Wireless broadband in the 26 GHz band

Options paper

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Executive summary

Millimetre wave (mmWave) frequency bands have for some time been considered the next frontier in the provision of mobile broadband services. Advances in radiofrequency (RF) technology, materials and components will soon unlock enormous amounts of data capacity available in bands above 24 GHz (strictly speaking, mmWave refers to 30 GHz and above), which until now could not practically be leveraged in consumer technologies.

Work towards the standardisation and harmonisation of mmWave bands for 5th generation (5G) wireless broadband services is well-advanced. As with previous technology generations, 5G will optimally be deployed across a number of complementary frequency bands, essentially split between lower ‘coverage’ bands and higher ‘capacity’ bands. The ACMA has already began the process of identifying and providing for the spectrum needs of 5G, with work ongoing towards the release of the highly important [3.6 GHz band](https://www.acma.gov.au/theACMA/3_6-ghz-band-legislative-instruments-consultation) for 5G coverage layer services.

Our attention is now turning to higher frequencies to provide for the shorter-range, higher capacity services that will result in ultra-fast wireless broadband communications to complement wide-area coverage in higher density areas. Consideration of the use of mmWave bands for these purposes is gathering momentum internationally. Within the Radiocommunication Sector of the International Telecommunication Union (ITU-R), a key item on the 2019 World Radiocommunications Conference (WRC-19) agenda is the examination of bands above 6 GHz for what is termed “International Mobile Telecommunications-2020” (IMT-2020), which essentially equates to ‘5G’ in regulatory parlance. For the purposes of this paper, the term ‘wireless broadband’ is used to capture all of these technologies, noting that services operating in the band under the umbrella of IMT-2020 may be mobile *or* fixed in nature.

Separately, a number of countries are already considering mmWave bands for pre-WRC-19 allocation and the ACMA has previously foreshadowed similar potential early allocations, firstly through the [*Five-year spectrum outlook* (FYSO) *2016–2020*](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/five-year-spectrum-outlook-2016-20) , and subsequently through other public consultation processes.

Central to all the above activities is the 26 GHz band, which comprises 24.25–27.5 GHz. This, along with the upper-adjacent (and partially overlapping) 28 GHz band, is likely to be the first of the mmWave bands to be allocated internationally on a widespread basis for wireless broadband services. While it is only one of a number of bands being considered under WRC-19 AI 1.13, 26 GHz has been the subject of heaviest focus for studies under that agenda item, and has also garnered the most interest among other developed countries for initial mmWave wireless broadband deployments.

Given this international momentum, along with a growing equipment ecosystem and limited incumbency issues in the band, the ACMA has been considering when an appropriate time might be to make it available for the provision of wireless broadband services in Australia. The ACMA held a spectrum tune-up in September 2017, where it was proposed that it might be appropriate to accelerate the progression of the band through the established stages of planning set out in the ACMA’s [mobile broadband (MBB) strategy](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/mobile-broadband-strategy-and-work-plan). Specifically, it was proposed that feedback in response to the 2016–2020 FYSO and the abridged consultation process that accompanied the tune-up could be considered a substitute for the *initial investigation* stage of planning the band.

There are a limited number of licensed incumbent services operating in the 26 GHz band in Australia. However, studies to date have shown that coexistence between future wireless broadband and the incumbent services should be feasible, without any need to constrain or modify existing operations. With that in mind, it was proposed at the spectrum tune-up that the risks of accelerating consideration of the band for allocation could be considered low in comparison to other spectrum refarming exercises.

The tune-up also floated some early ACMA thinking on potential technical planning scenarios and posed a number of [questions](https://www.acma.gov.au/theACMA/spectrum-for-broadband-in-mmwave-bands) for industry input. The ACMA received 27 [responses](https://www.acma.gov.au/theACMA/-/media/AF3D0BB2F7BB456EB073DD48F1C0FB00.ashx). A key question was the appropriateness of accelerating the band through the *initial investigation* phase to the *preliminary replanning* stage in the ACMA’s planning processes. After considering responses, the ACMA has decided to proceed with this accelerated process.

This paper, therefore, represents the next step in the planning of the 26 GHz band. It contains a range of potential options for both *what* should be allocated, in terms of specific frequencies and areas, and *how* the band should be allocated, in terms of which licence types should be adopted in the band to meet a range of potentially varying wireless broadband use cases.

Specifically, the proposed options represent a range of combinations of:

* allocating either the 24.25\*–27 GHz *or* 24.25\*–27.5 GHz band (\*see note below)
* allocating spectrum licences in defined areas comprising either major metropolitan areas only, *or* metropolitan areas *and* regional centres (under all options, wireless broadband services will be permitted access outside defined areas through coordinated apparatus licensing)

various combinations of spectrum, apparatus and (co-frequency) class licensing options within the defined geographical areas, to facilitate access for a number of different potential deployment models.

Note: The bottom frequency edge of the 26 GHz band is yet to be confirmed at the time of writing. The ACMA’s starting assumption remains that it will be 24.25 GHz, which is the lowest possible frequency; however, the ACMA does not yet have sufficient information to conclude whether it will be 24.25 GHz or some higher frequency.

Uncertainty about the lower boundary of any allocation

Unfortunately, the international work to date on coexistence with passive earth exploration satellite services (EESS) in the 23.6–24 GHz band has provided insufficient information to conclude where the lower boundary of any 26 GHz allocation should lie. While significant progress has been made towards studying the potential impact on these services and identifying any necessary constraints on wireless broadband—emission limits were recently agreed for wireless broadband services in the band in Europe—further work is needed to understand the impact of these limits on wireless broadband deployments in the lower part of the band.

Detailed information on the question of the lower boundary is scarce. Australia is one of the first countries to actively consider arrangements in the entire 26 GHz band, noting that Europe, for example, has focussed initially on the 26.5–27.5 GHz range. Nevertheless, some informed thinking on likely viable lower boundary approaches is possible and, at the very least, provides a range of potential approaches to the allocation of the band.

Noting the emission limits recently identified in Europe and based on likely early European allocations (and associated technical deliberations within Europe’s Electronic Communications Committee, or ECC), it is safe to conclude that a lower boundary of 26.5 GHz would protect EESS operating below 24 GHz, without any significant constraints being imposed on wireless broadband deployments above 26.5 GHz.

It may be that a similar conclusion could be drawn for a lower boundary of 25.5 GHz, based on current anecdotal industry thinking that a 1.5 guard band would be required above 24 GHz between passive and wireless broadband services—noting that the ACMA does not yet fully understand the implications of adopting the emission limits identified by Europe on wireless broadband deployments.

A further approach might be to adopt different (more relaxed) emission limits to protect passive services based on uniquely Australian deployment considerations, which may be different to those assumed in European scenarios. This would be informed by further studies on the issue (see below) and would influence the determination of what is a practical lower boundary to the 26 GHz band. Finally, the ACMA could simply allocate the entire band on a ‘buyer beware’ basis and allow industry to determine how mandated protection of the passive service would be achieved. This would carry its own set of risks, but may facilitate optimally efficient wireless broadband deployments in the band.

This paper asks a number of questions of industry that are intended to help the ACMA develop a domestic position that takes appropriate account of the international work to date. During the consultation period for this paper, the ACMA will also seek to convene a working group of interested stakeholders to consider the issue associated with frequency boundaries and associated coexistence, run in parallel with the consultation period for this paper. This working group would be a complement to, and not a replacement for, the usual Technical Liaison Group (TLG) that is established when putting together technical frameworks for an allocation. The working group would consider, among other things, the European emission limits in the context of the Australian radiofrequency environment and provide input to the ACMA on views regarding how much frequency separation is required above 24 GHz to adequately protect EESS services.

This group would also be an opportunity to discuss any issues of concern at the upper boundary of the band as well (that is, 27 or 27.5 GHz), as well as considering whether any additional, domestic-specific measures might be appropriate to help protect FSS satellite receivers. Views from this working group would help respondents to this paper form views on the implications of coexistence with EESS on potential frequency arrangements for wireless broadband. Proposed terms of reference for this working group and a call for nominations are contained in Appendix 3.

While the total amount of bandwidth available for wireless broadband is not yet confirmed, other parameters that form the basis of the options proposed in this paper are confirmed, including the upper frequency boundary for which there are two possible option variants (27 and 27.5 GHz). The uncertainty surrounding the lower frequency boundary of the band applies to all options, so it should have little bearing on the assessments in this paper of the relative merits and drawbacks of each option.

Licensing options

The ACMA has explored a number of different licensing combinations to authorise access to the band. While 5G *technologies* are beginning to take shape, potential business models are not yet so clear. In particular, how closely deployments will align with the now-traditional mobile network operator (MNO)-centric service provision model is yet to crystallise—indeed, the unique physical characteristics of the band and technology improvements may pave the way for a mix of deployment models previously not seen.

To address this uncertainty, this paper groups a range of potential deployment models under different ‘types’ of users, where type 1 use describes conventional wide-area mobile networks, type 2 describes smaller targeted wireless markets such as fixed wireless access networks and type 3 describes individual private deployments on private premises. The licensing options include a range of combinations of spectrum, apparatus and class licensing options to capture various combinations of these deployment models. Under all options, existing service allocations would not be removed from the band and would coexist with wireless broadband services—noting that coordination requirements may limit where new services could be deployed.

The paper also assesses the options against the ACMA’s [Principles for Spectrum Management](http://www.acma.gov.au/theACMA/About/The-ACMA-story/Facilitating/decisionmaking-process-fyso-25-1). A ‘no change’ option is also canvassed, which returns the least favourable assessment against the Principles. The ‘highest value use’ (HVU) of spectrum is central to two of the Principles, and as a starting point, the ACMA is confident that allocating spectrum from this band for wireless broadband would encourage the HVU of band. This is based on a simple cost/benefit premise that doing so would yield significant benefits with little or no cost to incumbent use, given the significant advances that mmWave wireless broadband promise to deliver, along with our assessment that coexistence with incumbent users (of which there are comparatively few) should be feasible.

The assessment against the Principles finds that, depending on various considerations (see below), the options that would best satisfy the Principles are those that would result in the entire band (24.25–27.5 GHz)[[1]](#footnote-2) being made available for type 1 use through spectrum licensing in metropolitan areas and regional centres. It also finds that it may be more beneficial to enable co-frequency access by type 3 users on a class-licensed basis, depending on both demand for these services and the feasibility of type 1 and 3 users coexisting under overlapping spectrum and class licences (with type 1 users afforded primary status outside private type 3-served premises).

However, the results of this assessment also leave the door open for setting aside some spectrum for type 2 users under apparatus licensing in those areas where spectrum licensing is proposed. Whether this is appropriate, and the degree to which this approach may be applied, depends on two broad questions:

* Coexistence at the lower end of the band with passive EESS services—for example, it might ultimately be determined that wide-area licensing for type 1 services below a certain frequency cannot adequately protect EESS, but lower-density apparatus licensing can.

How equipment standards and, as a result, spectrum licence lot configurations map across the total bandwidth available—for example, if it is optimal to deploy wireless broadband in certain frequency block sizes, but integer multiples of that block size leave a frequency gap above the lower end of the band (either 24.25 GHz or whichever frequency is assessed as the lowest possible for type 1 deployments that can adequately protect passive EESS), then that gap might be able to be used for apparatus licensed type 2 services instead.

A preliminary, pragmatic view is that licensing in the band might ultimately be influenced by a combination of the above two factors, so there might be scope for setting aside a portion of the lower part of the band for apparatus licensing in metro areas and regional centres (it is proposed that apparatus licensing will be available outside these areas by default).

These are preliminary views and this paper seeks comments on these, and other, issues. Feedback will inform the ACMA on how it progresses the band to the *refarming* stage. Given the emerging scope for accommodating a broader range of service models than the traditional MNO-only model, the ACMA is particularly keen to hear views from potential type 2 and 3 operators that have not traditionally engaged heavily in these processes.

The next step will be a planning decision on the configuration of the band, to be informed both by responses to this paper for general frequency, area and licensing configurations, and recommendations from the group set up to study EESS coexistence for specific frequency boundaries. In line with the current FYSO, this decision is expected to be made early in 2019.

The ACMA acknowledges that implementation of the Spectrum Review is currently ongoing, but expects that the likely release timetable for the 26 GHz band will occur under the *Radiocommunications Act 1992.* All the options and associated licensing aspects described in this paper are consistent with those of the current legislation.

# Issues for comment

The ACMA invites comments on the issues set out in this paper.

