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AMTA

Australian Mobile Telecommunications Association

AMTA Policy Position Paper

Spectrum for 5G and Beyond

The need for a long-term perspective of Australia's approach to mobile spectrum policy and planning

About AMTA

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 network operators and service providers, handset manufacturers, network equipment suppliers, retail outlets and other suppliers to the industry. For more details about AMTA, see http://www.amta.org.au.

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1. Executive Summary

Spectrum is a finite and scarce national resource that, when efficiently allocated to its Highest Value Use (**HVU**)[1] has the potential to provide enduring economic and social benefits for Australia (as outlined in **Appendix A**).

By 2027, 5G networks will carry 62% of the world's mobile data traffic and cover 75% of the world's population, as 5G cements its position as the world's fastest deployed mobile technology generation to date. [2] To meet forecast demand, as well as the performance expectations of consumers, businesses and industrial applications, sufficient quantum of spectrum must be allocated. Quality and type of spectrum is as important as quantity of spectrum to enable Mobile Network Operators (**MNOs**) to maximise the value of the spectrum and deliver the potential benefits of 5G.

Quality and type of spectrum needed for 5G

Mid-band spectrum[3] is the next immediate priority for allocation to ensure sufficient spectrum is available in a timely manner for the continued enhancement of Australia's 5G mobile networks. AMTA commissioned a study by Coleago[4] of mid-band spectrum needs for Australia (the 'Coleago Australian Report') which found that unless sufficient mid-bands spectrum is allocated, the necessary cell densification required to deliver 5G would be simply uneconomic and unfeasible.

Existing licensed bands must be harmonised and a long-term approach on spectrum planning is needed to provided certainty for continued investment in mobile networks. Planning decisions that result in high levels of fragmentation risk Australia's position at the forefront[5] of global 5G mobile network deployment and undermine the utility of scarce radio spectrum, leading to spectrum not being allocated to its HVU. In turn, this will result in missed economic and social benefits for Australia, foregoing the opportunity for increased growth and jobs.

Quantum of spectrum needed for 5G and beyond

The renewal of expiring spectrum licences will be critical to ensuring continuity of service for end-users of mobile services (see **Appendix B** for existing mobile spectrum holdings).

Additional spectrum must also be identified and considered for allocation for 5G and beyond, to accommodate forecast data traffic growth (see **Appendix A** for references).

Combining the demand studies in the Coleago Australian Report and considering the approach in foreign exemplar markets, AMTA is strongly of the view that the Government should set a target of 8 GHz in total spectrum assignments for IMT by 2030. This target takes into account existing mobile spectrum holdings of MNOs set out in Appendix B.

[1] ACMA, Mobile broadband strategy—The ACMA's spectrum management strategy to address the growth in mobile broadband capacity, February 2016
[2] Ericsson Mobility Report, Nov 2021
[3] 1-7 GHz
[4] IMT Spectrum demand, Estimating the mid-bands spectrum needs in the 2025-2030 time frame in Australia, Coleago Consulting Ltd, 15 November 2021
[5] Australian mobile operators were recently ranked as global 5G leaders by Opensignal in its 5G Global Mobile Network Experience Awards 2021 report, September 2021.

This requires an additional 800 MHz of mid-band and an additional 3.6 GHz of mmWave IMT spectrum by 2030 as shown in Exhibit 1. This target should be actioned by the ACMA.

The optimal outcome is for an MNO operating in Australia to be able to achieve consolidated holdings as set out in the Exhibit 1 below, noting the quanta would vary depending on the number of operators in market and varying business models.

Exhibit 1: Future spectrum requirements for 5G and beyond

Type of spectrum	Quantum (per MNO)	Timeframe	Priority bands
Low-band	80-110 MHz	2028-2030	600 MHz
Mid-band	At least 300 MHz; At least 500 MHz	By 2025 By 2030	3.4 – 4.2 GHz; 4.5/4.8 GHz; Upper 6 GHz
mmWave	2 GHz	By 2030	40 GHz

The need for a long-term policy perspective and plan

Clear guidance on the longer-term perspective of Australia's approach to spectrum policy and planning is required to ensure Government and industry can align their priorities to deliver the best mobile network experience and spectrum outcome for all Australians wherever they reside.

It is critical that the regulatory framework supports the allocation of spectrum to its HVU in a consistent, transparent, flexible and accountable way. Providing industry greater insight into the decision-making process for determining HVU, including analysis of qualitative aspects, will assist MNOs to understand and respond to the Australian Communications and Media Authority's (**ACMA**) consultation processes that drive the decision-making process.

A clear policy statement from the Minister is needed to provide the necessary direction to establish a consistent policy approach to guide the ACMA's decision-making and give effect to the Object of the *Modernisation Act* (**the Act**).[6] Such a direction will ensure the efficient allocation of spectrum to its HVU in order to meet future demand for mobile broadband and establish a strong foundation for Australia to fully realise the economic, productivity and social benefits of 5G.

[6] Radiocommunications Legislation Amendment (Reform and Modernisation) Act 2020

2. Future spectrum requirements for 5G and beyond

2.1 The need for a long-term perspective and plan

While Australia currently compares well internationally in terms of spectrum allocated for International Mobile Telecommunications (IMT), a longer- term plan is essential to meet strong forecast growth for 5G and prepare for future 6G[7] services. Standing still on making additional IMT spectrum available is the risky option.

Spectrum planning is increasingly complex, due to the inherent finiteness of the resource, the pace of technological change and increased competing demands for the resource. While spectral efficiencies are sought and gained as technology develops, there is still a physical limit to the efficiencies that can be realised through further innovations. Importantly, there is no greenfield or vacant IMT spectrum left; re-farming spectrum for IMT or, indeed, any alternative use is a challenging process which can take several years. Successful spectrum re-farming takes long term planning, extensive stakeholder engagement and world class implementation skills over an extended period in order to transition from legacy equipment to the most spectrally efficient technologies. Acknowledging it may not always be possible to clear spectrum for IMT, there is a need for world class engineering to permit coexistence as well as a monitoring and an enforcement regime.

To facilitate the above, Australia has been well served by the excellent five- year spectrum outlook prepared by Australian Communications and Media Authority (**ACMA**) in consultation with industry annually for a number of years.[8] Globally such a spectrum roadmap is viewed as an exemplar approach.

Australia's recent legislative reforms now enable spectrum licences to be allocated for 20 years, however, the requisite investment in innovative networks and related capacity cannot be made without adequate planning certainty over the longer-term.

To provide certainty to enable continued investment in mobile networks, Governments must adopt a long-term policy perspective to plan for spectrum allocations for mobile broadband, including harmonisation of existing licensed bands.

[7] Tentatively timed for 2030
[8] Refer to www.acma.gov.au/five-year-spectrum-outlook

2.2 Type of spectrum required

For 5G to do what it is designed to do and deliver the economic and social benefits, sufficient spectrum allocations at low-, mid- and high-band (i.e., mmWave) are critical.

Low-, mid- and high-band spectrum allocations for 5G are not fully substitutable. Each band has a distinct and complementary role to play. That is:

- Low-band spectrum (sub 1 GHz) is critical for providing a **coverage layer** due to its propagation properties that **enable both wide area and in-building coverage**, even in apartments and basements. Mobile networks deployed using low-band spectrum have overlapping cells so that when one site goes down, for example, due to loss of power or backhaul, the adjacent cells will provide some redundancy of coverage. This is most important given Australia's geography and the need to provide coverage and resilience of networks during natural disasters and other emergencies. Importantly usable low-band spectrum is the scarcest spectrum resource. The GSMA notes that low-band spectrum is important for bridging the digital divide between urban and regional areas by creating greater equality of broadband connectivity.[9]

- Mid-band spectrum (1-7 GHz) is the 'heavy-lifter' of 5G and is needed to **deliver eMBB** (enhanced mobile broadband) and fixed wireless access (FWA) which provides the substantially **faster data speeds** as well as **greater capacity** required in urban, **densely populated areas**. Mid-band spectrum provides balanced coverage and capacity that is critical to accommodating a wide variety of 5G use cases. [10] Importantly, adequate quantity of mid-band spectrum is needed to achieve 5G standard speeds for download and upload, while also reducing carbon footprint and deployment costs due to fewer base stations being required.[11]

- High-band spectrum (24-100 GHz) provides very high throughput over shorter distances. It enables[12] greatly **enhanced connectivity** through **lower latency, high capacity and faster speeds.** The use of this spectrum has the potential to transform industries including healthcare, education and industrial automation by enabling ultra-reliable low latency communications (URLLC) **for mission critical applications.**

Mid-band spectrum is the next immediate priority for allocation to ensure sufficient spectrum is available in a timely manner for the continued enhancement of Australia's 5G mobile networks. Beyond these immediate allocations, Australia must start planning now for mobile spectrum requirements into the next decade and beyond to ensure we are able to meet growing forecast demand and retain and build on our 5G leadership as the new measure of global competitiveness.

