of the band by both the embargoed incumbents and the new BWA services.

3	What bands are the most mature in terms of possible early moves on 5G mmWave bands?	It is difficult to conclude that any of the 5G millimetre wave bands are mature enough for 'early moves' prior to WRC-19. The 26 GHz band (24.25 to 27.5 GHz) seems to be gaining support internationally, including in Europe and China, but existing satellite use of 27.0 to 27.5 GHz by NBN Co and future use of 24.65 to 25.25 GHz to feed a new BSS allocation at 21.4 to 22 GHz (WRC-12) should be borne in mind. In a future converged 5G ecosystem, the BSS bands could be used efficiently to multi-cast commonly accessed content to caches located at multiple cell sites. Such multi-casting will be required if terrestrial 5G networks are to meet their ultra-low latency requirements. IMT/FSS sharing studies are underway at the ITU for this band. Thus, any early moves in this band should exclude the NBN Co band and the BSS feeder link band. The 32 GHz band (31.8 to 33.4 GHz) may also be a promising candidate for international harmonisation, given limited incumbency, but requires the addition of a mobile allocation. The 66 GHz band (66 to 76 GHz) and 81 GHz band (81 to 86 GHz) are being trialled in some countries, and are appealing because of limited existing and planned use by other radio services and potential synergy with WiGig systems in the 61 GHz band. These high millimetre wave bands should therefore be able to support the development of 5G mobile networks in high-density indoor and outdoor scenarios, such as stadiums, campuses or shopping malls located in urban and suburban areas. The 28 GHz band (27.5 to 29.5 GHz) is least suited for an 'early move' because of: (i) heavy use of the band for satellite services, including by NBN Co and the latest and next-generation HTS systems; (ii) the exclusion of the band from WRC Agenda Item 1.13; and (iii) ample other candidate bands for 5G under WRC Agenda Item 1.13. Early moves by the U.S. and Korea in this band are misconceived. The Q and V-bands (parts of the 37 to 52 GHz band) are also likely to be contended, as those bands are already being incorporated in the next generation of HTS and VHTS systems. The spectrum requirements of each future service will have to be examined carefully to determine spectrum availability. Sharing studies are also currently underway to determine the conditions under which FSS and MS would be compatible, given the shorter wavelengths of these frequencies.

4	What is the relative priority of investigation of mmWave bands versus other potential mobile broadband bands below 6 GHz?	In the absence of evidence of unmet demand for mobile broadband spectrum it is difficult to assign relative priorities, although it does seem that carriers are more focused on the 3.4 to 3.6 GHz band today rather than on any millimetre wave spectrum.
5	Are there any specific regulatory changes that would be required to facilitate and support satellite services in the context of 5G?	The ACMA should develop a comprehensive and inclusive wireless broadband strategy and think more holistically about communications infrastructure than just the spectrum being demanded for mobile broadband. Australia already recognises that terrestrial infrastructure alone cannot guarantee universal coverage, and that satellites can fill the gap. The ACMA should also recognise that satellites – especially new High-Throughput Satellite (HTS) and Very High Throughput Satellite (VHTS) designs – can also extend terrestrial 5G networks to places they may not otherwise reach, and multi-cast common content to 5G cell sites to enable low-latency delivery to handsets. Because satellites will be a part of the future 5G ecosystem, it should not be treated simply as an incumbent that needs to be accommodated or moved aside. Instead, it should be actively incorporated into the ACMA's spectrum planning processes. In general satellite services tend to favour areas not supported by fixed mobile broadband networks in higher frequency bands. Provided the protection into satellite services is sufficient to support operations and provided the protections required by the mobile broadband systems are not too onerous we believe these services can co-exist. We would note however that there are other services using or proposing to use these bands including High-Altitude Platform Stations (HAPS). It will also be important that whatever licensing method is eventually adopted by the ACMA following strong evidence of market need, that the protection criteria therein are not overly conservative and allow a seamless transition between the operation of different systems.
6	Should the 26 GHz band be accelerated through the initial investigation stage to the preliminary re-planning stage in the ACMA's process for consideration of additional spectrum for MBB services? Why/Why not?	With the imminent release of the 3.6 GHz Band and without any firm evidence beyond the statements of equipment vendors and the desire of carriers to dilute demand for, and thus reduce the cost of spectrum there is at this time no proven market demand for 26 GHz. The ACMA should therefore seek to avoid truncating its normal spectrum planning process. The ACMA's normal process is more likely to allow the ACMA time to be informed by developments at the ITU and in other parts of the world.