Specific questions are featured in the relevant sections of this paper and collated below:

1. Does the three-type model constitute an appropriate high-level representation of potential usage of the 26 GHz band? If not, are there any use cases that should be included, excluded or omitted?
2. What are the implications for 26 GHz wireless broadband in Australia of the Electronic Communication Committee of CEPT (ECC) decision on emission limits to protect passive EESS[[2]](#footnote-3)?
3. Are the proposed defined geographic areas for wide-area licensing appropriate?
4. What is the expected proliferation of—or demand for—services deployed under type 2 (apparatus-licensed) and/or 3 (class-licensed) models?
5. Comment is sought on preferred option(s) for configuring and licensing the 26 GHz band.
6. If options 3 or 5 (all variants[[3]](#footnote-4)) are preferred, how much of the band should be available for spectrum licensing and apparatus licensing?
7. If options 4 or 5 (all variants) are preferred, how much of the band should be available for class licensing?
8. If options 4 or 5 (all variants) are preferred, what conditions should be applied to a class licence to protect co-frequency spectrum-licensed operations (in defined areas)? Would it be appropriate to define a means of making class-licensed use visible (for example, through a form of voluntary device registration)?
9. Are there any other replanning options that should be considered?
10. Is there likely to be sufficient demand for type 1 services in regional centres outside metropolitan areas, and if so, what centres (either explicitly listed or by population threshold) should be included in the expanded licence areas?

Details on making a submission can be found in the *Invitation to comment* sectionat the end of this document*.*

# Introduction

This paper presents high-level options for replanning and allocating the 26 GHz band to facilitate the deployment of International Mobile Telecommunications 2020 services (IMT-2020), otherwise known as 5th generation (5G) mobile services. For simplicity’s sake, the term ‘mobile broadband’ (MBB) is used in this paper to refer to a variety of different technologies including terms such as 3G, 4G and 5G, and the term ‘wireless broadband’ is used specifically to describe 5G/IMT-2020 in the 26 GHz band to include non-mobile services such as fixed wireless broadband systems.

## Legislative and policy environment

Managing spectrum efficiently and effectively for the benefit of all Australians is a key priority for the ACMA[[4]](#footnote-5). The ACMA draws on a range of legislative and administrative tools and overarching guidance in executing these functions.

### Guiding legislation

Section 9 of the *Australian Communications and Media Authority Act 2005* (ACMA Act) sets out the spectrum management functions of the ACMA, including to:

* manage the radiofrequency spectrum in accordance with the *Radiocommunications Act 1992* (the Act)

advise and assist the radiocommunications community.

Consistent with the spectrum management functions set out in the ACMA Act, the object of the Act is to provide for management of the radiofrequency spectrum in order to (among other goals):

* maximise, by ensuring the efficient allocation and use of the spectrum, the overall public benefit derived from using the radiofrequency spectrum
* provide a responsive and flexible approach to meeting the needs of users of the spectrum

encourage the use of efficient radiocommunication technologies so that a wide range of services of an adequate quality can be provided.

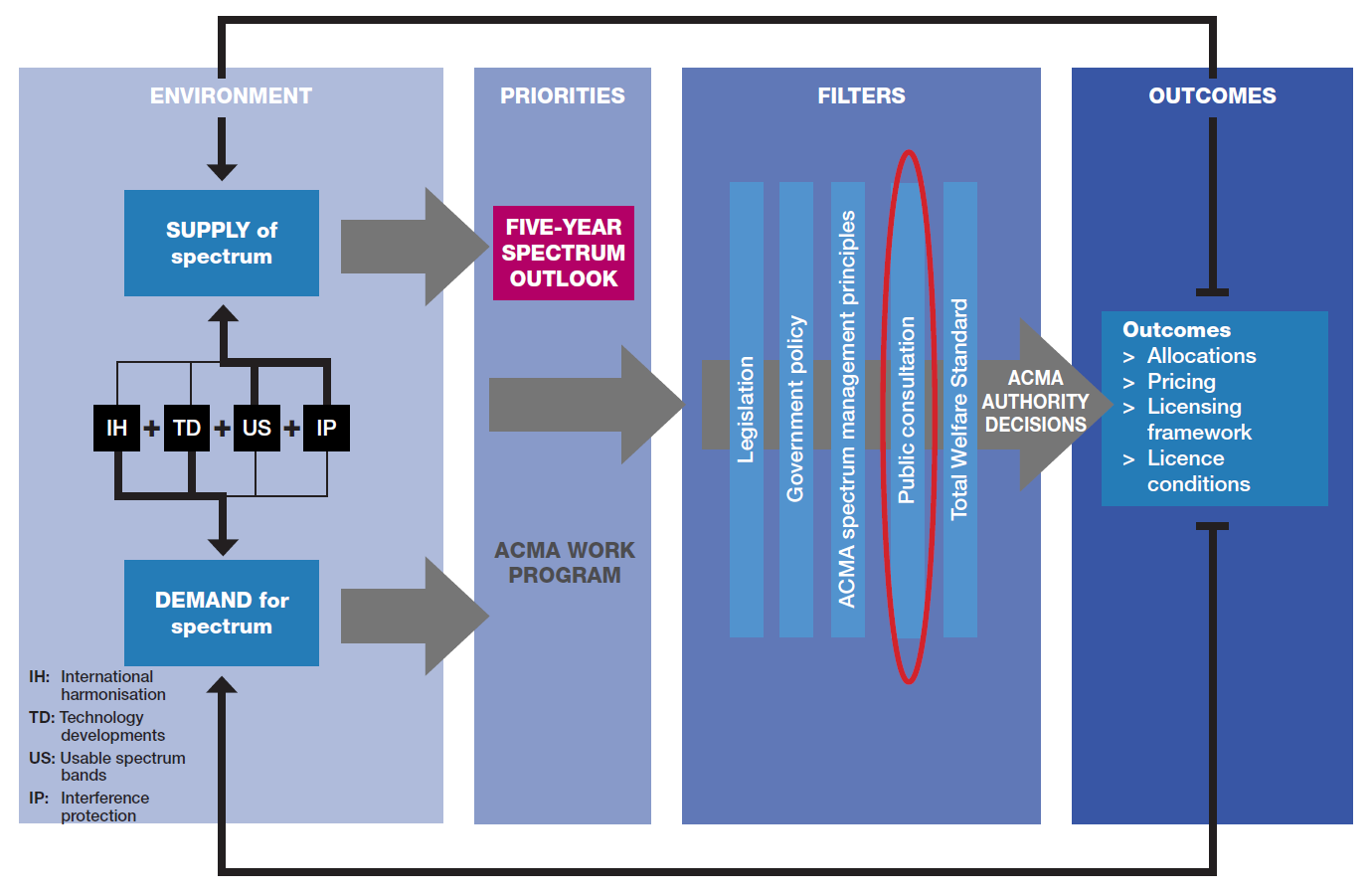
### Principles for spectrum management

The ACMA is also guided by the [Principles for Spectrum Management](http://www.acma.gov.au/theACMA/About/The-ACMA-story/Facilitating/decisionmaking-process-fyso-25-1)[[5]](#footnote-6) (the Principles), which are:

1. Allocate spectrum to the highest value use (HVU) or uses.
2. Enable and encourage spectrum to move to its HVU.
3. Use the least cost and least restrictive approach to achieving policy objectives.
4. To the extent possible, promote both certainty and flexibility.
5. Balance the cost of interference and the benefits of greater spectrum utilisation.

The ACMA adheres to the object of the Act and the Principles through a balanced application of market and regulatory mechanisms. Figure 1 describes the ACMA’s general approach to spectrum management decision-making. Consideration of the 26 GHz band for wireless broadband services was first publicly foreshadowed in in the ACMA’s *Five-year spectrum outlook* (FYSO) *2016–2020* (see below). In terms of the general approach, the release of this paper fits within the ACMA’s broad public consultation ‘filter’. The ACMA will continue to apply the elements of its spectrum management decision framework, including the spectrum management principles, as it considers the responses to this paper.

1. Spectrum management decision framework



### Existing licensing regimes

There are currently three licence types available to authorise access to spectrum—spectrum, apparatus and class licences. Note that this will change if the proposed new spectrum management legislation comes into effect (see below).

An apparatus licence authorises the use of a radiocommunications device (or group of devices) operating under a particular radiocommunications service type, in a particular frequency range, and at a particular geographic location[[6]](#footnote-7) for a period of up to five years. It is typically issued ‘over-the-counter’ in accordance with coordination rules developed by the ACMA.

A spectrum licence authorises the use of a particular frequency band within a particular geographic area for a period of up to 15 years under the current legislative framework. The geographic area can vary in size and can comprise the entire country. Spectrum licences have historically been utilised for the majority of bands used to deploy commercial mobile networks.

An inherent feature of spectrum licensing is technological flexibility—that is, the licensing rules, while usually optimised for an expected technology, generally specify only generic technical detail and limitations[[7]](#footnote-8), while not expressly mandating a particular type of technology or service. This allows a licensee to deploy any technology as long as it complies with the terms and conditions of the licence, without intervention from the regulator. It is up to the licensee to manage interference between devices, although the adoption of international standards mitigates the potential for interference between devices. Spectrum licences are more conducive to spectrum trading than apparatus licences, due to design features such as their longer and more certain tenure and their ability to be sub-divided.

Class licences are a standing authorisation to use spectrum without the need to apply to the ACMA for access, so long as the conditions of that licence are met. These conditions can be technical, geographic and/or pertain to the type of use or class of user.

### Future changes to spectrum management legislation

The Australian Government is implementing the recommendations of the [Spectrum Review Report](https://www.communications.gov.au/node/1190http:/www.communications.gov.au/spectrumreview), including recommendations to replace the current Actwith new legislation.

The reforms are intended to simplify the regulatory framework and support new and innovative technologies and services. They implement recommendations to:

* replace the current legislative arrangements with new legislation that removes prescriptive processes and streamlines licensing for a simpler and more flexible framework
* better integrate the management of public sector and broadcasting spectrum to improve the consistency and integrity of the framework

review spectrum pricing to ensure consistent and transparent arrangements to support the efficient use of spectrum and secondary markets.

In May 2017, the government released a [consultation package](https://www.communications.gov.au/have-your-say/consultation-new-spectrum-legislation) on the reforms. The government intends to consult further by releasing updated draft legislation, including provisions relating to transitional and broadcasting arrangements, which have not yet been exposed for comment. Following these further consultations, the legislation is expected to be introduced into the Parliament.

The full transition to a new licencing framework is expected to take place over a number of years. Given the timeframes associated with the 26 GHz band review, the ACMA is proposing to develop new arrangements in this band on the assumption that the existing regulatory regime will apply at the time of implementation.

It is, however, acknowledged that new arrangements for the 26 GHz band may need to be accommodated under the proposed new legislative framework, depending on the implementation timeframes for this band relative to the transition to the new legislation.

## Meeting increasing spectrum demand for mobile broadband

### MBB strategy

The ACMA has developed a [set of strategies](http://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/mobile-broadband-strategy-and-work-plan) to address the growth in demand for MBB capacity. A key part of these strategies is a spectrum management process to release additional spectrum for MBB in bands where there is evidence of a change in HVU (ACMA also considers the potential for changes in HVU in favour of other applications).

The stages of the process for consideration of additional spectrum for MBB services are outlined in the ACMA’s [MBB strategy](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/mobile-broadband-strategy-and-work-plan). These stages are designed to provide visibility of the ACMA’s early thinking or progress on particular frequency bands. At a high level, these stages are:

* *monitoring*—keeping abreast of developments relating to MBB in a particular band
* initial investigation—consideration of potential planning options in the band
* *preliminary replanning*—identification of planning arrangements, including relevant detailed technical studies

*refarming*—detailed frequency/channel planning for both incumbent and new use (as applicable) and development of relevant licensing frameworks.

The 26 GHz band has previously been identified as being in the *monitoring* stage; however, a recent consultation process sought views on the band being progressed to a more advanced stage (further discussion in next chapter).

### Five-year spectrum outlook

The ACMA communicates its forward work program through the annual [FYSO](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/5-Year-Spectrum-Outlook). It sets out the ACMA’s spectrum management priorities and provides a forum for industry to help shape those priorities.

The 2016–2020 FYSO sought feedback on a number of issues surrounding MBB use of bands above 24.25 GHz. A number of submissions were received indicating support for progression of some bands, as well as encouraging the ACMA to take account of international studies. The 2017–2021 FYSO further proposed a number of potential forward allocation scenarios, essentially setting out an order of priority of frequency bands that might be allocated in the coming years. While the 26 GHz band was one of the bands considered under those scenarios, potential allocation mechanisms or timing are beyond the scope of this paper.