[9] GSMA 5G Spectrum GSMA Public Policy Position March 2021
[10] GSMA Vision 2030, Insights for mid-band spectrum needs, July 2021
[11] Ibid
[12] GSMA mmWave 5G success sets the stage for big benefits , Oct 2019

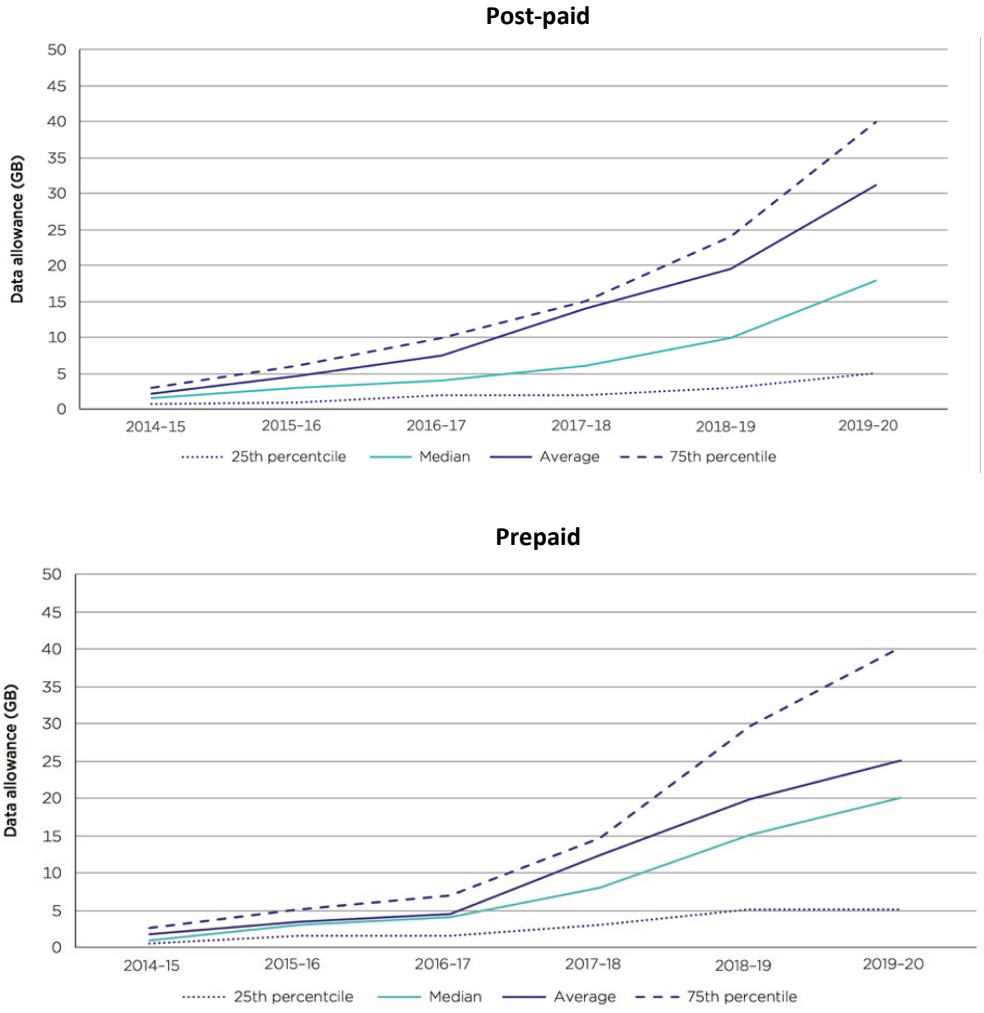
The successful 2021 mmWave auction secured additional spectrum assignments for MNOs in the deployment of 5G networks, noting that mmWave spectrum has characteristics that enable certain applications of 5G technology such as increased data speed per user through a combination of a larger quantum of spectrum (hundreds rather than tens of MHz) and the shorter propagation distances allow higher cell-to-user ratios. The combination of mid - and high- band spectrum will also facilitate mobile operators offering increasingly competitive high speed 5G FWA offerings comparable, if not superior to fixed network services.

The auction of 850/900 MHz low band spectrum in late 2021 will also provide much needed spectrum for coverage, particularly in regional areas of Australia.

2.3 Drivers of the quantum of IMT spectrum demand

History shows that forecast demand for mobile services and the requisite spectrum to meet that demand has repeatedly been underestimated with each generation of mobile technology. For example, increased data usage per user upon year is detailed by the ACCC in its annual Communications Report (see Exhibit 2 below). Such demand in turn drives IMT spectrum demand, as well as substantial investment in network infrastructure by the mobile operators.

Exhibit 2: **Average, median, 25th percentile and 75th percentile data allowance for post-paid and prepaid mobile phone services from 2014–15 to 2019–20:**



Source: ACCC, *Communications Market Report 2019–20*, page 36

New 5G home broadband offerings from mobile operators, with monthly limits of up to 1 TB[13] will further drive average usage per user especially based on European data that data-only SIMs can have up to 10 times the average SIM card wireless data usage.[14] Already, traffic from data- only SIM devices represents more than 20 percent of total mobile data traffic of one Australian mobile operator.[15]

[13] Refer to https://exchange.telstra.com.au/ridiculously-fast-5g-home-business-internet-is-here/
[14] tefficent, Mobile data usage got a boost when we were immobile, Industry Analysis #2, 2021, 13 July 2021, page 10
[15] Ibid

There are three significant drivers of demand arising from the COVID-19 pandemic which translate into increasing IMT spectrum demand which are also worth highlighting. These are:

The digital transformation of industries

It has often been observed that the COVID-19 pandemic has been a catalyst to seismic shifts in social media group interaction, online streaming of content and distribution, learning and online commerce, amongst other things. The pandemic has also resulted in profound regulatory changes in Australia. Such changes allow online banking and financial transactions,[16] court hearings, telehealth, pharmaceutical dispensation, and similar. The 2020/2021 period was an extraordinary time – change that would normally take decades has happened in weeks as activities that could go online across the country, did. The changes may be rapid, but the extent to which they will prove to be permanent is unknown – although for many sectors of the economy the new normal is now in place.

Increased subscription and BVOD television streaming in Australia

During the COVID-19 pandemic there was a massive increase in the number of Australians who subscribed to and watched subscription video on demand (SVOD). Australia had 19.4 million streaming subscriptions at the end of Q3, 2021, representing a household penetration of 60 per cent based on an average number of 3.5 streaming services per household.[17] In addition there was substantial growth in catch-up, also known as broadcast video on demand (BVOD), television, with Roy Morgan estimating that 8.6 million Australians now watch BVOD services which include ABC iView, SBS On Demand, 7plus, 9Now and 10 Play.[18] Such estimates do not include streaming viewership on YouTube and similar services.

Such estimates are confirmed by the recent ACMA report which noted that the 2019–20 year saw a growing preference to watch video content on demand rather than in linear form.[19] The uptake of online SVOD and BVOD continued to accelerate, while the viewership of live FTA television declined. Some three-quarters of Australians now live in households with at least one SVOD service, with approximately half of all households having access to 2 or more subscription services.

While the watching of streaming services was initially delivered over fixed networks in Australia, an increasingly large proportion of such watching is happening over mobile networks and is delivered on small screens – namely those of smartphones and connected tablets. Such access is preferred by a younger demographic.

The move to suburban and regional Australia arising from working from home (WFH)

The COVID-19 pandemic forced up to 40 percent of Australian workers to experiment with working from home. [20] While the lockdown orders that forced this sudden social change have been lifted across Australia, the level of WFH is likely to remain much higher than it was before the pandemic. A September 2021 research paper from the Productivity Commission entitled *Working from Home*[21] considers that many firms are likely to experiment with the hybrid model, where workers spend two to three days a week in the office and two to three days working from

[16] For example, temporary amendments to the law on digital signatures. See www.nortonrosefulbright.com/en-au/knowledge/publications/0c4f149c/out-of-the-dark-ages-for- now
[17] This is according to research from Media Partners Asia's research platform, AMPD. Refer to www.afr.com/companies/media-and-marketing/disney-beating-out-amazon-prime-thanks-to-vast-content-library-20211102-p59561.
[18] Refer to www.roymorgan.com/findings/8607-broadcaster-video-on-demand-services-september-2020-202101282247
[19] ACMA, Communications and media in Australia, Supply and use of services, 2019–20, April 2021
[20] Refer to www.pc.gov.au/research/completed/working-from-home/working-from-home.pdf
[21] Ibid

home.[22] If all workers who could work from home did so two days per week, around 13 percent of all hours worked across the economy would be remote.