		It will also enable the ACMA to avoid the risks of moving too early (as described above).
7	Are there specific issues that may affect the timeframe in which the 26 GHz band could be made available for broadband services?	Yes, specific issues can be summarised as follows: • the lack of definitive evidence that demand exists. • the large amount of bandwidth otherwise available to 5G. • the imminent release of 3.6 GHz. • the potential to develop 5G standards via 3GPP for bands such as the 2 GHz expansion bands, the 800/900 MHz bands and the 1800 MHz band. • the need for services in Australia that support areas beyond the major capitals. • the need to provide seamless systems interoperation which depends on the deployment of viable sharing strategies. Furthermore, the ACMA should await the outcome of IMT/FSS sharing studies at the ITU for this band in order to avoid interference into existing satellite users of the 27.0 to 27.5 GHz band (NBN Co) and to provide certainty for future users of the 24.65 to 25.25 GHz BSS feeder link band. As noted above, this feeder link band is intended to support a new BSS downlink allocation at 21.4 to 22.0 GHz (made at WRC-12). The loss of the feeder link band is likely to lead to difficulties in using the new BSS band because of insufficient other feeder link spectrum. The ACMA has contributed greatly to the study of IMT interference into satellite receivers in space. However, an equally detailed study must be conducted into ground path interference from satellite earth stations into IMT. Existing co-primary satellite earth stations should not be constrained by the deployment of IMT in the band, and the siting of future co-primary earth stations should also not be unduly constrained.
8	Should the 24.25–27 GHz or 24.25–27.5 GHz be made available initially for broadband services?	The ACMA appears to be convoluting 'Fixed Broadband' and 'Mobile Broadband'. Here we will comment on Fixed Broadband which has different technical characteristics and a different market dynamic to Mobile Broadband. The failure of the ACMA's 3.6 GHz process to cater for existing fixed broadband services suggests this is not a good strategy. It harms the industry when a band is made available for one service only to be cleared a few years later when carriers/vendors want another band to roll out new services without the inconvenience of being required to transition in use bands. For mobile broadband services, and with the development of new sharing strategies the 26 GHz band could be made available once these strategies were in place.

		Regarding the upper spectrum boundary, NBN Co is already operating in 27.0 to 27.5 GHz. In addition, the 24.65 to 25.25 GHz band is intended to feed a new BSS allocation made in WRC-12. The loss of the feeder link band is likely to lead to difficulties in using the new BSS band because of insufficient other feeder link spectrum. We would therefore recommend that the ACMA focus on the 24.25 to 24.65 GHz and 25.25 to 27.0 GHz bands for initial investigation, but not as part of any accelerated spectrum release.
9	What licensing approach should be used for broadband in the 26 GHz band?	This depends on the outcomes of sharing studies which in turn will depend on agreed FSS parameters. Area exclusive licensing is probably inappropriate in a 5G composite platform. This is too blunt an approach when sophisticated combinations of services is becoming relevant. We should not get stuck in the rut of spectrum licensing, area re-assignment, and re-location of specific services. This appears to be an ongoing expectation by the ACMA and may be convenient in its ruthless simplicity but it avoids better measures involving co-existence. Spectrum licensing of small defined areas would be appropriate provided the technical frameworks become sophisticated enough to allow a gradual transition from one service to another, i.e. seamless integration. It is important that any licensing approach is adapted to each band and that it affords the necessary flexibility while taking into account the principle of technology neutrality. The design of licences for 5G in this band are influenced by several factors, including the need to ensure that other services in the same and adjacent frequency bands are adequately protected from interference.
10	What geographical areas should be made available for broadband in the 26 GHz band?	The sharing studies related to the potential interference to satellite systems have made important assumptions about the technical characteristics and deployment characteristics of terrestrial 5G systems. Some of the assumptions, such as mobile base station EIRP, antenna pointing, and deployment only in very high population density areas are key to the feasibility of sharing the spectrum. Hence one of the tasks for the 5G licences is to ensure that actually deployed 5G systems are consistent with those study assumptions - failure to do so could lead to harmful interference to, for example, receiving satellites. Licences should therefore be for geographic areas which are very high in population density and should include technical conditions to limit the EIRP in the direction of the geostationary orbit. Licence exemption of terrestrial 5G networks would not be feasible while meeting these requirements.