In the draft 2018–2022 FYSO, released for industry comment in May 2018, the ACMA acknowledged that the next round of consultation (being this paper) would be delayed owing to unresolved international spectrum harmonisation considerations (as described in the *Inter-service coexistence – Passive earth sensing* component of the *Interference management and coexistence between services* section of this paper), which will have implications for what parts of the lower end of the band will be usable for wireless broadband. In the draft FYSO, the ACMA noted that:

Due to the absence of timely international conclusions on these issues, in particular regarding [earth exploration satellite services] EESS (passive) compatibility, the ACMA’s preferred option is to delay consideration of the 26 GHz band until international clarity and consensus is achieved, with the potential dual advantages of optimising the amount of spectrum available and heading off the risk of potential fragmentation of holdings that could result if the lower part of the band were to be allocated at a later date.

The alternative is to proceed initially with domestic consideration of a subset of the 26 GHz band where coexistence is clear—under some circumstances, this could be as little as 26.5–27.5 GHz initially …

… In forming its preliminary view, the ACMA sees major risks in proceeding with only part of the band to start with and revisiting the possibility of additional allocations later. Such an approach is likely to result in fragmented holdings, which could be difficult to rectify in the future. The ACMA’s preference is ‘to do it once and do it right’, meaning we would continue to monitor international studies on coexistence with EESS services before releasing an options paper.

The proposal to delay the release of this paper was supported in responses by the Australian Competition and Consumer Commission (ACCC), Communications Alliance’s Satellite Services Working Group (SSWG) and Optus. Vodafone Hutchison Australia (VHA) and ViaSat proposed delays of the eventual allocation, albeit for other reasons.

Telstra proposed that if uncertainty around coexistence with passive EESS could not be resolved in a timely manner, then the upper part of the band (nominally 26.5–27.5 GHz) should be released as a priority, with the remainder to be released later. Equipment manufacturers Nokia and Qualcomm were of the view that the release of the band should be a priority, while at the same time expressing concerns around potentially stringent emission limits being imposed on wireless broadband services in order to protect passive EESS.

It remains the ACMA’s preference for the 26 GHz band to be allocated through a single process, both to minimise complexity and reduce the potential for future fragmentation of licence holdings in the band. Delivery of mmWave wireless broadband services will benefit significantly from large contiguous spectrum holdings, and the ACMA believes that this benefit outweighs the disadvantages of delaying the process by a few months.

The ACMA would be open to consideration of whether a policy of allowing early access to the band prior to the commencement of spectrum licences might help to alleviate any disadvantages of delaying the process, noting that issuing further licences before or during a reallocation period may raise other issues and concerns.

## International developments in the 26 GHz band

There is ongoing work to consider and develop arrangements for wireless broadband services in the 26 GHz band in other international jurisdictions, in particular in the United States (US) and Europe. Developments to date are summarised below.

In July 2016, the US Federal Communications Commission (FCC) announced that it will open up nearly 11 GHz of spectrum above 24 GHz for 5G services.[[8]](#footnote-9) This included the band 27.5–28.35 MHz (which is part of the 28 GHz band). Since this original decision, the FCC has taken additional steps, and in November 2017, announced that it will make available 1700 MHz of spectrum above 24 GHz for terrestrial 5G use. This included spectrum in the bands 24.25–24.45 GHz and 24.75–25.25 GHz (parts of the 26 GHz band).[[9]](#footnote-10)

In November 2016, the Electronic Communication Committee of CEPT (ECC) approved a comprehensive list of actions for CEPT regarding 5G—the CEPT roadmap for 5G. It has since been updated to reflect the progress of ECC activities. The roadmap outlines the CEPT’s actions for 5G, including clearly signalling an intention to harmonise the 26 GHz band (24.25–27.5 GHz) in Europe for 5G prior to WRC-19 and to promote it for worldwide harmonisation. In July 2018, the ECC released an ECC decision on harmonised technical conditions for 5G in the 26 GHz band.[[10]](#footnote-11)

In July 2017, Ofcom (the UK spectrum regulator) opened a consultation process on 5G spectrum access at 26 GHz.[[11]](#footnote-12) In this process, Ofcom highlighted that the 24.25–27.5 GHz band is being prioritised across Europe as the first high frequency band for 5G. Ofcom also outlined the status of work on other potential 5G bands above 30 GHz, and announced its intention to start working on making spectrum available in the 66–71 MHz band.

## Purpose of this paper

This paper signals the ACMA’s intention to progress its work on whether to make the 26 GHz band available for wireless broadband services to the *preliminary replanning* stage. This was the subject of a recent [consultation process](https://www.acma.gov.au/theACMA/spectrum-for-broadband-in-mmwave-bands)—see the *Consultation* section of this paper for more detail. In that sense, the previous process essentially formed an abridged *initial investigation* stage.

Consistent with the four stages of the MBB strategy, this paper should be regarded as an ‘options’ paper. The options presented go a little deeper than high-level planning options, in that the conventional frequency range and area options are combined with a range of potential licensing implementation options. Given the stark physical differences between mmWave 5G in comparison to previous generation technologies and lack of any commercial deployments, the ACMA does not yet have a complete understanding of potential deployment models for mmWave wireless broadband. With that in mind, three categories of delivery model are proposed in this paper, which map to different combinations of licensing options.

The paper also contains some qualitative analysis of the Principles against the various options, to ascertain which combination(s) of options would best satisfy those principles, and ultimately inform an ‘ACMA preferred’ option, which is also contained in this paper.

Technical studies that are usually conducted at this stage have largely been undertaken externally (albeit in some cases with significant ACMA input, particularly within the ITU-R). So instead of including detailed technical studies in this paper, studies already undertaken have been referred to and summarised (see *Appendix 1*—  
*Summary of coexistence studie*s).

This paper seeks stakeholder input on a range of issues that, in general, intend to add depth to the abovementioned options and help provide the ACMA with the necessary details to inform progression of the band to the *refarming* stage.

## Issues not within the scope of this paper

The purpose and scope of this paper is outlined above. The following issues are not within the scope of this paper:

Detailed licensing and allocation options

Detailed licensing and allocation options (such as auction methods and lot configuration) will be considered as part of any possible refarming process after the most suitable planning direction is determined.

Other mmWave bands

The sole focus of this paper is the 26 GHz band. The potential future use of other mmWave bands such as the 28 GHz, 40 GHz and 60 GHz bands for wireless broadband services is outside the scope of this paper.[[12]](#footnote-13) Respondents will be able to contribute views on the relative priorities of other bands through the [FYSO](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/5-Year-Spectrum-Outlook) process.

Engagement in international activities

International developments and activities are relevant to domestic considerations. In the case of the 26 GHz band, the ACMA, along with other domestic stakeholders, has been closely involved in studies being carried out in the ITU-R under WRC-19 agenda item 1.13 on mmWave bands for wireless broadband services. These studies are important in informing ACMA views on the potential for coexistence between wireless broadband and incumbent services and are referred to extensively in this paper (including a summary of studies contained in *Appendix 1—Summary of coexistence studies.*

However, the scope of this paper does not extend to Australian strategies or positions on WRC-19 agenda items. These matters are dealt with separately through relevant ACMA and Department of Communications and the Arts (DoCA)-led preparatory processes. Stakeholders interested in these processes can get more information from the [ACMA website](http://www.acma.gov.au/theACMA/international-telecommunications-activities) or by contacting the ACMA’s International Radiocommunications Section ([IRS@acma.gov.au](mailto:IRS@acma.gov.au)).

# The process to date

## Consultation

The potential for the 26 GHz band to be used for wireless broadband services first gained momentum when it was included within the scope of WRC-19 agenda item 1.13. This was noted in the [2016–2020 FYSO](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/five-year-spectrum-outlook-2016-20), where it was also undertaken that the ACMA would monitor international developments in the band and look at the feasibility of early (pre-WRC-2019) implementation, depending on the progression of interference studies and development of equipment economies of scale.

The band was listed under the *monitoring* stage for MBB planning at the time and comment was sought in the 2016–2020 FYSO on a number of issues related to bands above 24.25 GHz.[[13]](#footnote-14)

The 26 GHz band has subsequently emerged as a frontrunner for early mmWave wireless broadband services and, in the meantime, the ACMA has been heavily engaged in interference studies associated with WRC-19 AI 1.13 that specifically pertain to the 26 GHz band. In September 2017, the ACMA hosted a spectrum tune-up[[14]](#footnote-15), which included speakers from the ACMA and industry. The tune-up provided an opportunity to update industry on current ACMA thinking on the use of various mmWave bands under consideration.

The tune-up had a strong focus on the 26 GHz band, and noting increasing domestic and international interest in the band, along with limited incumbency issues (and the emergence of favourable coexistence studies), the ACMA proposed to use the spectrum tune-up as the basis for a streamlined [consultation process](https://www.acma.gov.au/theACMA/spectrum-for-broadband-in-mmwave-bands) for early consideration of the 26 GHz band and, if supported by submissions, potentially other mmWave bands. A number of questions were asked during this process:

* What disposition should the ACMA adopt in progressing possible 5G mmWave bands? Specifically, is a traditional approach appropriate, where Australia would wait until there were clear signs of a harmonised, widespread ecosystem developing in a band before it was seriously considered domestically? Or should a more proactive approach be adopted that would potentially make available bands very early in a more speculative manner? What are the benefits and risks to each approach?
* When, or under what circumstances, would it be appropriate for potential 5G mmWave bands to progress beyond *monitoring* in the ACMA’s MBB work program?
* What bands are the most mature in terms of possible early moves on 5G mmWave bands?
* What is the relative priority of investigation of mmWave bands versus other potential MBB bands below 6 GHz?
* Are there any specific regulatory changes that are going to be required to facilitate and support satellite services in the context of 5G?
* 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 or why not?
* Are there specific issues that may affect the timeframe in which the 26 GHz band could be made available for broadband services?
* Should the 24.25–27 GHz or 24.25–27.5 GHz be made available initially for broadband services?
* What licensing approach should be used for broadband in the 26 GHz band?
* What geographical areas should be made available for broadband in the 26 GHz band?
* 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 or why not?
* Are there specific issues that may affect the timeframe in which other mmWave bands could be made available for broadband services?
* Should part or all of any these bands be considered initially for broadband services?
* What licensing approach should be used for broadband in other mmWave bands?

What geographical areas should be made available for broadband in other mmWave bands?

The following *Summary of submissions* section contains responses to this consultation process.

## Summary of submissions

Full submissions to the consultation process can be found [here](https://www.acma.gov.au/theACMA/-/media/AF3D0BB2F7BB456EB073DD48F1C0FB00.ashx). Five broad themes emerged in submissions:

* discussion of high-level system architecture aspects
* advancement through the planning stages under the MBB strategy
* timing and priorities
* licensing and sharing issues

Electromagnetic Energy (EME) exposure.

The following sections provide a summary of submissions as they relate to these themes.

### High level architecture aspects

Satellite wireless broadband solutions

Communications Alliance and SES New Skies Satellite Australia highlighted that wireless broadband technologies will comprise more than just terrestrial MBB networks, and that satellite wireless broadband solutions should also be included in planning arrangements for future spectrum allocations. SES added that satellite is more than just an incumbent service, as it will be important to the provision of wireless broadband services, with the potential to extend wireless broadband networks to areas they otherwise may not reach. Intel, however, noted that it is unaware of any work being undertaken on satellite components of wireless broadband networks, and that satellite services are unlikely to fulfil all wireless broadband performance requirements.

Wireless broadband deployment requirements

Respondents provided information on what factors might be required to ensure that wireless broadband deployments are successful. Most mobile network operators (MNOs) and equipment vendors were of the view that wireless broadband services will require access to multiple frequency bands, with Ericsson, Huawei, Intel, Qualcomm and Telstra elaborating that access to low, medium and high frequency bands would be crucial. Ericsson, Huawei, Optus and Telstra also noted that large, contiguous licensed bandwidths would be necessary, with Ericsson, Nokia, and Vodafone adding that globally harmonised spectrum would also be important.

### Advancement through the MBB strategy planning stages

As expected, a predominant theme of submissions was the proposed acceleration of the 26 GHz band through the planning stages set out in the MBB strategy. The benefits and risks of this accelerated approach were discussed in depth in submissions, along with the criteria to be satisfied when considering the advancement/acceleration of a band through these planning stages. A range of views were also supplied on which bands, if any, should be considered for advancement/acceleration. These issues are explored further in the following sections.

Benefits and risks of acceleration

Generally speaking, responses were divided into two broad groups. Respondents that provided views on the benefits of an accelerated process included MNOs and equipment vendors, while respondents that highlighted the risks of acceleration generally comprised incumbent service (satellite) operators.