Concurrently, there has been a move to suburban and regional Australia from CBDs which is putting pressure on mobile and fixed telecommunications networks in such regions. 5G mobile broadband is an excellent technology to address such demand. This is best summarised in Exhibit 3 which summarises the recent Infrastructure Australia report entitled '*Reforms to meet Australia's future infrastructure needs'*

Exhibit 3: Summary of Infrastructure Australia Report

In August 2021, Infrastructure Australia released an expansive report, '***Reforms to meet Australia's future infrastructure needs'***, to drive infrastructure reforms through a practical and actionable roadmap. In terms of Australia's telecommunications, the report envisions a fully connected Australia that offers resilient, superfast, equitable and wide coverage to everyone by 2036. To achieve this, the report has highlighted the following underlying issues within Australia that call for a digital reform:

- ***COVID-19 response.*** The COVID-19 pandemic marked a new era in many Australians' relationship with technology, introducing a growing reliance on digital services as well as an unprecedented shift to digital channels for interaction.
- ***Digital inclusion.*** There is still a digital divide which exists in Australia, at a time where access to digital services is essential for full participation in society, employment prospects and preserving mental health.
- ***Regional Australia.*** It is crucial to find a sustainable model for ongoing investment in networks and assets for regional Australia to provide coverage to growing communities, especially given the growing importance of telecommunications and vast expanse of land involved.
- ***Enabling the future.*** The Australian Government needs to improve alignment across the industry, open a public dialogue about the growing need for technology, and tackle the misinformation that risks the acceptance of emerging technologies such as 5G, smart cities and the IoT.

Altogether, there is a strong need to fully realise economic benefits of emerging technologies by better enabling 5G through regulation, investment, and coordination.[23]

Migration to regional Australia

Due to the pandemic, the impact of large-scale remote working has led to a surge in usage, with demand being redistributed from central business districts to suburban and regional areas.[24] Many regional sites that cover low-density areas are simply not commercially viable and require partnerships and subsidies to bring a new site online. It is vital to connect regional Australians by improving the coverage, quality and reliability of telecommunications, through continued government investment in infrastructure outcomes.[25]

Making spectrum flexible and affordable

The Report recommended facilitation of the introduction of 5G to regional areas by giving flexibility to operators to utilise any low-band spectrum to roll out 5G coverage in regional Australia.[26] Overall, a lack of easy, timely access to affordable spectrum will limit how much the telecommunications sector can expand network capacity to accommodate Australia's growing data demand.

[22] Such an approach is supported by many of Australia's largest corporates – see www.smh.com.au/business/companies/the-five-day-office-week-is-dead-long-live-the-hybrid-model-says-productivity-boss-20210706-p587d4.html
[23] Infrastructure Australia, Reforms to meet Australia's future infrastructure needs (Australia Government, August 2021), page 32-33.
[24] Infrastructure Australia, Infrastructure beyond COVID-19 – A national study on the impacts of the pandemic on Australia – An Interim Report for the 2021 Australian Infrastructure Plan (Australian Government, December 2020).
[25] Infrastructure Australia, op cit, August 2021, page 97.
[26] Ibid, page 99.

2.4 Estimating the additional IMT spectrum needed

In AMTA's view, the renewal of existing spectrum holdings will be critical to ensuring continuity of service for end-users of mobile services (see **Appendix B** for existing IMT spectrum holdings). Additional spectrum must also be identified and considered for allocation for 5G and beyond, to accommodate the forecast traffic growth (see **Appendix A** for references). To compute the IMT spectrum which the industry and mobile operators need going forward we have undertaken a bottom-up study on the need in Australian cities focusing on mid-band spectrum and utilising the same methodology used by the GMSA in its acclaimed mid-band spectrum needs report (see Exhibit 4 below). The analysis, focusing on Sydney, Melbourne and Brisbane, found that up to an additional 827 MHz in mid-band spectrum was needed in the 2025-2030 timeframe.

Exhibit 4: 'Estimating the Mid-Band Spectrum Needs in the 2025-2030 Timeframe' report by Coleago Consulting Ltd for the GSMA (July 2021)

Coleago Consulting's study examined mid-band spectrum requirements for the 5G spectrum rollout. Mid-band spectrum offers a good mixture of coverage and capacity and hence access to an increasing amount of mid-band spectrum is key to the 5G era.

Coleago and the GSMA found that particularly in high-density areas, more IMT spectrum is needed to deliver a user experience of 100 Mbit/s in downlink and 50 Mbit/s in the uplink. Their modelling found that substantial amounts of mid-band spectrum are required to deliver this quality of 5G service in cities with a population density of more than 8000 people per km2. Densely populated cities need, on average, a total of 2 GHz of mid-band spectrum. Precise spectrum demands vary depending on population density, fibre availability and other factors.

Total mid-band spectrum needs in the 2025-2030 timeframe

	Minimum Estimate	Maximum Estimate
High income cities	**1,260 MHz**	**3,690 MHz**
Upper middle income cities	**1,020 MHz**	**2,870 MHZ**
Lower middle income cities	**1,320 MHz**	**3,260 MHz**

Source: GSMA, July 2021

The study notes that small cell densification is not an economically feasible substitute for additional mid band spectrum. Significantly increasing outdoor small cells would increase power consumption, be very costly, and have a negative impact on the city environment from an aesthetics point of view. Additional base stations would generate a carbon footprint 1.8-2.9x higher without sufficient spectrum.

The study also explored whether mmWave could be a substitute to additional mid band spectrum. Coleago Consulting found that mmWave densification approach would not represent a viable option, being very costly and undesirable from an environmental perspective due to the large number of sites.

In areas with a population density below 8,000 per km^2, additional spectrum would also deliver benefits including lower site density and higher speeds, and the ability to deliver fibre-like 5G FWA to small towns.

In conclusion, the GSMA recommends that governments and regulators:

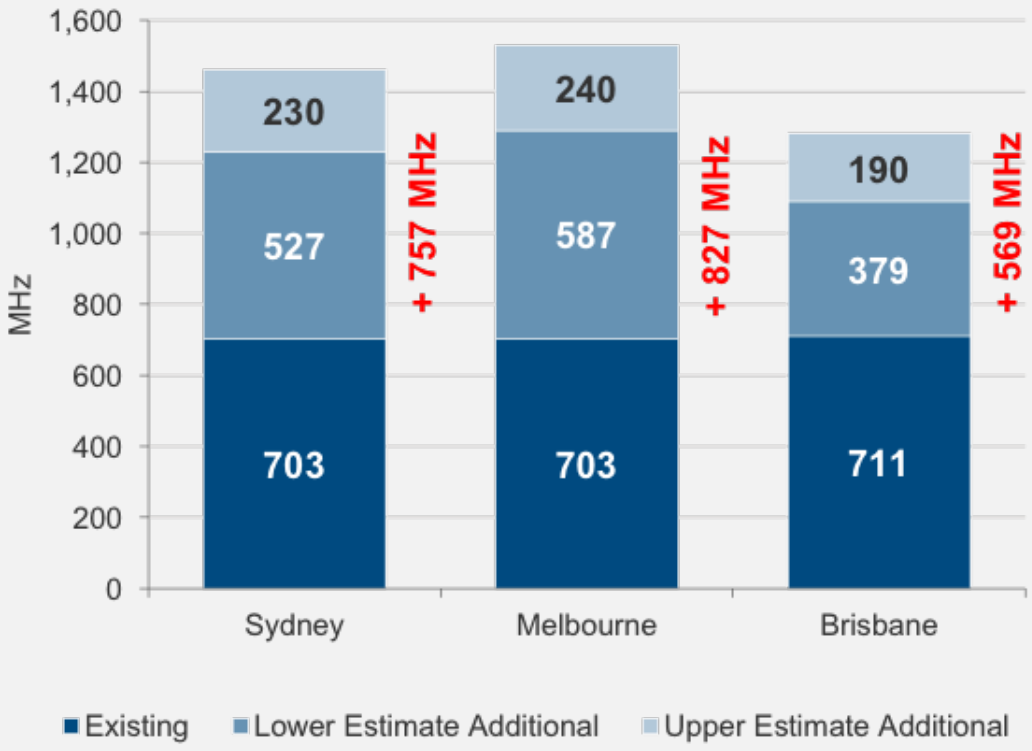
- plan to make 2 GHz of mid-band spectrum available in the 2025-2030 time frame. This is the average value needed to guarantee the IMT-2020 requirements for 5G;
- carefully consider 5G spectrum demands when 5G usage will be reaching its peak, and advanced use cases will carry additional needs;
- base spectrum decisions on real-world factors including population density and extent of fibre rollout; and
- support harmonised mid-band 5G spectrum (e.g. within the 3.5 GHz, 48 GHz and 6 GHz ranges) and facilitate technology upgrades in existing bands.