11	Should any other mmWave bands be accelerated through the initial investigation stage to the preliminary re-planning stage in the ACMA's process for consideration of additional spectrum for MBB services? Why/Why not?	In the absence of any evidence of demand, no millimetre wave bands should be considered for accelerated spectrum planning. Of the sharing studies which have commenced, the most mature point to serious compatibility issues, while the less mature studies are inconclusive. Furthermore, Australia will be undertaking a significant risk in moving too early. Spectrum earmarked for MBB could lie fallow for a long time if demand, equipment and/or investment cycles are not aligned, and there may be significant costs and delay in re-planning if Australia chooses wrongly. The 31.8 to 33.4 GHz band would be a potential target. The Q and V bands need the outcomes of sharing studies and higher bands probably will not get a high priority at this stage. Emphasis should be put on the potential of the '32 GHz' band as a band that is relatively unused and which, therefore, could easily be allocated to the mobile service on a primary basis as it was recognised during the WRC-15 and by CEPT and other regions globally. Even though there is no current international allocation to the mobile service at 32 GHz, it is quite likely that sufficient international agreement could be found at WRC-19 to create an Agenda Item for such an allocation to be officially made before any true 5G services are ready to be deployed. The physical characteristics of this band are nearly identical to the 26 GHz band that will have already been studied, and the 32 GHz band has the enormous advantage of being supported by the satellite industry as a place for the entire, multi-technology '5G ecosystem' to flourish. In addition prioritisation for the 66 to 71 GHz band is also welcomed. The bands around 66 to 86 GHz have very little incumbent use and are a perfect fit for high density indoor use or high density outdoor scenarios like stadiums, campuses or shopping malls. They provide extremely wide bandwidths for terrestrial 5G applications, up to 15 GHz. Deployment of 5G in these bands would benefit from synergies with WiGig, which is being deployed at 61 GHz by various vendors with speeds of up to 4.6 Gbps.
12	Are there specific issues that may affect the time frame in which other mmWave bands could be made available for broadband services?	Yes. WRC-19 will determine which (if any) parts of the 26 GHz or other millimetre wave bands will be designated for IMT-2020/5G and the technical conditions under which such services are to be conducted. At present sharing studies with FSS and HAPS are immature, and sharing studies with passive services point to serious technical difficulties, Planning developments and introduction of new satellite services are also factors, especially considering that FSS operators are seeking new spectrum to replace spectrum from which they have been displaced.

13	Should part or all of any these bands be considered initially for broadband services?	No. Again if a band is 'on the radar' for MBB it should not be released for fixed broadband. If a band is released for fixed broadband it should be quarantined for at least 15 years from replanning. FSS needs should now take a higher priority as 4G/5G has received a considerable amount of attention, and spectrum, over the last two decades usually at the expense of other services.
14	What licensing approach should be used for broadband in other mmWave bands?	Too early to say since it is still unclear which (if any) parts of the other millimetre wave bands will be designated for IMT-2020 by the ITU and the technical conditions under which such services are to be conducted.
15	What geographical areas should be made available for broadband in other mmWave bands?	Too early to say since it is still unclear which (if any) parts of the other millimetre wave bands will be designated for IMT-2020 by the ITU and the technical conditions under which such services are to be conducted.

Attachment 1

Satellite Services Working Group membership

Australian Private Networks (APN)
Coutts Communications
Mississippi Consulting
Foxtel
FreeTV
Inmarsat
Intelsat
Ipstar
Nbn
Omnispace
Optus
Orion Satellite Systems
Pivotel Satellite
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