A number of respondents outlined the benefits of adopting a proactive and accelerated approach to planning mmWave bands for potential wireless broadband services. In particular, it was argued that providing wireless broadband spectrum as early as possible would allow Australia to be an early adopter of wireless broadband technologies and, therefore, realise the economic benefits of these deployments earlier. Telstra submitted that waiting for WRC-19 outcomes would unnecessarily delay wireless broadband deployments in Australia. Inster added that an early release of spectrum would allow pre-standard systems to be deployed immediately.

Conversely, some respondents argued that following the established process should not prevent spectrum becoming available when both wireless broadband market demand and equipment availability are established. Communications Alliance and SES expressed concern that an accelerated approach would present significant risks, such as the potential for spectrum to lie fallow as a result of slower than expected development of wireless broadband ecosystems, investment and market demand.

NBN Co added that spectrum being earmarked too far ahead of market demand and equipment availability would result in a risk that the band could be underutilised while potentially locking out other services.

Advancement criteria

There was some degree of consensus about which criteria should be met before a band could be progressed through the planning stages. The majority of respondents agreed that global/regional spectrum harmonisation and an equipment ecosystem should be key preconditions for progression. Other suggested criteria discussed (where there was less support) included completion of ITU-R sharing studies, evidence that existing bands can no longer support traffic demand and the relevance of the highest value use (HVU) concept.

There were polarised views on the importance of waiting for ITU-R sharing studies to be completed and/or completion of WRC-19. Boeing, CSIRO and NBN Co shared the view that it is essential to wait until completion of studies, so results could be considered before progressing to the next stage. Airbus and NBN Co added that it would also be prudent to wait until after WRC-19 to ensure that planning decisions were in line with international directions. Other responders noted that spectrum harmonisation and equipment ecosystems will have developed before the end of these processes.

Communications Alliance and ViaSat were of the view that there should be evidence that existing MBB bands are being fully utilised before considering the potential release of additional bands. ViaSat also noted that the MBB strategy only focusses on MBB capacity and not demand for wireless broadband services.

There was some discussion of the HVU concept. Some respondents took the view that the HVU of bands should be re-assessed given current international interest in wireless broadband deployments. Others questioned whether the HVU concept is still relevant in the mmWave context, and there was some concern that HVU assessments in favour of MBB historically resulted in clearance of incumbent users to enable exclusive access for MNOs. Both Communications Alliance and ViaSat highlighted that a second service sharing with MBB would provide more value than a single service model. There was also concern that HVU assessments fail to adequately account for qualitative, non-monetary aspects, which can distort the outcome of those assessments.

Which frequency bands should be considered for acceleration?

A number of respondents (primarily incumbent operators) said that no bands should be progressed/accelerated on the basis that there isn’t sufficient demand for new services, and that international harmonisation and equipment ecosystems are not mature. The latter point was linked to the fact that potential wireless broadband mmWave bands are still being considered by the ITU-R.

Other respondents (primarily equipment vendors and MNOs) argued that some bands are now sufficiently mature to progress through the planning stages, citing strong evidence of developments in harmonisation and equipment ecosystems. It was also suggested that market demand for mmWave wireless broadband services is already strong.

Of all frequency bands proposed for acceleration, the 26 GHz band received the most support from equipment vendors and MNOs. Again, this was based on the maturity of international spectrum harmonisation activities (largely driven by European interest in the band), and the resultant inertia towards the development of a significant equipment ecosystem. Ericsson, Huawei, Qualcomm, Telstra, TPG and Vodafone all expressed the view that the 26 GHz band is the highest priority mmWave band for wireless broadband deployments. In most cases a release of the entire band, that is, 24.25–27.5 GHz, was supported; however, it was noted that coexistence with satellite services above 27 GHz would need further consideration.

The majority of equipment vendors and MNOs that provided responses suggested that the 37–43.5 GHz band was also firming as a candidate for release. However, support for this band to be accelerated through the planning process was limited, with only Ericsson, Huawei and Intel expressing the view that it should progress to the *preliminary replanning* phase.

There were some views that the 28 GHz band is currently the most mature mmWave band for wireless broadband. This stemmed from the US announcement for early wireless broadband deployments in 27.5–28.35 GHz and Intel proposed the acceleration of this band to the preliminary re-planning phase. Communications Alliance, NBN Co and SES, however, were of the view that the 28 GHz band should not be considered for wireless broadband services given its current use by satellite services.

Bands in the 57–71 GHz frequency range were the subject of some interest from Facebook, Intel, Microsoft, Optus and Qualcomm. Airbus and Communications Alliance suggested the 66–76 GHz and 81–86 GHz bands are mature for wireless broadband services, with Optus also expressing an interest in those bands.

TasmaNet and WiSPAU were of the view that the 59–63 GHz and 71–76 GHz bands should not be progressed to the preliminary re-planning phase as they are currently encumbered, and largely harmonised globally, for short-range, high-speed links.

### Timing and priorities

There was strong support (primarily from MNOs and equipment vendors) for the 26 GHz band to be the highest priority mmWave band for consideration for wireless broadband services. The 37–43.5 GHz band was, in general, viewed as the second priority. There was also support for the 3.6 GHz band to also remain a high priority, as wireless broadband services will need access to multiple bands with differing propagation characteristics and bandwidths.

Optus indicated that while the 26 GHz band should be the highest priority mmWave band, the ACMA should prioritise work on releasing sub-2 GHz bands (in particular, the 900 MHz and 1.5 GHz bands). NBN Co also noted that bands below 6 GHz, in particular the 3.6 GHz band, should be prioritised ahead of mmWave bands. Vodafone indicated a preference for the 3.6 GHz and 26 GHz bands to be allocated at the same time so that wireless broadband deployments could be planned and coordinated more efficiently.

There were a range of views expressed on potential timings for access by wireless broadband services to the 26 GHz band—these are summarised in Table 1.

1. Timing preferences for wireless broadband access to the 26 GHz band

|  |  |
| --- | --- |
| **Stakeholder** | **Access to the 26 GHz band** |
| Nokia | Around 2020 | |
| Qualcomm | No later than 2018 | |
| Samsung | 2018–19 | |
| Telstra | By end of 2018 | |
| Vodafone | From 2020 | |

Telstra noted that allocation of the 27–27.5 GHz segment might need to be delayed until after ITU-R sharing studies with fixed satellite services (FSS) have been completed, and Optus added that timings for the release of bands for wireless broadband services should align with the readiness of Australian markets.

### Licensing and sharing issues

The application of a conventional spectrum licensing regime for wireless broadband services in mmWave bands received significant support (Ericsson, Huawei, Intel, Optus, Qualcomm, Telstra, TPG and Vodafone), particularly for lower mmWave bands such as 26 GHz. Facebook, Intel, Microsoft and Qualcomm all proposed that access to the higher mmWave bands (various portions in the range 57–71 GHz) should be ‘licence exempt’.

Although there was strong support for the application of area-based licences, there were differing views on the size of the geographic areas to be made available for licensing. Large areas were supported by Ericsson, Huawei, Intel, Optus and Telstra. In general, there was reasonable agreement that access in major metropolitan areas should be a priority. Huawei and Telstra added that access in regional population centres and transport corridors would also be important. A phased approach to rolling out wireless broadband services, commencing in metropolitan areas and expanding to regional areas, was suggested by Huawei, Qualcomm and Samsung. Communications Alliance and ViaSat suggested that national or large area assignments should be avoided, and Vodafone suggested the national licences would be unlikely to be useful in mmWave bands.

Ericsson, Nokia, Optus, Telstra and Vodafone all suggested that large licence bandwidths would be important for wireless broadband services in mmWave bands.

Shared access to mmWave frequency bands was also discussed by various respondents, including Communications Alliance, which argued that exclusive access to mmWave bands by single services would deny the potential for coexistence with other services whose technical characteristics might be conducive to such coexistence. Communications Alliance also suggested that alternative approaches to spectrum management to help foster coexistence between services should be explored.

Nokia shared the view that exclusive licensing schemes might not always be appropriate in mmWave bands, and that other licensing options, such as sub-licensing, co-primary sharing and light licensing, could also be considered. Microsoft, TasmaNet and WiSPAU suggested the application of other licensing concepts, such as a dynamic spectrum licensing/access approach to enhance spectrum sharing. Conversely, Vodafone was of the view that sharing arrangements should not be mandated, suggesting that sharing should be facilitated via third-party access and secondary trading.

Consideration of incumbent services, particularly FSS, Earth Exploration Satellite Service (EESS) and Space Research Service (SRS), was also a key theme in responses. Airbus, Boeing, CSIRO, Huawei, Optus and SES all commented on the need to protect satellite earth stations (downlinks), with some respondents suggesting that coexistence could be managed through the implementation of geographical separation between earth stations and wireless broadband base stations. This is consistent with ACMA thinking on domestic management of coexistence between wireless broadband services and satellite downlinks operating in the abovementioned services.

### Electromagnetic Energy (EME) exposure

Some respondents (EMFacts Consultancy, ORSAA, Richard Cullan and Stop Smart Meters Australia) raised concerns about potential EME exposure resulting from wireless broadband equipment and infrastructure. It was argued that local government and the general public would have minimal control on where network infrastructure can and cannot be deployed, and as a result would have difficulty in controlling EME exposure. Some respondents also suggested that no potential wireless broadband mmWave bands should be progressed though the MBB strategy planning stages, further adding that no wireless broadband spectrum should be released until all health effects that may result from EME exposure are known.

## Next steps

At the start of consultation, the ACMA stated:

Regarding the 26 GHz mmWave band specifically, unless there are significant reasons raised to the contrary, the ACMA will use the information garnered from this process and proceed with development of an options paper for release in the first quarter of 2018.

Having reviewed submissions to the consultation process, and again noting the relatively low impact on incumbents, the ACMA has determined that it is appropriate to take that next step. This paper therefore signals progression of the 26 GHz band to the *preliminary replanning* stage.

We expect that submissions made in response to this paper will inform more detailed planning proposals, which will be set out in an outcomes paper that will signal progression to the *refarming* stage. Refarming timeframes will depend on which of the allocation scenarios proposed in the 2017–2021 FYSO is ultimately adopted, which will determine the priority order of allocations of different frequency bands.

# Case for action

The case for action on making the 26 GHz band available for wireless broadband is straightforward. Frequency harmonisation and development of relevant standards are well advanced, and there is growing international interest in the band for wireless broadband services. There is also significant domestic interest in making spectrum in this band available for wireless broadband, which is evidenced in submissions to the previous consultation process (see the *Summary of submissions* section of this paper).

This chapter describes how the band is currently used and the following chapter (specifically the *Interference management and coexistence between services* section) examines the coexistence potential between current use and wireless broadband, with the conclusion drawn that such coexistence is indeed feasible without practical degradation to existing services.

Given the limited ‘cost’ of taking any action, and noting the significant benefits of doing so, it follows that there is a strong case to do ‘something’, and conversely that the starting position is that doing ‘nothing’, essentially an invocation of the default ‘no change’ option (see options proposed in *26 GHz band options* ) would not represent the optimal use of the band. It is not the intent of this chapter to examine the relative merits of specific planning options – this is dealt with in *Chapter 5* – rather, this chapter endeavours to make a case for taking *any* action, by considering how wireless broadband services could make use of a mmWave spectrum allocation and how coexistence with incumbent services can be achieved.

## Millimetre wave wireless broadband overview

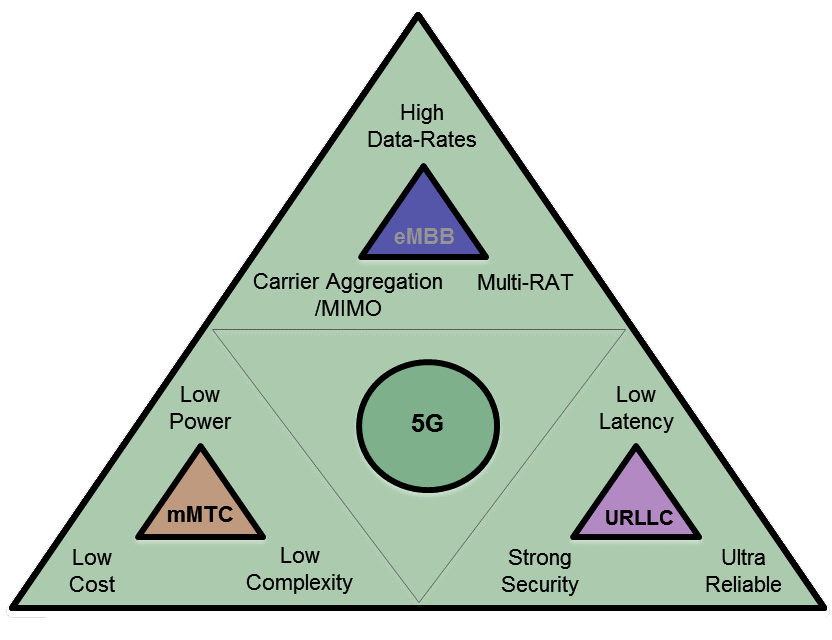
The wireless broadband technologies described in this paper encompasses those specified under [3GPP release 15 (R15)](http://www.3gpp.org/release-15) onwards. While the ITU-R refers to these technologies as [IMT-2020](https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Pages/default.aspx), the common marketing term is ‘5G’. It is true that 5G will represent a generational shift from established 4th generation Long Term Evolution (4G LTE) technologies, with significant improvements in data rate and latency being touted.