Exhibit 4 continued

As the GSMA/Coleago Study July 2021 did not include Australia, AMTA engaged Coleago Consulting to re-run its projections on the mid-band spectrum need in Australia's largest and most population dense cities. Coleago carried out a population density analysis of Sydney, Melbourne and Brisbane[27] (the 'Coleago Australian Report') all of which have a sizeable densely populated area. Compared to the cities analysed in the Global report, population densities in those three cities are at the lower end of the scale, but still sufficiently high to require significant amounts of mid-band spectrum beyond that which is currently available.

The Coleago Australian analysis shows that in Sydney there is a need for 1,230 to 1,440 MHz of mid-band spectrum compared to 703 MHz currently assigned to operators. Therefore, to deliver the city-wide 5G user experience in an economically and technically feasible manner in the 2025-2030 timeframe, an additional 527 to 757 MHz of mid-bands spectrum is required. For Melbourne an additional 587 to 827 MHz is needed and for Brisbane it is an additional 379 to 569 MHz. This is summarised in the Exhibit below.

Mid-band spectrum needs in Australian cities



Source: Coleago, Estimating the mid-band spectrum needs in the 2025-30 time frame in Australia, November 2021

Secondly, AMTA has benchmarked key exemplar foreign markets in terms of their IMT spectrum targets and policies. Those exemplar markets had overall IMT release goals set by Government and/or are working on new targets given the importance of IMT spectrum to the growth of the digital economy. These are summarised in Exhibit 5 below.

[27] IMT Spectrum demand, Estimating the mid-bands spectrum needs in the 2025-2030 time frame in Australia, Coleago Consulting Ltd, 15 November 2021

Exhibit 5: Selected foreign country IMT spectrum targets and planned releases

Country	Future spectrum plans	Comments
China	Plan for 100 MHz per MNO in low and mid-spectrum in 2025 rising to 500 MHz per MNO in 2030. Given 4 major MNOs in China, this equates to 2 GHz in total mid-band spectrum.[28]	Target is driven by average usage is forecast to be 250 GB per user per month in 2030.
European Union	In November 2016 the Radio Spectrum Policy Group (RSPG), a strategic roadmap Opinion on spectrum related aspects for next-generation wireless systems (5G) for 5G was first published.[29] The work in 2016 through 2020 focused on identifying the building blocks needed for a rapid launch of new wireless services in the next generation wireless systems:, namely the 3.4-3.8 GHz band, as the first primary band for 5G, 26 GHz (24.25-27.5 GHz) as the primary mmWave band, and then 700 MHz as the 5G primary coverage band.	RSPG survey EU25 of Additional Spectrum and Harmonisation Needs published in February 2021 found interest for further spectrum and harmonization needs is concentrated primarily around upper mid bands and possibly on low bands.[30] Commercialisation has also started in existing lower mid bands, like 1.8, 2.1 2.6 GHz, while some interest has been expressed for the 2.3 GHz band.
Japan	In accordance with the *Frequency Reorganization Objectives* (August 2018), the target was to have released 4 GHz of spectrum by the end of 2020. This was an increase from 1,320 MHz (including 420 MHz of WLAN spectrum in 2018). Of the target 2,500 MHz was for MNOs including the 2.3, 2.6, 3.7, 4.5 and 28 GHz bands and 150 MHz additional WLAN spectrum.[31] The MIC has set a spectrum target of 16 GHz for 5G, HAPs etc for 2025.	It should be noted that Japan has already released 500 MHz of C-Band spectrum (3.7-4.1 GHz) for 5G plus 100 MHz of 4.7 GHz for 5G (plus another 300 MHz of 4.7 GHz spectrum band for local enterprise use).[32]
Saudi Arabia	CICT is planning to make available, or improve access to more than 23 GHz of spectrum for a wide range of uses, of which: • Almost 4 GHz will be licensed; • 6.2 GHz will be license-exempt; and • More than 13 GHz will be lightly licensed. For Mobile IMT, a summary of spectrum release plans by 2023 on total of existing assignments: • Low band (below 1 GHz): 116 MHz • Mid band (1-10 GHz): around 350 MHz; • High band (above 10 GHz): 3.25 GHz[33]	CITC plan to make available licensed spectrum in the bands 600 MHz, 700 MHz, 1500 MHz, extended 2100 MHz, 3800 – 4000 MHz and 26 GHz for mobile use between 2021 and 2023. In addition, MNOs can benefit from various other forms of access to bands at 4000 – 4200 MHz, 6 GHz, 28 GHz, 70 GHz and 80 GHz.

[28] Zeng Fansheng, Bureau of Radio Regulation, MIIT, *Consideration of 5G Spectrum Planning & Future Development in China*, 7th Annual Asia-Pacific Spectrum Management Conference, May 2021
[29] Refer to https://rspg-spectrum.eu/wp-content/uploads/2013/05/RSPG19-007final-3rd_opinion_on_5G.pdf
[30] Refer to https://rspg-spectrum.eu/wp-content/uploads/2021/02/RSPG21-008final_Draft_RSPG_Opinion_on_Additional_Spectrum_Needs.pdf
[31] Refer to www.soumu.go.jp/main_sosiki/joho_tsusin/eng/presentation/pdf/20200513Frequency_Reorganization_Action_Plan.pdf
[32] Refer to https://www.soumu.go.jp/main_content/000613734.pdf
[33] Refer to www.citc.gov.sa/en/mediacenter/pressreleases/PublishingImages/Pages/2021033001/Spectrum%20Outlook%20for%20Commercial%20and%20Innovative%20Use%202021-2023.pdf

Country	Future spectrum plans	Comments
South Korea	In November 2019, MSIT launched its "5G+spectrum plan" which aimed to "secure the world's largest 5G spectrum supply" by assigning a total of 5,320 MHz spectrum by 2026 includes plans for licensed, unlicensed, and local 5G spectrum. [34] This includes assigning 320MHz in the 3.4–3.42 GHz and 3.7–4GHz ranges by 2021, thus making available 600 MHz of contiguous spectrum in the mid-bands.	South Korea is currently in the process of allocating the 4.7 GHz spectrum band.
United Kingdom	Ofcom released "Supporting the UK's wireless future: Our spectrum management strategy for the 2020s" in July 2021.[35] Areas of increased focus for the next decade are 1. Supporting wireless innovation; 2. Licensing to fit local and national services; and 3. Promoting spectrum sharing.	Strategic spectrum roadmap including for mobile and 5G will be released for comment in Q3, 2021/22 and to be published Q4, 2021/22. This work will also inform Ofcom's approach to WRC-23.[36]
United States	In addition to making available additional unlicensed spectrum, the FCC is acting to improve use of low-band spectrum (useful for wider coverage) for 5G services, with targeted changes to the 600, 800 and 900 MHz bands. As mid-band spectrum has become a target for 5G buildout given its balanced coverage and capacity characteristics, the FCC is making more than 600 MHz available in the 2.5, 3.5 and 3.7-4.2 GHz bands. The FCC has made available almost 5 GHz of mmWave spectrum in the 24, 28, upper 37, 39 and 47 GHz band, and its working to free up 2.75 GHz of 5G spectrum in the 26 and 42 GHz bands plus use in the 70/80/90 GHz bands.[37]	While, currently in the transition to the new FCC Chair, FCC Commissioners have recently called for more mid-band spectrum to be made available. The 3.45-3.55 GHz band auction is currently taking place. There are other spectrum bands which will also be auctioned.

Source: WPC analysis of industry sources, November 2021

To enable Australia to take advantage of economies of scale from global suppliers and reduce the need for bespoke equipment and devices for the Australian market, alignment with internationally harmonised spectrum bands is crucial to avoid unnecessary cost increases borne by consumers. This includes alignment with spectrum allocations determined by the World Radio Conference (WRC) and adopted in other markets.

[34] Refer to https://openknowledge.worldbank.org/bitstream/handle/10986/35780/Entering-the-5G-Era-Lessons-from-Korea.pdf
[35] Refer to www.ofcom.org.uk/__data/assets/pdf_file/0017/222173/spectrum-strategy-statement.pdf
[36] Refer to page 40 of www.ofcom.org.uk/__data/assets/pdf_file/0019/216640/statement-plan-of-work-202122.pdf
[37] Refer to www.fcc.gov/5G

Combining the demand studies in the Coleago Australian Report and considering the approach in foreign exemplar markets, AMTA is strongly of the view that the Government should set a target of 8 GHz in total spectrum assignments for IMT by 2030. This target takes into account existing mobile spectrum holdings of MNOs set out in Appendix B.

This requires an additional 800 MHz of mid-band and an additional 3.6 GHz of mmWave IMT spectrum by 2030 as shown in Exhibit 1. This target should be actioned by the ACMA.

The optimal outcome is for an MNO operating in Australia to be able to achieve consolidated IMT spectrum holdings as set out in Exhibit 6 below, noting that these quanta would vary depending on the number of operators in market and varying business models.

Exhibit 6: Future spectrum requirements for 5G and beyond

Type of spectrum	Quantum (per MNO)	Timeframe	Priority bands
Low-band	80-110 MHz	2028-2030	600 MHz
Mid-band	At least 300 MHz; At least 500 MHz	By 2025 By 2030	3.4 – 4.2 GHz; 4.5/4.8 GHz; Upper 6 GHz
mmWave	2 GHz	By 2030	40 GHz

2.5 Rewarding spectral efficiency

AMTA's request that Government makes available additional IMT spectrum is framed and supported by the industry's continual substantial investment in new technologies. Such technologies substantially improve consumer utility as well as have greater spectral efficiency.

The Australian mobile industry is a very efficient user of IMT spectrum. Larger contiguous blocks of spectrum are needed by mobile operators to deploy compelling 5G NR services and future mobile technologies. For example, 5G has a greater spectral efficiency[38] than 4G/LTE resulting in a higher capacity per unit of spectrum (Hz) as shown in Exhibit 7 below.

Exhibit 7: Improvements in spectral efficiency with new 5G technology

		Average Spectral Efficiency (bps/Hz)		% Increase
Spectrum	**Antennas**	**LTE**	**5G**	
Low band	4x2 MIMO	2.1	2.5	19%
Mid band	4x4 MIMO	2.5	3.8	52%
mmWave	mMIMO	N/A	7[1]	N/A

[1] mmWave sites assumed to have ~10% of coverage compared to low/mid band

Source: T-Mobile (US) submission to FCC, October 2018. Average Spectral Efficiency is used to represent what a "typical" network cell will operate under an average network traffic loading

Since the introduction of mobile cellular technology in Australia, the industry has continually invested in and upgraded the technologies which it has deployed. Thus, the Australian mobile industry switched off 1G (AMPS) in September 2000, 2G (both CDMA in April 2008 and GSM in the period December 2016- June 2018), and 3G switch-off has already announced by Telstra for June 2024. Concurrently, the Australian mobile industry is investing in 4G and 5G services and is well-positioned for 6G[39] services. In all cases the industry has re-farmed its spectrum assignment for use with newer technologies including W-CDMA (3G) in 900 MHz, world leading moves to deploy 4G/LTE in the 1800 MHz band and recent re-farming of the 700 MHz band for 5G (see Exhibit 8 below).

[38] This is the metric used by the industry to compare different radio technologies and is usually measured in bps/Hz.
[39] Tentatively timed for 2030

Exhibit 8: Current usage of IMT spectrum by technology in Australia highlighting re-farming

MNO	700 MHz	850 MHz	900 MHz	1.8 GHz	2.1 GHz	2.3 GHz	2.6 GHz	3.5 GHz	26 GHz
Optus	4G/5G(1)	-	3G/5G(2)	4G	3G/4G/5G (3)	4G/5G	4G	5G	5G
Telstra	4G/5G	3G/5G(4)	4G	4G(5)	4G	4G	4G/5G	5G	5G
TPG	4G/5G	4G	3G	4G(5)	4G	-	-	5G	5G

Source: Optus December 2020, updated by WPC, October 2021 from public sources;

Note: (1) Optus is trialling DSS (2) and plans to use 900 MHz for 5G post 850/900 MHz auction (3) 3G will be switched off in the Optus 2100 MHz band from April 2022 and then it used for 4G and 5G (4) Telstra has announced it will switch off all 3G services in Australia from mid-2024 (5) The 1800 MHz band will be used for 5G DSS after the spectrum restack between Telstra and TPG announced on 6 July 2021

In contrast, AMTA contends that other actual or potential users of spectrum which could otherwise be used for IMT purposes namely terrestrial broadcasters (e.g. UHF band), and Wi-Fi (e.g. 5/6 GHz band), have historically not made significant ongoing investments to best transition to future technologies.[40] Nor have they taken the hard decisions to discontinue supporting older legacy technologies and migrate customers to newer more spectrally efficient technologies.

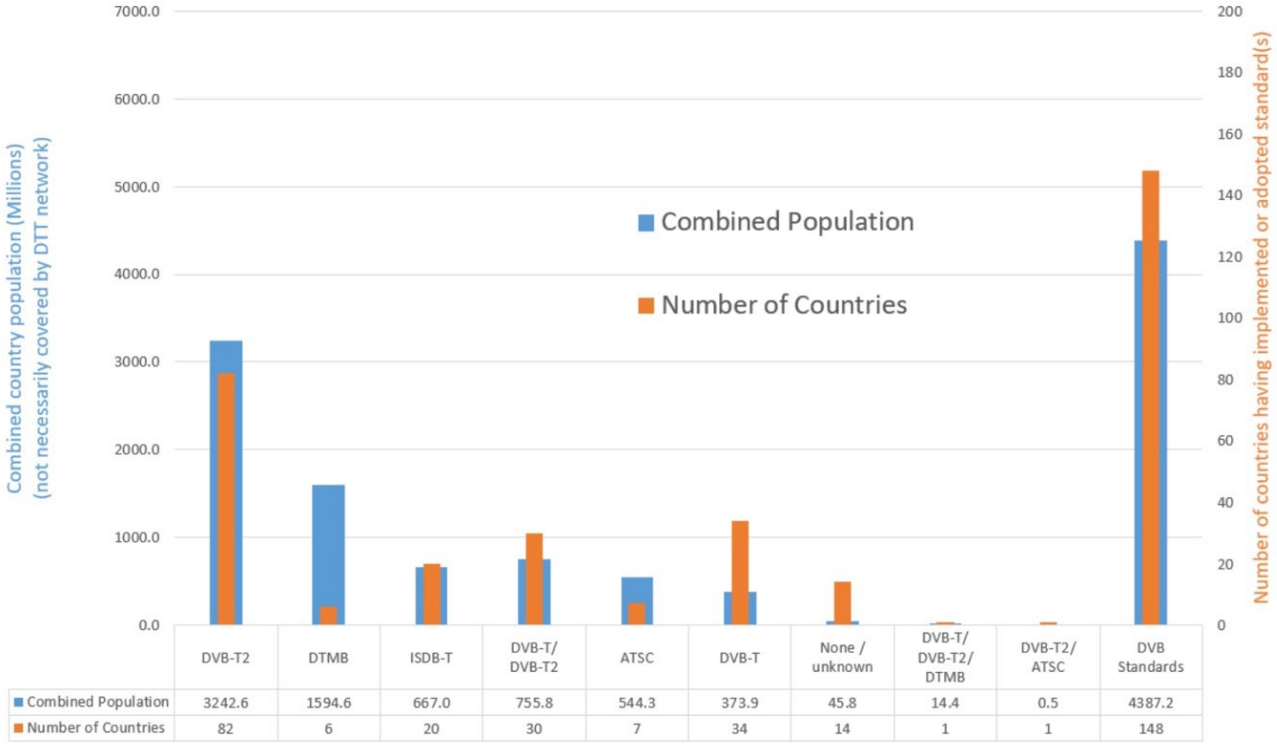
For example:

Terrestrial broadcasting: As evidenced in the debate following the release of the Australian Government's Media Reform Green Paper: Modernising television regulation in Australia,[41] in November 2020, there still seems to a debate about how and when Australia should move to DVT-T2/HEVC from legacy DVB-T technology which was introduced over 20 years ago in 2000. It should be highlighted that globally, as at April 2021, the population of countries using only DVB-T technology represented less than 8.5 percent of the total global population using DVB technology while almost 75 percent used only DVB-T2 technology (see Exhibit 9 below).

[40] Recently the satellite industry has – with small satellites, high-throughput satellites, satellites with all-electric propulsion and low-Earth orbiting (LEO) satellites - adopted game-changing innovations enabling a range of solutions including enhanced imagery and data from orbit.