The number of interconnections is also expected to increase dramatically as end-use expands from largely human-driven applications to ubiquitous interconnected machines. Wireless broadband services will therefore be a key enabler of the rapidly-expanding Internet of Things (IoT) concept. These benefits are collectively encapsulated under three primary deliverables of so-called 5G technologies— ‘enhanced mobile broadband’ (eMBB), ‘ultra-low latency communications’ (URLLC) and ‘massive machine-type-communications’ (mMTC), as described in Figure 2.

As has conventionally been the case with mobile network deployments, ‘low band’ (for example, sub-6 GHz frequency bands, such as the soon-to-be-allocated 3.6 GHz band) spectrum will provide the wide-area coverage layer for networks, while higher bands—in this case mmWave bands—will provide more localised, higher capacity services. This owes to a combination of differing propagation characteristics and larger amounts of spectrum being available at higher frequencies.

Indeed, while conventional spectrum bands have been measured in terms of ‘MHz’ of bandwidth, mmWave bandwidths are measured in terms of ‘hundreds of MHz’ or even ‘GHz’. This represents a potentially enormous amount of capacity that has previously been unable to be leveraged by mobile networks due to a combination of less favourable propagation characteristics (including small cell size) and the lack of available equipment that can efficiently operate at these frequencies.

1. 5th generation wireless broadband technology use cases and characteristics[[15]](#footnote-16)

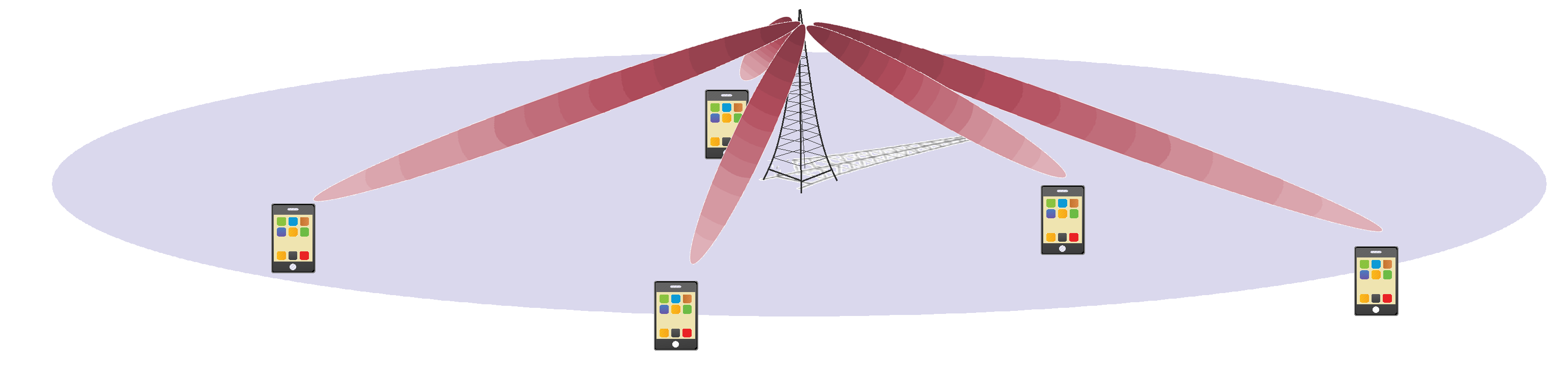


Materials and manufacturing developments have now improved to the extent that mmWave equipment can be developed in small form-factor devices. Tellingly, this includes improvements in antenna system manufacturing that have enabled mobile base stations (BS) and user equipment (UE) to be developed with complex beam-forming arrays (less complex on UE than on BS). Beam-forming involves individually feeding multiple antenna elements (the more elements, the more complex the array) with the same signal at different phase delays in order to ‘steer’ the antenna beam towards the target device. This improves the gain in the direction of that device, which increases the effective isotropic radiated power (EIRP) in the ‘wanted’ direction at the expense of gain in ‘unwanted’ direction, which essentially adds to the range between which a BS and UE can communicate (as shown in in Figure 3).

In basic terms, the implementation of beam-forming on wireless broadband devices will partly overcome the physical range limitations of mmWave frequencies. This does not mean mmWave cells will be comparable in size to conventional macro mobile networks operating at lower frequencies. Indeed, the relevant ITU-R task group considering mmWave bands for IMT-2020 under WRC-19 AI 1.13 specifies that 99 per cent of user devices will be less than 130m from a base station for suburban deployments, with smaller cells specified for urban and indoor deployments.[[16]](#footnote-17) So while complex antenna systems help improve the range of mmWave wireless broadband communications, bands such as 26 GHz will ultimately be used for small cell, high capacity communications.

Figure 3 provides a simplified depiction of the use of dynamic beam forming to both maximise cell coverage and significantly improve data capacity when operating at short propagation range frequencies such as mmWave bands. Traditional 2, 3 and 4G mobile deployments used much wider single static sector antenna beams (on BS) or notionally omni-directional beams (on UE) at lower frequencies (ranging from 700 to 2500 MHz).

1. Use of dynamic beam forming to maximise cell coverage and significantly improve data capacity



The improvements in antenna systems will also have a bearing on interference management, both in terms of *inter-service* (between wireless broadband and other services) and *intra-service* (between different wireless broadband systems) interference coordination. Conventional mobile networks used sector (panel) antennas on BS and (notionally) omni-directional antennas on UE. This resulted in a relatively predictable interference environment, even when considering networks using MIMO[[17]](#footnote-18) antenna systems (while far more complex than simple SISO16-based systems, the additional complexity was more attributable to physical channel diversity and coding than directionality).

The upshot of beam-forming being specified for wireless broadband systems is that interference will be far less predictable, essentially moving from a deterministic to probabilistic set of scenarios. While the likelihood of wireless broadband systems causing interference to, or suffering interference from, another service or device will be far lower than for conventional sectorised mobile systems, this will mean that different approaches need to be taken when assessing coexistence with other systems. It also means that conventional notions around ‘protection’ and ‘exclusivity’ for mobile networks need to be reassessed.

Another key aspect of the technology that will influence how spectrum is allocated will be its spectral characteristics. The technical standards for 5G, R15 5G new radio (NR), specifies carrier bandwidths of 50, 100, 200 and 400 MHz (with possible OFDM subcarrier bandwidths dependant on carrier bandwidth; for example, 400 MHz carriers are currently limited to the maximum 240 kHz subcarrier-spaced OFDM configuration due to limitations in FFT processing).[[18]](#footnote-19) There is also speculation that larger bandwidth profiles, for example, 800 MHz, will be included in the standard. All of this will have a bearing on how spectrum lots are ultimately configured in an allocation process (a matter for future consultation).

## Potential wireless broadband deployment models

The unique characteristics of wireless broadband in mmWave, including its suitability for highly localised deployments, will allow for a range of potentially heterogeneous deployment models, with greater scope for coexistence between these models than has previously been the case in lower frequencies. To aid in the development of planning options, the ACMA as considered three broad categories of use, however notes that deployments might ultimately form some hybrid or combination of these categories:

* **type 1:** Conventional wide-area subscriber networks, served by ubiquitous (albeit very densely arranged, at mmWave frequencies) base stations operated by one or more mobile service providers.
* **type 2:** Limited market subscriber networks, including—but not limited to—fixed wireless broadband services (including WISPs) and fleet-oriented mobile services.

**type 3:** Business enterprise services operated by private entities within the confines of their own premises or land estate.

Please note that these types don’t (necessarily) represent different levels of primacy or priority of access—they are simply intended to reflect the likely scale of deployment under each model. Note also that there are currently alternatives to 26 GHz allocations being considered for mmWave type 2 use—for example, in the frequency adjacent 28 GHz band.[[19]](#footnote-20)

1. **Is the three-type model an appropriate high-level representation of potential usage of the 26 GHz band? If not, are there any deployment models that should be included, excluded or omitted?**

## Scope for non-traditional authorisation

The abovementioned potential for multiple overlapping deployment models for IMT-2020 technologies flows on to consideration of how spectrum access under these models might be authorised. When considering the combined effect of propagation characteristics of mmWave frequencies and the antenna beam forming techniques that will be used by IMT-2020 at those frequencies, it follows that there may be arguments for moving away from the traditional single spectrum licensing frameworks used to authorise IMT-2020 and potentially applying a combination of the licence types described in the *Existing licensing regimes* section of this paper. This was echoed in responses to the previous round of consultation (see the *Licensing and sharing issues* section in this paper).

While any of the available licences could, in theory, be used to authorise any of the abovementioned types of use, there are clear linkages between use types 1, 2 and 3 and spectrum licensing, apparatus licensing and class licensing (respectively). Thus, the choice of licence that will ultimately authorise wireless broadband access to the band will likely be informed by policy positions on the intended types of use of the band (and the balance/proportionality of deployments under those use types). Responses to this paper, in particular to questions 1 and 3 regarding deployment models/use types, will help inform those policy positions.

## Service allocations and incumbency

The band under consideration, 24.25–27.5 GHz, is currently allocated to the mobile service on a primary basis in Australia. This allocation provides the high-level regulatory legitimacy to wireless broadband services being deployed in Australia, if that is ultimately the outcome of this process.

This frequency band is also allocated to a range of other co-primary services. These vary by frequency—Table 2 contains relevant excerpts from the *Australian Radiofrequency Spectrum Plan 2017* (ARSP). Table 3 provides a breakdown of licenses held in the band (currently 97 in total, excluding short-term scientific licences) by service.

1. Current allocations in the 24.25–27.5 GHz band in the ARSP. Column 1 contains international service allocations as set out in Article 5 of the ITU Radio Regulations, Column 2 contains service allocations unique to Australia

| **Column 1: ITU Radio Regulations Table of Allocations** | | | **Column 2:** |
| --- | --- | --- | --- |
| **Region 1** | **Region 2** | **Region 3** | **Australian Table of Allocations** |
| **24.25 – 24.45**  FIXED | **24.25 – 24.45**  RADIONAVIGATION | **24.25 – 24.45**  RADIONAVIGATION  FIXED  MOBILE | **24.25 – 24.45**  RADIONAVIGATION  FIXED  MOBILE  AUS87[[20]](#footnote-21) |
| **24.45 – 24.65**  FIXED  INTER–SATELLITE | **24.45 – 24.65**  INTER–SATELLITE  RADIONAVIGATION  533 | **24.45 – 24.65**  FIXED  INTER–SATELLITE  MOBILE  RADIONAVIGATION  533 | **24.45 – 24.65**  FIXED  INTER–SATELLITE  MOBILE  RADIONAVIGATION  533 AUS8720 |
| **24.65 – 24.75**  FIXED  FIXED–SATELLITE (Earth-to-space) 532B  INTER–SATELLITE | **24.65 – 24.75**  INTER–SATELLITE  RADIOLOCATION–SATELLITE (Earth-to-space) | **24.65 – 24.75**  FIXED  FIXED–SATELLITE (Earth-to-space) 532B  INTER–SATELLITE  MOBILE  533 | **24.65 – 24.75**  FIXED  FIXED–SATELLITE (Earth-to-space) 532B  INTER–SATELLITE  MOBILE  533 AUS8720 |
| **24.75 – 25.25**  FIXED  FIXED–SATELLITE (Earth-to-space) 532B | **24.75 – 25.25**  FIXED–SATELLITE (Earth-to-space) 535 | **24.75 – 25.25**  FIXED  FIXED–SATELLITE (Earth-to-space) 535  MOBILE | **24.75 – 25.25**  FIXED  FIXED–SATELLITE (Earth-to-space) 535  MOBILE  AUS8720 |
| **25.25 – 25.5** FIXED  INTER–SATELLITE 536  MOBILE  Standard frequency and time signal–satellite (Earth-to-space) | | | **25.25 – 25.5**  FIXED  INTER–SATELLITE 536  MOBILE  Standard frequency and time signal–satellite (Earth-to-space)  AUS8720 |
| **25.5 – 27** EARTH EXPLORATION–SATELLITE (space-to-Earth) 536B  FIXED  INTER–SATELLITE 536  MOBILE  SPACE RESEARCH (space-to-Earth) 536C  Standard frequency and time signal–satellite (Earth-to-space)            536A | | | **25.5 – 27**  EARTH EXPLORATION–SATELLITE (space-to-Earth)  FIXED  INTER–SATELLITE 536  MOBILE  SPACE RESEARCH (space-to-Earth)  Standard frequency and time signal–satellite (Earth-to-space)  536A AUS8720 |
| **27 – 27.5**  FIXED  INTER–SATELLITE 536  MOBILE | **27 – 27.5**  FIXED  FIXED–SATELLITE (Earth-to-space)  INTER–SATELLITE 536 537  MOBILE | | **27 – 27.5**  FIXED  FIXED–SATELLITE (Earth-to-space)  INTER–SATELLITE 536 537  MOBILE |