[41] Refer to www.infrastructure.gov.au/have-your-say/new-rules-new-media-landscape-modernising-television-regulation-australia

Exhibit 9: DTT Standards implemented and adopted globally



	DVB-T2	DTMB	ISDB-T	DVB-T/ DVB-T2	ATSC	DVB-T	None / unknown	DVB-T/ DVB-T2/ DTMB	DVB-T2/ ATSC	DVB Standards
Combined Population	3242.6	1594.6	667.0	755.8	544.3	373.9	45.8	14.4	0.5	4387.2
Number of Countries	82	6	20	30	7	34	14	1	1	148

Source: DVB, April 2021. Number of countries having adopted or implemented a given DTT system (orange) and the combined population of those countries (blue). (Source: DVB/EBU/BNE DTT Deployment Database, April 2021)[42]

The continued use of DVB-T especially with less efficient MPEG-2 technology is akin to continuing to use legacy 2G cellular technology, when the mobile industry is powering to 5G technology. As terrestrial broadcasting's market share falls and is replaced by digital video content delivered over fixed and mobile cellular networks, it ought to be encouraged to be a more efficient user of the valuable UHF spectrum which it occupies.[43] Furthermore, the broadcasting sector should adopt infrastructure sharing (i.e. in relation to multiplexors) similar to sharing approaches adopted in the telecommunications sector. AMTA sees a role for Government to facilitate an expedited transition of legacy broadcast to technology to newer generation equipment, including the transition of consumer devices.

Wi-Fi: Currently according to the ACMA[44] up to 630 MHz of 2.4 and 5 GHz spectrum bands made available for Wi-Fi services in Australia. These are subject to conditions of *Radiocommunications (Low Interference Potential Devices) (LIPD) Class Licence 2015*.[45]

While AMTA supports easing certain technical restrictions on the use of the 5 GHz band and making some additional spectrum (i.e. 500 MHz) available[46] for Wi-Fi 6e,[47] it is important to highlight that generally the Wi-Fi standard and devices are not spectrally efficient. Part of the

[42] Available at https://dvb.org/solutions/dtt-deployment-data/
[43] Refer to AMTA's Submission to the Media Reform Green Paper, May 2021. Available at www.infrastructure.gov.au/sites/default/files/documents/mrgp-australian-mobile-telecommunications-association.pdf
[44] ACMA, Exploring RLAN use in the 5 GHz and 6 GHz bands: Discussion and options paper, April 2021, page 6
[45] Refer to https://www.legislation.gov.au/Details/F2016C00432
[46] See the discussion for an additional 500 MHz in the 6 GHz band in the recent ACMA paper entitled Proposed updates to the LIPD Class Licence for 6 GHz RLANs: Consultation paper, October 2021. Available at www.acma.gov.au/consultations/2021-10/radio-local-area-networks-rlans-6-ghz-band-consultation-372021
[47] Refer to https://au.pcmag.com/networking/84969/what-is-wi-fi-6e

reason for this is they always provide backward compatibility[48] and do not adopt difficult and complex transition paths. It is contended that the lack of spectral efficiency may underpin requests for the 1,200 MHz of the 6 GHz band to be made available for Wi-Fi services rather than being partitioned between Wi-Fi and IMT services.

Importantly, the total allocation of mid-band spectrum to LIPD/Wi-Fi services was comparable to the entire allocation of IMT spectrum to mobile operators (i.e. 630 MHz versus 668 MHz) prior to the assignment of the 3.6 GHz and mmWave band. Following the allocation of an additional 500 MHz in the lower 6 GHz band to LIPD/Wi-Fi uses, the total amount of spectrum of allocated to such services (a total of up to 1,130 MHz) will greater exceed the total amount of IMT spectrum allocated to all Australian mobile operators including the 3.6 GHz band licences.[49] There are therefore strong arguments – based on an approach where spectrum is enabled to move to its highest value use[50] – for the allocation of additional mid-band IMT spectrum like the 6 GHz band to support the continued development of the Australian digital economy (see Exhibit 10 below).

[48] While such compatibility can be switched off during configuration this is not generally done by the network manager. Even when full backward compatibility is switched off, compatibility is usually allowed back to WI-FI 4 (802.11n) which was introduced in 2009 or 802.11g (from 2003). Refer to www.techtarget.com/searchnetworking/answer/Is-Wi-Fi-6-backward-compatible-Yes-and-no

[49] mmWave spectrum has excluded from this comparison.

[50] ACMA, Mobile broadband strategy—The ACMA's spectrum management strategy to address the growth in mobile broadband capacity, February 2016

Exhibit 10: Windsor Place Consulting: The compelling case for 6 GHz band partitioning in Asia-Pacific

The Windsor Place Consulting report, *Optimising IMT and Wi-Fi mid-band spectrum allocations: The compelling case for 6 GHz band partitioning in Asia-Pacific*, was published in October 2021.

The report contends that it is critical for Asia-Pacific to examine its approaches to mid-band spectrum for 5G and its evolutions, especially for the 6 GHz band. It is important that such approaches are bespoke; customized for the region today and its future. The report makes the argument that the 6 GHz spectrum band represents the largest remaining single block of spectrum which could be allocated for mobile services in the mid-band. While Asia-Pacific ought to be informed by the approaches in North America and Europe to the 6 GHz band, the unique characteristics of the region including the legacy allocations of spectrum in ITU Region 3, necessitate the early partitioning of the 6 GHz band between IMT and Wi-Fi uses.

The report makes a compelling case for policy makers, regulators, and mobile network operators (MNOs) in Asia-Pacific to allocate only the lower part of the 6 GHz band (5925-6425 MHz) for unlicensed use for low power devices with the upper part of the band (6425-7125 MHz) allocated to IMT services as soon as practicable, subject to addressing the possible interference/co-existence issues in relation to existing 6 GHz services, namely FSS and FS services.

Crucially such an approach preserves future flexibility as any assignment of the 6 GHz band to unlicensed use is not a decision that can be reversed, unlike the assignment of the 6 GHz band to licensed uses. Importantly, a decision to allocate the upper part of the band (6425-7125 MHz) to IMT services can be made by any jurisdiction now, before WRC-23.

The major reasons for this recommended approach articulated in the report which are applicable in Australia are:

- A need for additional mid-band spectrum in Australia given lack of C-Band and low-band spectrum which could be partially addressed by the partitioning of the 6 GHz band. Early field studies show that the 6 GHz band is a very good substitute for the 3.5 GHz band in terms of performance;
- The allocation of 1,200 MHz of prime spectrum to Wi-Fi is not supported by any demand analysis in Australia. Further, such a decision would be premature as experience and studies in leading markets like South Korea are showing that faster broadband services (especially 5G)/larger data allowances/ recharges mean reduced Wi-Fi offload;
- Strong FWA growth supports an IMT allocation in the 6 GHz band: Growth in 5G FWA would be supported by reservation of additional mid-band spectrum in the 6 GHz band to support additional users and higher download usage patterns;
- The likely economic benefits are maximised with shared allocation of the 6 GHz band spectrum as the short- and long-term economic benefits of improved IMT and Wi-Fi services can both be secured;
- Partitioning the 6 GHz band assists in future proofing for upcoming 6G services; and
- Possible additional proceeds to Federal Government arise from the allocation of IMT spectrum in the 6 GHz band.

2.6 Quality of spectrum[51]

While the right balance and quanta of the above-mentioned spectrum types is required for 5G, the quality of spectrum is equally as important.

Allocated spectrum needs to be contiguous, preferably unencumbered and protected from undue harmful interference to be useful for building mobile networks. Efficient allocations and harmonisation, including international harmonisation, are therefore critical. This requires the adoption of a longer-term perspective in spectrum planning to meet demand.

To meet forecast demand as well as the performance expectations of consumers, businesses and industrial applications, quality of spectrum is as important as quantity for MNOs in delivering the potential benefits of 5G.

When spectrum is not allocated efficiently, the utility of the spectrum can be compromised, due to piecemeal or short-term planning decisions that result in fragmentation. Fragmentation in a band and/or across inappropriate geographical boundaries will inevitably result in interference, dead-zones and spectrum inefficiency with too many concurrent use cases. This unnecessarily complicates licensee coordination and interference management.

It is possible to accommodate multiple users in a band provided co-existence is well planned and managed. However, where planning decisions are made without adopting a longer-term view, the negative implications for 5G deployment can be significant. Specifically, the more Area Wide Licence (AWL) allocations there are in a band, the more potential there is that boundaries will be created and these need to be managed appropriately to avoid creating unnecessary dead zones. Further, the use of AWLs remains unproven, even at mmWave where the interference will be easier to manage due to the propagation characteristics and deployment scenarios in these bands. The use of AWLs for mid-band, with its well-known and understood interference issues over substantial distances should be approached with caution, noting that the use of AWLs also risks significant geographical fragmentation of the band, exacerbating the known problems described above.