1. Current assignments for service allocations in the 24.25–27.5 GHz band in the ARSP, as of 1 July 2018

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Service** | **Radiodetermination** | **Earth receive** | **Fixed point-to-multipoint** | **Fixed earth** |
| **# licences** | 9 | 2 | 1 | 5 |
| **# licensees** | 9 | 2 | 1 | 3 |
| **# sites** | 9 | 2 | 12 | 13 |
| **# assignments** | 18 | 2 | 24 | 39 |
| **Freq range (GHz)** | 24.25–30 | 25.5–27 | 26.65–27.62 | 27–27.5 |
| **Purpose, predominant licensees** | Airports, law enforcement | Space research, CSIRO, Inmarsat Solutions | Pre-deployment 5G trials, Telstra | NBN Co, iPSTAR |

# Technical issues

## Interference management and coexistence between services

This chapter provides an overview of the interference management and coexistence issues that need to be considered for a potential introduction of wireless broadband services into the 26 GHz band. These issues are divided into inter-service and intra-service categories. A summary of international inter-service coexistence studies is also provided in Appendix 1.

### Inter-service coexistence

The ACMA is satisfied that coexistence of new wireless broadband services with incumbent services is largely achievable through the implementation of domestic policy and licensing arrangements. For example, considering the various licensed services shown in Table 3, the ACMA feels that these services are unlikely to experience any adverse effects from wireless broadband deployments:

Radiodetermination

Apparatus-licensed radiodetermination uses are generally limited to body scanning systems, which makes them largely confined to airport security screening areas and operating within shielded enclosures. The probability of interference to/from wireless broadband base stations and UE with dynamic beam forming antennas is likely to be very low. Preliminary analysis using information on a body scanner made available to the ACMA shows that separation distances between wireless broadband and body scanning systems to prevent interference under a *worst-case* scenario (direct antenna beam coupling, time and/or frequency coincidence) would be limited to ‘hundreds’ of metres, and most probably considerably less. This can be further mitigated when considering:

* From an interference *into* wireless broadband perspective, body scanners are essentially narrowband signals that are rapidly frequency-modulated across a wide bandwidth without dwelling on a specific frequency. OFDM-based signals, such as 4G and 5G wireless broadband, are by nature highly-tolerant to short duration, frequency-selective narrowband interference.

From an interference *from* wireless broadband perspective, in the unlikely event that interference occurs, the dynamic nature of antenna beam forming means this would likely only occur for a very short duration. The consequence of interference might be a failed scan, resulting in a request to rescan the subject—body scanners are programmed not to return ‘false negatives’ when a scan fails. The ACMA assesses that the combination of a low probability and low consequence of such an occurrence results in an acceptable risk.

In any case, careful site management, such as not directly co-locating wireless broadband mmWave base stations with airport body scanners or control of wireless broadband use in security screening areas, would be a prudent measure.

The [Low interference potential devices (LIPD) class licence](https://www.legislation.gov.au/Details/F2018C00500/Download) also permits the operation of a number of short-range radars in parts of the band. Of most interest is ultra-wideband (UWB) short-range vehicle radars operating in the frequency range 22–26.5 GHz. These radars are used to support various driver-assist systems such as adaptive cruise control and autonomous emergency braking. While vehicle radars in this band are being phased out in favour of more modern 77 GHz vehicle radars, it is acknowledged that legacy 26 GHz radars will remain in circulation for some time.

Again, considering the dynamic beam forming/scanning nature of mmWave wireless broadband technologies, and noting the ultra-wideband nature of these radars, the probability of any interference occurring is considered low. Specifically, the likelihood of radars having an adverse effect on wireless broadband receivers is very low, and any interference from wireless broadband services into radars is likely to be sporadic and very short in duration. Driver assist technologies are just that—they ‘assist’ drivers in decision making, and like body scanners, won’t return false positives in the event of a short-duration interference event, so the practical impact of the potential introduction of co-frequency wireless broadband services on vehicle radars is considered to be low.

In any case, operation under the LIPD is authorised on a ‘no interference, no protection’ basis—indeed radars currently coexist with other incumbent, co-frequency-licensed services—so they are afforded no formal protection from existing or new licensed services.

Earth receive

Earth receive stations support space research activities and are currently restricted to a limited number of space communications facilities at New Norcia, WA, and Tidbinbilla, ACT. Despite the stringent protection requirements for these earth stations, interference potential from wireless broadband services can be mitigated through the implementation of coordination and/or exclusion zones around those sites—this is supported by the results of ITU-R studies (see Appendix 1). This is normal practice when considering the specific protection requirements of satellite or space research earth stations—the ACMA would consult with incumbent licensees when determining which regulatory measures are necessary to afford this protection.

Fixed point-to-multipoint

Fixed point-to-multipoint licences have been used to provide temporary authorisation to parties (including MNOs) for conducting pre-deployment trials of wireless broadband technologies in the 26 GHz band. Coexistence with these users is therefore not necessary as they would be subsumed by more permanent arrangements if put in place.

Passive earth sensing

Coexistence between wireless broadband and near-adjacent band (23.6–24 GHz) global space-borne passive sensing services operating under the earth exploration satellite (EESS) service also needs to be assessed before making a decision on the lower bound of the frequency range to be allocated (or at least any conditions imposed on wireless broadband services at the lower end of the 24.25–27.5 GHz band). These considerations are ongoing within TG-5/1 of the ITU-R, as well as in other regional organisations.

In Europe, this work has so far resulted in the specification of emission limits on wireless broadband use of the 26 GHz band. In July 2018, the Electronic Communication Committee of CEPT (ECC) released a [decision paper](https://www.ecodocdb.dk/document/3361) setting out in-band and out-of-band emission (total radiated power, or TRP) limits. Specifically, these are:

* in-band base station emission limits (assuming TDD synchronisation between licensed operators):
* ≤ 50 MHz separation from licensed block edge: 12 dBm/50 MHz
* > 50 MHz separation from licensed block edge: 4 dBm/50 MHz.
* out-of-band emission limits into 23.6–24 GHz:
* from base station: -42 dBW/200 MHz
* from user equipment: -38 dBW/200 MHz.

How this will affect frequency arrangements and, ultimately, equipment markets for wireless broadband in Europe is not yet clear. However, throughout the ECC consultation process, members of the MBB community expressed the view that the proposed (and ultimately adopted) out-of-band emission limits would make the lower part of the band unusable for outdoor 5G deployments and would severely degrade services in other parts of the band.[[21]](#footnote-22) While there are currently no formal decisions on the size of the necessary frequency separation required for wireless broadband devices to meet the European limit, some preliminary views can be drawn from:

* the significant number of European countries considering an allocation only in the upper 1 GHz for the 26 GHz band (26.5–27.5 GHz)—a snapshot of national positions and developments in the 26 GHz band is available alongside this report on the [ACMA website](https://acma.gov.au/consultations).

the necessary frequency separation between wireless broadband transmissions and the passive band to meet a more relaxed emission limit of -37 dBW/200 MHz was estimated to be 1–1.5 GHz.[[22]](#footnote-23) The stricter European limits may require a larger frequency separation, although further study is required.

The scenarios studied to reach these outcomes are likely to differ from the Australian wireless broadband environment, particularly in terms of numbers of devices that would contribute to aggregate interference into space-borne EESS receivers. For example, if the peak device density assumed for Europe were to be double that of Australia, then the above limits, if imposed in Australia, could in theory be relaxed by 3dB. While European frequency arrangements will influence impact global equipment markets, it is also the case that Europe is not the only wireless broadband equipment market.

While some preliminary observations are possible, further work is required to develop suitable domestic planning arrangements around the lower part of the 26 GHz band. For example, it is highly likely that a lower boundary of 26.5 GHz would simultaneously meet the emission limits for EESS protection as determined by Europe, without any constraints on wireless broadband deployments being necessary. Taking a step further, a lower boundary of 25.5 GHz might also be feasible with the use of additional filtering, based on industry observations that suggest a 1.5 GHz frequency offset is needed for the additional filtering to provide 20 dB of signal attenuation.[[23]](#footnote-24)

A further approach might be to adopt different (potentially relaxed) emission limits that take into account differing deployment environments between Australia and Europe. Lastly, we could simply allocate the entire band on a ‘buyer beware basis’ and allow industry to determine how mandated protection of the passive services could be achieved.

Logically, potential outcomes would appear to range between three possible scenarios:

1. The band is allocated down to 24.25 GHz with no constraints on wireless broadband services.
2. The lower part of the band is not allocated in order to protect passive EESS services. The exact location of the revised lower edge would be informed by study outcomes.
3. The band is allocated down to 24.25 GHz, but with constraints imposed on wireless broadband services below a nominal frequency between 24.25 and 26.5 GHz (depending on study outcomes), including, but not limited to:

* indoor use only
* licensing restrictions that constrain the number of devices and therefore level of aggregate out-of-band interference into passive EESS, or
* lower permitted in-band emission limits than wireless broadband services operating above the nominal frequency.

We welcome responses from industry on appropriate domestic arrangements for the protection of EESS services. Particularly helpful would be concrete data on anticipated wireless broadband deployment scenarios and the technical characteristics of equipment (including, for example, expected filter characteristics of wireless broadband user equipment and base stations).

1. **What are the implications for 26 GHz wireless broadband in Australia of the** **Electronic Communication Committee of CEPT (ECC) decision on emission limits to protect passive EESS?**

How the issue of protection of passive EESS is resolved will be critical in determining the nature and timing of any reallocation of all or part of the 26 GHz spectrum. As the ACMA has insufficient information to develop firmer options beyond the three broad scenarios described above, we were not able to include a preliminary view on the correct approach to the protection of passive EESS, including the lower boundary of any allocation, in the *Replanning options* chapter of this paper. The ACMA will be keen to hear ideas in response to Question 2 that might help shape a useful outcome.

To further assist its deliberations, the ACMA proposes to convene a working group of interested stakeholders to consider appropriate measures to protect EESS below 24 GHz in the Australian context. Proposed terms of reference and a call for nominations for participation in this group are contained in Appendix 3.

* The group will be chaired by the ACMA.
* The group will be active during the consultation period for this paper, so respondents can better understand the inter-service coexistence issues to (in particular) help elicit practical suggestions in response to question 2 above.
* The focus of the group will be to study the frequency boundaries of the 26 GHz band—both at the bottom, regarding coexistence with EESS (passive), and at the top, regarding coexistence with fixed satellite services (FSS—see discussion below).

A secondary focus of the group may be to look at alternative licensing arrangements at the lower end of the band in frequencies in which it has been assessed that wide-area licensing cannot afford EESS the requisite amount of protection.

A call for nominations for participation in this group will follow in due course. The group’s recommendations will help inform ACMA planning decisions regarding frequency boundaries for the allocation of the 26 GHz band.

Fixed satellite (earth-to-space)

Fixed earth station uplink (earth-to-space) licences in 27–27.5 GHz are of considerable interest to the ACMA, as there is a need to assess the potential for interference both from earth stations into wireless broadband services and, potentially more challengingly, aggregate interference from (potentially) globally-deployed wireless broadband networks into FSS space receivers. This latter issue is complex and goes beyond the Australian domestic context. It has been the subject of extensive studies undertaken within Task Group 5/1 (TG-5/1) within the ITU-R on WRC-19 agenda item 1.13, of which Australia has been a significant contributor. These studies show that coexistence between wireless broadband services and FSS uplinks is possible under likely deployment scenarios—Appendix 1 contains a summary of these studies.

On the other hand, a less challenging interference management issue involves dealing with the potential for interference from fixed earth stations (typically large gateway earth stations) *into* wireless broadband systems.