Planning decisions that result in high levels of fragmentation risk both Australia's position at the forefront of global 5G mobile network deployment and will also undermine the utility of scarce radio spectrum and leads to spectrum not being allocated to its HVU. In turn, this will result in in missed economic and social benefits for Australia with the outcome ultimately being foregone opportunity for increased growth and jobs.

[51] One of AMTA's members, Pivotel, has a different view than that outlined in Section 2.6.

3. The need for a clear and consistent policy approach

The Act[52] streamlines allocation and reallocation processes. The legislative reforms also clarify the respective roles and responsibilities of the Minister and the ACMA with regard to the allocation of spectrum and the maximisation of the public benefit derived from the use of spectrum.

The improved flexibility of the Act will enable faster and more efficient decisions on the allocation of spectrum. It is important the increased decision-making flexibility is also balanced by transparency and clear, fundamental policy principles to ensure spectrum is allocated to its HVU.

3.1 Policy principles

To ensure spectrum is allocated to its HVU, the following principles are fundamental to guiding decisions involved in Australia's spectrum planning and management:

- Efficiency – spectrum is a finite national resource that must be used efficiently in order to maximise the overall public benefit. To achieve this, allocation decisions must always consider longer-term planning objectives, especially given some licences will have terms of up to 20 years. Spectrum users should be incentivised to use spectrum efficiently over the term of the licence. In practice, this means assessing which spectrum users are likely to upgrade networks to keep pace with technology evolution and incentivising those use cases ahead of less spectrally efficient technologies. Similarly, geographic boundaries should be avoided when allocating spectrum licences suitable for mobile use as these give rise to dead-zones, especially on lower frequency bands that are used for wide-area coverage. Incompatible technology types (e.g., FDD and TDD) should similarly be separated wherever possible. Further, decisions related to one band must also consider the implications for adjacent bands to ensure quality elsewhere is not compromised.

- Flexibility balanced with certainty – flexibility in the licensing and management framework must be tempered with appropriate checks and balances to ensure investors have certainty. Spectrum licence holders must have certainty and confidence in the regulatory framework to encourage continued investment.

- Transparency and Accountability – there must be clarity around the evidence stakeholders should provide to the regulator during consultation processes related to decision-making. Similarly, the assessment criteria, including any proposed weightings on the evidentiary materials provided (both qualitative and quantitative), used to evaluate and determine the HVU of spectrum should be clear to all stakeholders, as outlined in more detail below.

[52] Radiocommunications Legislation Amendment (Reform and Modernisation) Act 2020

3.2 A clear policy directive

Ministerial Policy Statements (MPS) were introduced via the Act to provide a means of ensuring the above fundamental policy principles guide and direct the ACMA's decision-making processes on spectrum planning.

The Object of the Act states it is "*to promote the long-term public interest derived from the use of the spectrum by providing for the management of the spectrum in a manner that… supports the communications policy objectives of the Commonwealth Government*."

Spectrum management is becoming more complex to administer. Demand for spectrum access is rapidly growing within existing industries and innovative new uses for spectrum are constantly emerging with the deployment of 5G.

A clear policy statement from the Minister would provide the necessary direction to establish a consistent policy approach to guide the ACMA's decision-making and give effect to the Object of the Act; and in doing so, ensure the efficient allocation of spectrum to its HVU in order to meet future demand for mobile broadband and guarantee Australia fully realises the economic and social benefits of the technology.

3.3 Determining highest-value use

Allocating spectrum to its HVU is an essential, yet complex component of achieving the Object of the Act. Regulators need to consider a wide range of quantitative and qualitative factors in order to assess the total welfare standard and arrive at the HVU. It is well recognised that HVU is not simply a calculation of the greatest economic benefit, and that qualitative elements and broader government policy objects will factor into a HVU decision. This is an increasingly challenging and complex task as the overall demand for spectrum grows, technology evolves, and the variety of use cases also expands.

A set of clearly identified factors to be used in (or expressly excluded from) the determination of HVU would assist stakeholders understand how HVU is calculated, and would ensure consistency across successive planning decisions. Examples of policy areas where guidance could be provided include: the use of spectrum for fixed versus mobile communication in consumer mass-market applications (for example, the famous 'Negroponte switch'[53]); quantity of spectrum to support Defence and national Broadcast applications; and the role of satellite communications to provide coverage outside traditional mobile network coverage including out at sea.

In addition, transparency in the determination of HVU would also give stakeholders clarity and understanding of the reasoning underpinning HVU decisions as well as delivering accountability in the decision-making process.

It is critical that the regulatory framework supports the allocation of spectrum to its HVU in a consistent, transparent, flexible and accountable way. Providing industry greater insight into the decision-making process for determining HVU, including analysis of qualitative aspects, will assist MNOs understand and respond to the ACMA's call for submissions to consultation papers that drive the decision outcomes.

A MPS should be issued to provide guidance on ensuring transparency of spectrum planning decisions made by the ACMA involving proposed changes of use for a band including:

- identification of the factors, both quantitative and qualitative to be considered in an HVU analysis; and
- a requirement that the HVU analysis be published to ensure transparency.

Appendix A outlines the projections of benefit to the Australian GDP arising from mobile services to assist the ACMA in quantitative analysis of the benefit of increasing spectrum available for mobile networks. In part, these projections are reliant on access to an adequate quantum of spectrum over the coming decade.

[53] Negroponte, N. (1995). Being Digital. New York: Vintage Books. (Negroponte observed that we have ended up with static devices such as televisions receiving their signals over the airwaves, while devices that could become mobile, namely telephones, were served by wires. He proposed they should 'trade places. The question here is whether the same misfortune is occurring using radio spectrum to deliver fixed services to consumer residential markets.)

Appendix A:
Economic and Social Benefits of 5G

The Minister for Communications, Urban Infrastructure, Cities and the Arts designated 2021 as the 'Year of 5G'[54] and industry acknowledges with appreciation the Government's policy priority to support the role and deployment of 5G networks as a key contributor to a digital led COVID recovery.

Allocating sufficient spectrum for mobile technologies, including 5G, will ensure that the highest value use of spectrum is achieved which will result in optimal economic and social benefits for Australian businesses and the public. Allocation of sufficient spectrum for 5G is fast becoming a measure of global competitiveness. A recent Austrade benchmark report found that,

> *"Australia's 5G network is superb by international standards. Average download speeds are currently far faster than in many major economies, including the US, Germany, the UK and Canada. Access to high-speed internet and mobile networks is central to economic growth and job creation. A study across OECD countries found that an increase in internet speed positively affected GDP per capita."*[55]

It is therefore critical for Australia's economy that Government ensures a pipeline of spectrum for 5G to meet forecast demand for mobile broadband.

Below is an outline of the economic and social impact of mobile technologies as well as evidence of actual and forecast growth in demand.

Investment in 5G drives productivity and economic growth

In this 'Year of 5G', substantial private investment by Mobile Network Operators (MNOs) will continue to be the main enabler of mobile connectivity and the digitalisation of Australian businesses and the economy. As MNOs continue to deploy 5G networks and adoption of 5G applications increases across industries and businesses, we see great value and opportunity for the Australian economy to be derived from mobile connectivity in the post-pandemic recovery.

Deloitte Access Economics estimates that the productivity impact of mobile will be equivalent to $2 500 for every Australian by 2023. This amounts to a total of $65 billion of additional GDP by 2023, or 3.1% increase in GDP which is more than the 2.8% contribution of the agricultural sector in 2018.[56]

The same research found that the mobile industry continues to make a significant contribution to Australia's economy and has an enabling impact on other industries, with an estimated contribution from mobile of $22.9 billion of value added to GDP in 2017-18. This figure includes $8.2 billion contributed directly from mobile industry activities as well as $14.7 billion supported through indirect activity in related sectors and across the economy. The mobile industry also

[54] Minister Fletcher, Media Release – 2021 will be the 'year of 5G' - Nov 2020
[55] Austrade benchmark report, Innovation & Skills, 2021
[56] Deloitte Access Economics, Mobile Nation 2019- The 5G Future, 2019

supported approximately 116,100 full time equivalent employees. For every full-time employee in the mobile industry there are 3.7 full time roles supported in other sectors.[57]

Similarly, PwC predicts that the impact of 5G on Australia's GDP will amount to US$20bn by 2030 with a total global impact of US$1.3tn.[58] Looking at five industries, PwC forecast the following impacts by 2030 from 5G:

- Healthcare by US$9bn
- Industrial manufacturing by US$2bn
- Smart utilities US$4bn
- Consumer and media US$4bn
- Financial services US$2bn

PwC observes:

> *"These numbers quantify impact, but perhaps, more important, our study findings reflect the value of 5G. The new levels of connectivity and collaboration that 5G enables will amplify and deepen the insight that organisations can gain from connected technologies. Companies will be able to see, attempt and achieve more, opening up new opportunities for growth as they rethink and reconfigure the way they do business in the post-pandemic world. 5G will be a key part of their new operating environment and technology toolkit."*[59]