Current Australian licensing arrangements require earth stations to be authorised via an apparatus licence with operating details, including location, recorded in the Register of Radiocommunications Licences. Having knowledge of fixed earth station locations simplifies the management of interference from fixed earth stations into wireless broadband services. As with protecting earth receive stations, this could be mitigated through the imposition of coordination or exclusion zones around those earth stations. Alternatively, a less interventionist approach might be to issue licences for wireless broadband services with an advisory note, and on the basis, that they will generally not be afforded protection from existing fixed satellite uplinks.

As mentioned under the discussion of coexistence with passive EESS above, it is intended that this issue will also be included within the scope of the domestic working group set up to study inter-service coexistence (see Appendix 3 for proposed terms of reference).

Intra-service coexistence

The above discussion of potential wireless broadband deployment models introduced the concept of type 2 and type 3 users. If and how these deployment models are ultimately accommodated are open questions that this consultation process is seeking to address. However, some of the licensing options (described in the *26 GHz band options* section) identify potential co-frequency sharing arrangements between type 3 users, who operate within the confines of their own premises or business area, and type 1 users who service the ‘outside world’.

Under these options, type 1 and type 3 use would be authorised by spectrum and class licences respectively—both area-wide licensing constructs that promote deployment flexibility. The class licence would essentially ‘underlay’ the spectrum licence in such a way that type 1 users would be protected from interference from type 3 users outside the latter users’ service areas. This would require that the class licence would need to be carefully crafted to ensure this protection can be assured. This may include specific conditions such as boundary PFD/PSD[[24]](#footnote-25) conditions and/or possibly device registration (or similar) to provide visibility to Type 1 operators. Comment on both the viability and potential implementation specifics of these proposals are invited in the *26 GHz band* *options* section of this paper.

## Other technical considerations

Electromagnetic energy (EME) exposure

As described in the *Summary of submissions* in this paper, some respondents to the previous consultation raised concerns about the EME effects of potential wireless broadband deployments in the 26 GHz band.

The ACMA is responsible for regulating radiofrequency EME for consumer devices (for example, mobile phones) and telecommunications facilities (for example, mobile phone towers). To make sure EME exposure is kept low, the ACMA applies the EME exposure limits set by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). ARPANSA is the Australian Government’s expert body on the health effects from EME produced by telecommunications facilities and other sources.

At typical levels, emissions from communications equipment are significantly below the ARPANSA exposure limits. ARPANSA and the [World Health Organization](http://www.who.int/peh-emf/en/) have assessed the scientific evidence on EME and health, and have concluded that there are no established health effects at levels below the exposure limits in the ARPANSA Standard.

Further information regarding EME is available from the ACMA’s [EME consumer hub](https://www.acma.gov.au/Citizen/Spectrum/About-spectrum/EME-hub).

Time-division duplex (TDD) synchronisation

A prospective wireless broadband allocation in the 26 GHz band is likely to be optimised for TDD operation. Synchronisation is an efficient method to manage adjacent channel interference between adjacent services operating in a TDD configuration.

Further consideration of how a synchronisation requirement should be applied in a 26 GHz band wireless broadband allocation will occur during the TLG process. The need to apply synchronisation to resolve interference is likely to be limited to small geographic areas due to the nature of signal propagation at 26 GHz. In any case, where there is a requirement for inter-network synchronisation, this will be considered by the TLG.

# 26 GHz band options

## Considerations

The ACMA has identified a number of options for replanning the 26 GHz band. Some were foreshadowed in a prior consultation and others have come to light in submissions to that consultation process. Each option is essentially a different permutation of a combination of a handful of key independent variables, which can be grouped broadly by:

* the geographic area(s) within which the band will be allocated
* frequency range(s) to be allocated

licensing arrangements, that is, applicability of spectrum, apparatus or class licensing regimes in different areas or frequency segments, including implications for exclusivity, sharing, device registration and/or coordination.

These variables are expanded below. Additionally, the deployment model of the intended end use will shape different combinations of the above three variables.

Defined geographic area

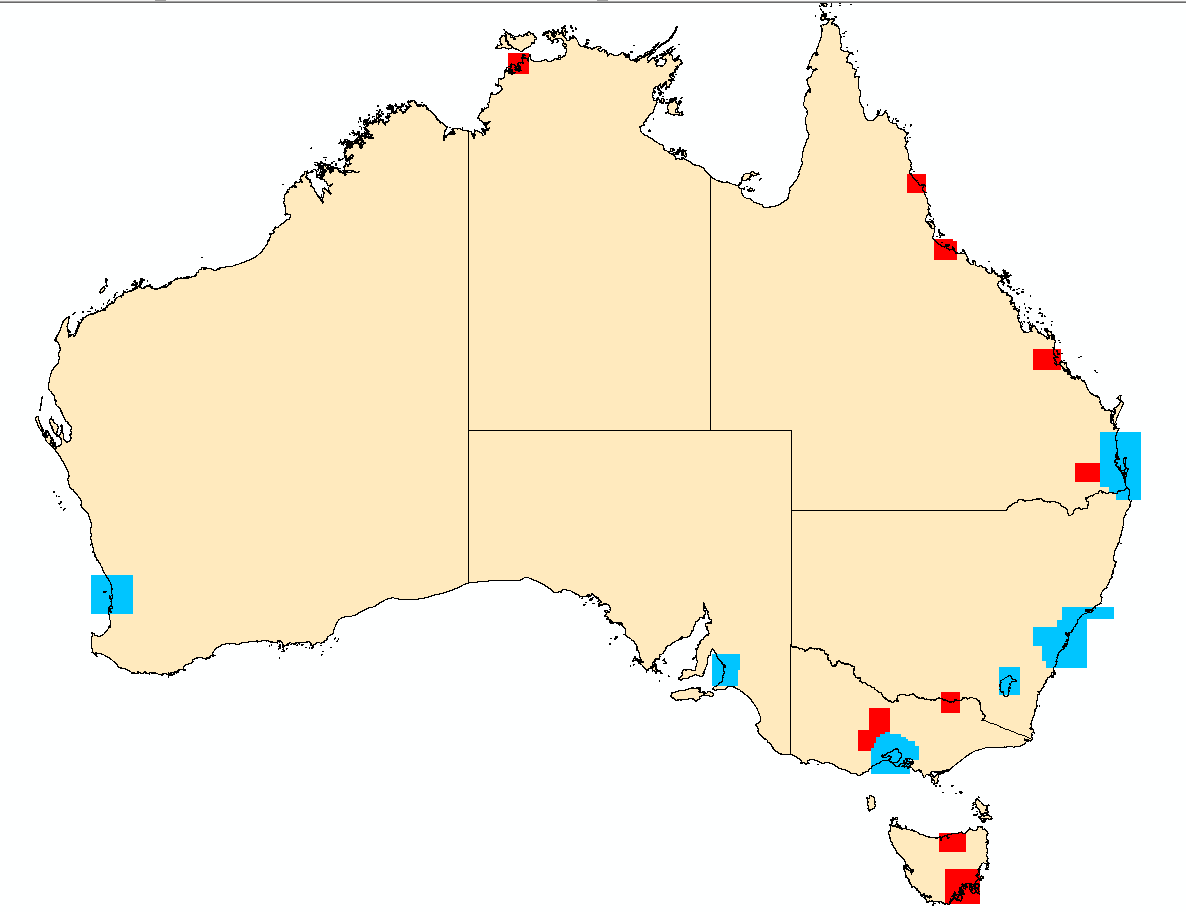
Areas that may be subject to area-wide licensing can range from those covering high-density urban environments, to Australia-wide. Given the propagation characteristics and likely deployment scenarios of wireless broadband services in the 26 GHz band, the ACMA currently does not see a case for the application of Australia-wide spectrum licensing. For the purposes of this paper, the areas that would ultimately be made available for spectrum licensing are termed ‘defined areas’. Note also that apparatus licensing will still be available outside these defined areas, and, under some options presented below, would be available within defined areas (although on different frequencies to spectrum licenses).

Current thinking is that it is likely to be appropriate to limit areas to be made available for spectrum licensing in the band to those areas where there is a genuine likelihood of extensive ‘wide-area’ networks under a type 1 style deployment model. In these bands, it is most likely to be in higher population centres such as metropolitan areas and possibly major regional centres—these are more akin to the areas re-allocated for spectrum licensing in the 3425–3442.5 MHz and 3475–3492.5 MHz bands. Figure 4 provides possible defined areas, with metro areas in blue and major regional centres in red.[[25]](#footnote-26)

1. **Are the proposed defined geographic areas for wide-area licensing appropriate?**

These zones are not settled and will be shaped by responses to the above question; however, the general approach of limiting spectrum licence areas to densely populated areas accords with most submissions to this consultation process—see *Licensing and sharing issues*.

1. Possible defined areas to be made available for spectrum licensing in the 26 GHz band—metro areas only (blue shading) or metro plus regional centres (blue and red shading)



Frequency

The ACMA has previously foreshadowed that 24.25–27 GHz or 24.25–27.5 GHz could be released for wireless broadband technologies. The question of the upper limit (27 or 27.5 GHz) reflected questions regarding coexistence with FSS uplinks. The lower limit of 24.25 MHz was originally contemplated assuming coexistence with passive services was achievable with wireless broadband operating all the way down to 24.25 GHz—as discussed elsewhere in this paper, this remains a key question to be considered.

Whichever frequency range is ultimately determined as suitable for an allocation, its specific structure remains an open question, in terms of both lot configuration (which is beyond the scope of this paper and will be the subject of a future consultation) and how different segments within the band might be licensed.

Licensing

At present, there are three different licence types that might be applied to authorise access to the 26 GHz band—spectrum, apparatus and class licensing. Traditionally, wide-area wireless broadband (most commonly used for mobile purposes) services are authorised under a spectrum licence. However, given the possible heterogeneity of deployment models, sharing potential of wireless broadband technologies at mmWave frequencies and localised nature of wireless broadband cells, it may be more efficient to consider the application of a combination of two or more of these licence types. Different licence types could apply in either different frequency segments and/or geographic areas, or even be applied in the same frequencies/areas with licence conditions setting out coordination or sharing requirements.

Deployment models

Getting the mix right between spectrum, apparatus and class licensing will depend, to some extent, on how accurately we can anticipate demand and use cases. Models for wireless broadband services in the 26 GHz band have been identified (see *Potential wireless broadband deployment models*). Ultimately, the ACMA will seek to optimise spectrum arrangements so they are conducive to the optimal balance of these deployment models.

Much of this, therefore, hinges on making pre-determinations of likely deployment models, which presents a risk that spectrum efficiency might not ultimately be optimised if the deployment models that inform licensing arrangements do not materialise. It stands to reason, for example, that type 1 use is likely to be prolific. However, whether there is merit in accommodating one or more of the other deployment models, particularly at the expense of spectrum/space resources allocated for type 1 deployments, remains an open question. Industry feedback will therefore be critical in forming policy on optimal deployment models and, by extension, which frequency, area and licensing combinations are optimal.

1. **What is the expected proliferation of—or demand for—services deployed under type 2 (apparatus-licensed) and/or 3 (class-licensed) models?**

## Replanning options

With the above in mind, several spectrum options have been identified for the 26 GHz band for wireless broadband services. In accessing the following replanning options, it is important to note that:

* Under all options existing services will not be removed from the band and will be able to coexist with wireless broadband services. However, given that additional assignment requirements may be needed to manage coexistence between wireless broadband services and services operating under other allocations, there may be some additional constraints on the deployment of new services. This will be considered in detail through the TLG process.

As the lower frequency limit is currently unknown, owing to the still unresolved issue of coexistence with adjacent band passive services, the lowest frequency in the replanning options—24.25 GHz—is marked with an asterisk.

The first option is, by default, ***Option 1—No change***. Operation of wireless broadband systems under this option would require that prospective operators gain access to spectrum via apparatus licences under the existing mobile allocation.

Options 2–5 entail different combinations of the abovementioned area, frequency and licensing regime characteristics to cover a range of potential deployment models. The primary option number pertains to potential licence types, with different combinations of licence types proposed under each option to meet the needs of these deployment models.

Note that under all options, ‘no change’ would apply outside of the geographic areas specified, meaning that wireless broadband services could be operated outside these areas under apparatus licences. It is yet to be decided how apparatus licences would be issued in these areas. For example, there may be rationale to issue area-wide, as opposed to ‘traditional’ site-based apparatus licences. Such arrangements could enhance the flexibility and utility of apparatus licences used to authorise wireless broadband services.