And:

> "*With 5G, enterprises can take a fresh look at how they operate, reconsidering product offerings, go-to-market approaches, and even the industries and geographies in which they manoeuvre. Collaboration and partnerships will be key: as we highlighted in Making 5G pay, 5G opens the way to a wide array of business and revenue models powered by collaborative relationships between telecoms and partners in other sectors. Again, a positive and willing attitude from policy-makers will be vital."*[60]

Social benefits of 5G

Mobile phones have moved well beyond being a means of voice communications to being indispensable to how we live, work and enjoy entertainment, including increasingly video. Recent research by anthropologists concluded that smartphones have become a "place within which we live, rather than as a device that we use," with the study further describing the phenomena as "human snails carrying our home in our pockets".[61] This is consistent with Australian research that found that 94% of mobile users do not leave the house without taking their smartphone with them.[62] The same study found that mobile technology provides significant social benefits with 60% of Australians reporting that their smartphone has replaced 3 or more other devices or items, such as cameras, street directories, or calendars.[63]

5G applications and use cases are revolutionising the health, transport and education sectors. Mobile devices provide social connectivity as well as enable flexible work arrangements,

[57] Deloitte Access Economics, Mobile Nation 2019- The 5G Future, 2019
[58] The global economic impact of 5G. Powering your tomorrow. PwC 2021 p7 and p5
[59] The global economic impact of 5G.Powering your tomorrow. PwC 2021 p6
[60] The global economic impact of 5G. Powering your tomorrow. PwC 2021 p19
[61] The Global Smartphone, beyond a youth technology, 6 May 2021, UCL Press
[62] Deloitte Access Economics, Mobile Nation 2019: the 5G Future,
[63] Deloitte Access Economics, Mobile Nation 2019: the 5G Future, page 33

promoting greater workforce participation.[64] Wearable mobile devices can help Australians track their health and reach fitness goals, and can also provide more critical health monitoring, enabling older Australians to live in their own homes for longer. Transport and logistics will be able to rely on IoT smart trackers to improve efficiency and autonomous vehicles will reduce costs as well as improve safety and accessibility for all road users. The NRMA notes that autonomous vehicles will deliver improved safety, decrease congestion, provide options for young, elderly and disabled people, as well as reduce pollution and emissions.[65]

Demand for mobile broadband is unrelenting

AMTA notes that demand for mobile data continues to be strong and this is partly due to the economic and social impact of the global pandemic which has not slowed the deployment of 5G and has driven further demand for broadband services.[66]

Ericsson's November 2021 Mobility Report[67] finds that 5G has cemented its position as the fastest deployed mobile technology to date, with an estimate of 660 million 5G subscriptions by the end of this year. Other key insights from the Report include:

- Network data traffic: Mobile data traffic in Q3 2021 alone was more than all mobile traffic ever generated up until the end of 2016. In 2027, 5G networks will carry 62% of the world's smartphone traffic with the monthly global average usage per smartphone predicted to reach 11.4 GB by the end of 2021 and 41 GB by the end of 2027.

- Global coverage: 5G is expected to cover 75% of the world's population; and 4.4 billion 5G subscriptions are now forecast for the end of 2027 – roughly half of all mobile subscriptions at that time.

- 5G handset sales: 5G handset sales have taken off as adoption of 5G has accelerated for both networks and devices. Over 400 5G smartphone models have been launched and global shipments of handsets were up 19% in the first half of 2021, with 5G handsets now accounting for 23% of global volumes, compared to 8.7% for 4G at the corresponding time in its cycle.

- Broadband IoT has now surpassed 2G/3G as the segment with the largest share of IoT applications.

- 5G standalone (SA) continues to evolve as more markets enable it with: 5G-native voice over NR (VoNR) services, support for network slicing, dual connectivity using an NR anchor carrier (NR-DC), allowing the use of mmWave spectrum in SA networks.

- Fixed Wireless Access (FWA) connections are forecast to grow almost threefold through to 2027, reaching almost 230 million. Out of these, 5G FWA connections are expected to grow to around 110 million by 2027, representing almost half of total FWA connections, accounting for more than 20 percent of total mobile network data traffic globally. Over 75 percent of all service providers are now offering fixed wireless access (FWA) services and

[64] Ibid
[65] NRMA, Driverless cars: the benefits and what it means for the future of mobility
[66] IEEE Innovation at Work, As Pandemic Increases Demand for 5G, Network Operators Plan to Avoid Delays, June 2020
[67] Ericsson Mobility Report, Nov 2021.

during the last 6 months, the number of service providers offering 5G FWA has grown by almost 25 % with FWA forecast to offer broadband to over 800 million people by 2027.[68]

The Ericsson report[69] also highlights some key insights relating to our market area in particular:

- 5G subscriptions – 5G will represent around 39 percent of mobile subscriptions in India and 45% in South East Asia & Oceania region at the end of 2027, estimated at about 1.060 billion subscriptions.

- Data traffic growth – South East Asia and Oceania will see data traffic per smartphone increasing at the fastest rate globally over the forecast period, reaching 46GB per month in 2027 at a CAGR of 34 percent

- Smartphone users – The number of smartphone subscriptions is expected to be 810 million at the end of 2021 and is projected to grow at a CAGR of 7 percent, reaching over 1.2 billion by 2027 in India. In the South East Asia and Oceania region, smartphone subscriptions are expected to reach 1.12 billion from an estimated 910 million at the end of 2021.

- LTE subscriptions – In India, 4G is expected to remain the dominant technology in 2027, however these are forecast to drop from 790 million in 2021 to 710 million in 2027, showing an annual average decline of 2 percent.

AMTA also notes the ACMA's view and forecast on the future demand for mobile data. The ACMA's Five-Year Spectrum Outlook (FYSO) 2021-26 observes "*over the next 5 years, data growth will inform continued investment in 5G networks and complementary technologies are likely to spur spectrum demand*" and "*Growing demand for data capacity remains a key environmental factor driving demand for new spectrum or changes to existing spectrum management arrangements*."[70] We agree with and reiterate the ACMA's conclusion that "*…further spectrum will be needed to support the growth in broadband applications and mobile data in the short and medium term.*"[71]

AMTA also considers that the Government should more explicitly acknowledge the economic and social value of enhanced 5G FWA services to promoting broader sector competition to the NBN and fixed network services. 5G FWA services are both a viable substitute as well as complement to FTTx fixed services as evidenced by the global and regional growth of such services[72] including in Australia.

[68] Ericsson Mobility Report, Nov 2021, p14
[69] Ericsson Mobility Report, Nov 2021
[70] ACMA's Five Year Spectrum Outlook 2021-26 (FYSO), September 2021 at pages 5 and 7.
[71] ACMA, FYSO at page 9.
[72] Refer to GSA, Networks, Technologies & Spectrum Snapshot: June 2021 and https://gsacom.com/press-release/fwa-device-shipments-global-survey/

Appendix B:
Existing mobile spectrum holdings

Disclaimer: the diagrams below are designed to convey an 'at a glance' understanding of existing mobile spectrum holdings and they are not definitive. There are different supplies (total MHz) in different bands, not all licensees are shown for all bands and amounts have been rounded to the nearest 5 MHz.

Low-Band

BAND	TELSTRA	OPTUS	TPG TELECOM
700 MHz			
Metro	40 MHz	20 MHz	30 MHz
Regional	40 MHz	20 MHz	30 MHz
850 MHz			
Metro	20 MHz		20 MHz
Regional	30 MHz		10 MHz
850/900 MHz	Auction in 2021 - 2 x 10 MHz in 850 expansion band (excludes PSMB) and 2 x 25 MHz in 900 band		

Mid-Band

BAND	TELSTRA	OPTUS	TPG TELECOM
1800 MHz			
Metro	30 MHz	30 MHz	60 MHz
Regional	80 MHz in various regions	40 MHz	20-30 MHz
2.1 GHz			
Metro	30 MHz	40 MHz	50 MHz
Regional	40 MHz	30 MHz	30 MHz
2.3 GHz			
Metro		100 MHz	
2.6 GHz	80 MHz	40 MHz	
3.4 - 3.7 GHz			
Metro	60 MHz	65 - 100 MHz	65 - 95 MHz
Regional	50 - 80 MHz	30-35 MHz (except 65 MHz in WA)	40 MHz in most areas

mmWave

BAND	TELSTRA	OPTUS	TPG TELECOM
26 GHz	1000 MHz	800 MHz	600 MHz

Note: The mmWave holdings are in major population areas only and do not include the various AWL holdings.

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