These primary licensing options for wireless broadband services in the band are as follows:

Option 2—Spectrum licensing only

* The entire frequency range available in the defined areas (subject to option variants below) would be allocated via spectrum licensing.
* Existing site-based apparatus licenses within defined areas would be retained.
* This would likely result in licences being held exclusively by type 1 users, such that type 2 and 3 users would need to gain access through third-party authorisation.
* Spectrum lot configurations would be defined at a later date, although it is recognised that wireless broadband services will optimally be deployed using bandwidths of multiples of 100 MHz, with 400 MHz being the current largest channel size included in standards (noting that this could change along with the possibility of carrier aggregation).[[26]](#footnote-27)

Apparatus licensing would be available outside the spectrum-licensed area for wireless broadband deployments.

Option 3—Combination of spectrum and apparatus licensing

* Part of the frequency range available in the defined areas (subject to option variants below) would be allocated via spectrum licensing, while the remainder would be available for apparatus licensing.
* Existing site-based apparatus licenses within defined areas in the spectrum-licensed frequency range would be retained.
* This would reduce the amount of spectrum optimised for type 1 use, but provide scope for type 2 and 3 users to gain access to spectrum in the apparatus-licensed segments (along with type 1 users if they so choose).
* The ACMA is also considering the upper-adjacent 28 GHz band for fixed wireless broadband services[[27]](#footnote-28), which may influence amount of spectrum allocated via apparatus licensing for type 2 use under this option.
* Spectrum lot configurations, including how much would be available for spectrum vs apparatus licensing, would be defined at a later date, although it is recognised that wireless broadband services will be optimally deployed using licensed bandwidths of multiples of 100 MHz (currently up to 400 MHz).[[28]](#footnote-29)
* Depending on the outcomes of domestic consideration of how to manage coexistence between wireless broadband and EESS below 24 GHz, it might be best for apparatus licensing, if accommodated, to apply at the lower end of the band (assuming fewer devices would be deployed under apparatus licensing than spectrum licensing). Where the frequency boundary between spectrum and apparatus licensing is, might also be influenced by EESS coexistence requirements.
* Apparatus licensing would be available outside the spectrum-licensed area for wireless broadband deployments.

Option 4—Combination of spectrum and class licensing

* The entire frequency range available in the defined areas (subject to option variants below) would be allocated via spectrum licensing.
* Existing site-based apparatus licenses within defined areas would be retained.
* An Australia-wide class licence would also be put in place that authorises secondary access to part or all of the band for type 3 users in an ‘underlay’ capacity. Technical limits/conditions would be imposed to manage interference to type 1 users outside of the physical premises/estate serviced by the type 3 operator, and to other incumbent services.
* The ACMA is also considering providing additional access to the 60 GHz band under a class licence arrangement, which will be suitable for some usage scenarios.[[29]](#footnote-30)
* Type 3 users requiring guaranteed protection from interference would need to gain access to spectrum by third-party agreement with spectrum licensees.
* Spectrum lot configurations would be defined at a later date, although it is recognised that wireless broadband services will be optimally deployed using licensed bandwidths of multiples of 100 MHz.
* The portion of the band that is included in the class licence (also likely to be a multiple of 100 MHz in bandwidth) would be defined at a later date.

Apparatus licensing would be available outside the spectrum-licensed area for wireless broadband deployments.

Option 5—Combination of spectrum, apparatus and class licensing

* Part of the frequency range available in the defined areas (subject to option variants below) would be allocated via spectrum licensing, while the remainder would be available for apparatus licensing.
* Existing site-based apparatus licenses within defined areas in the spectrum-licensed frequency range would be retained.
* This would reduce the amount of spectrum available for type 1 use, but provide scope for type 2 users to gain access to spectrum in the apparatus-licensed segments (along with type 1 users if they so choose).
* An Australia-wide class licence would also be put in place that authorises secondary access to part or all of the band for type 3 users in an ‘underlay’ capacity. Technical limits/conditions would be imposed to manage interference to type 1 and 2 users outside of the physical premises/estate serviced by the type 3 operator, and to other incumbent services.
* Spectrum lot configurations would be defined at a later date, including how much would be available for spectrum vs apparatus licensing, and the portion of the band that is included in the class licence would be decided at a later date. It is recognised that wireless broadband services will be optimally deployed using licensed bandwidths of multiples of 100 MHz.
* Depending on the outcomes of domestic consideration of how to manage coexistence between wireless broadband and EESS below 24 GHz, it might be best for apparatus licensing, if accommodated, to apply at the lower end of the band (assuming fewer devices would be deployed under apparatus licensing than spectrum licensing). Where the frequency boundary between spectrum and apparatus licensing is might also be influenced by EESS coexistence requirements.
* Apparatus licensing would be available outside the spectrum-licensed area for wireless broadband deployments.

The notes under option 3 regarding the 28 GHz band and 60 GHz bands under option 4, also apply to this option.

Each of options 2–5 is to be accompanied with a spectrum space variant (a, b, c, d), which pertains to the different combinations of geographic areas and frequency ranges. In describing broad licensing options, the option number without the variant is used. The spectrum space variants are defined as followed (noting that the lower frequency limit may be higher than 24.25 GHz depending on further considerations regarding coexistence with adjacent band passive EESS services, therefore 24.25 GHz is marked with an asterisk):

* **Spectrum space ‘a’:** The frequency band 24.25\*–27 GHz would be allocated in metropolitan areas only.
* **Spectrum space ‘b’:** The frequency band 24.25\*–27 GHz would be allocated in metropolitan areas, along with large regional centres.
* **Spectrum space ‘c’:** The frequency band 24.25\*–27.5 GHz would be allocated in metropolitan areas only.

**Spectrum space ‘d’:** The frequency band 24.25\*–27.5 GHz would be allocated in metropolitan areas, along with large regional centres.

It follows that the combination of licensing options and spectrum space variants essentially represents 17 options, being options 1, 2a, 2b, 2c … 5b, 5c, 5d. For example, option 4c would entail allocation of all of the 24.25\*–27.5 GHz band in metropolitan areas by spectrum licensing, but with an underlay class licence applied to some or all of the band for type 3 users on an Australia-wide basis (apparatus licenses would be available outside metropolitan areas, as with all other options). Table 4 provides a high-level summary of these options.

1. Summary of options (*Option 1—No change* is not included)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Spectrum licensing** | | | |
|  | **+ apparatus licensing in part of the band** | **+ co-frequency class licence (underlay across entire band)** | **+ apparatus licensing in part of the band + co-frequency class licence (entire band)** |
| 24.25\*–27 GHz in metro | Option 2a | Option 3a | Option 4a | Option 5a |
| 24.25\*–27 GHz in metro + major regional centres | Option 2b | Option 3b | Option 4b | Option 5b |
| 24.25\*–27.5 GHz in metro | Option 2c | Option 3c | Option 4c | Option 5c |
| 24.25\*–27.5 GHz in metro + major regional centres | Option 2d | Option 3d | Option 4d | Option 5d |

1. **Comment is sought on preferred option(s) for configuring and licensing the 26 GHz band.**
2. **If options 3 or 5 (all variants) are preferred, how much of the band should be available for spectrum licensing and apparatus licensing?**
3. **If options 4 or 5 (all variants) are preferred, how much of the band should be available for class licensing?**
4. **If options 4 or 5 (all variants) are preferred, what conditions should be applied to a class licence to protect co-frequency spectrum-licensed operations (in defined areas)? Would it be appropriate to define a means of making class-licensed use visible (for example, through a form of voluntary device registration)?**
5. **Are there any other replanning options that should be considered?**

An assessment of each of the above options is included in the following section of this chapter (see Table 5) and has been used to inform an ‘ACMA preferred’ option.

The government is currently in the process of reforming Australia’s spectrum management framework (refer to the *Spectrum Review).* Given the timeframes associated with the release of the 26 GHz band, arrangements are being developed on the assumption that the existing regulatory regime will apply. However, depending on when any new legislation begins, any new arrangements for the 26 GHz band may need to be accommodated under the new legislative framework. The ACMA will consider relevant opportunities offered by the implementation of the new legislative framework.

## Assessment of options

An assessment of each of the identified options against the [Principles for Spectrum Management](http://www.acma.gov.au/theACMA/About/The-ACMA-story/Facilitating/decisionmaking-process-fyso-25-1) (as described in the *Legislative and policy environment* chapter), is contained below. This analysis is informed by both ACMA analysis and responses to the *Questions for consultation* paper. The Principles are:

1. Allocate spectrum to the highest value use (HVU) or uses.
2. Enable and encourage spectrum to move to its HVU.
3. Use the least cost and least restrictive approach to achieving policy objectives.
4. To the extent possible, promote both certainty and flexibility.
5. Balance the cost of interference and the benefits of greater spectrum utilisation.

Given it has been assessed that the potential for interference from 26 GHz wireless broadband systems into incumbent services is negligible, there is no need to quantify the value attributable to each service with respect to one another. Instead, this section makes a qualitative assessment of the different options against each of the Principles. The degree of heterogeneity between options depends on the Principle under consideration; for example, in considering some Principles, the suitability of primary licensing options might be highly variable, but assessment might be homogenous across spectrum space variants (or vice versa).

The uncertainty surrounding the lower boundary of the band, subject to assessments of how to coexist with EESS operating below 24 GHz, applies to all options (except, of course, the ‘no change’ option), so does not have any bearing on a comparison of options.

### Principle 1—Allocate spectrum to the highest value use (HVU) or uses

The highest value use (HVU) of the 26 GHz band is likely to be highly contestable if considering the relative value of specific deployment models. For example, the ACMA would argue strongly that the HVU in this band would consist of wireless broadband services, as well as earth exploration satellite, space research and fixed satellite services, owing to the well-established international growth in support for wireless broadband services in a range of industry and government forums, including:

* progress of standardisation within the 3rd Generation Partnership Project (3GPP, band number n258 has been allocated to 24.25-27.5 GHz)
* consideration of the 26 GHz band as a candidate IMT-2020 band in the WRC-19 process, as well as ITU-R studies showing that coexistence with other services is feasible (as detailed in *Appendix 1: Summary of coexistence studies*)
* consideration for adoption of part or all of the band by individual administrations, including the US, Korea, Japan, the European Union and China
* some responses to the ACMA’s *Questions for consultation* paper (noting that not all responses were in support)
* domestic trial activities[[30]](#footnote-31)

future availability of 26 GHz-capable wireless broadband equipment.[[31]](#footnote-32)

Given the likely emergence of a ubiquitous mass-market wireless broadband ecosystem in this band internationally, the ACMA is strongly of the view that not facilitating the deployment of wireless broadband in the 26 GHz band would place Australia at a significant social, productivity, and commercial disadvantage with its international partners.

To assert that this means that wireless broadband on its own represents the HVU would necessitate a qualitative and quantitative analysis of the relative costs and benefits for incumbent services. However, when it is considered that coexistence with incumbent services in the band has largely been established, that is:

* wireless broadband can be deployed in 24.25\*–27 GHz with little or no disruption to incumbent operations, and

as described in Appendix 1, ACMA (and other) studies have shown that wireless broadband can coexist with FSS uplinks in the 27–27.5 GHz band,

it becomes clear that the HVU need not represent a single service, rather the HVU can be achieved by accommodating both incumbent *and* proposed services in the band. This is a view shared by Communications Alliance and ViaSat, which both suggested that a second service sharing with wireless broadband will provide more value than a single service model. With respect to the specific Principle to be addressed—*Allocate spectrum to the highest value use (HVU) or uses*—if a prospective *high value* service can be accommodated without displacement of existing services, then the *highest value* use would result from doing so.

Thus, without needing to consider the relative value of incumbent services, we can conclude that deployment of wireless broadband services in the band represents the HVU and, therefore, an allocation of spectrum within a given space would, in a broad sense, return a favourable assessment against Principle 1.

Principle 1 goes specifically to *allocation* (in the Australian legislative sense, as distinct from the ITU ‘service’ allocation sense)*,* which in a frequency and area sense warrants an examination of spectrum space variants (a, b, c and d), the licensing options (options 1, 2, 3, 4 and 5) are more germane to Principle 2 (*enable and encourage spectrum to move to its HVU*—discussed below) as they will facilitate, to varying degrees of optimisation, the transition from current to future use.

So, having established that an allocation of spectrum to facilitate wireless broadband would satisfy Principle 1, it can further be determined which of the spectrum variants would *best* satisfy this Principle. Given the ACMA’s satisfaction that wireless broadband can coexist with FSS uplinks in the 27–27.5 GHz band, there does not appear to be any reason to preclude an allocation above 27 GHz. If it is accepted that the costs of doing so are negligible, it stands to reason that the highest value use would be realised through an allocation of as much spectrum as possible (so long as it is all useful) in the band.

This simple proposition that yields benefits with little/no cost can also be applied to geographic areas as well—if there is expected to be demand for type 1 services in larger regional centres outside metropolitan areas, then the HVU would be represented by expanding type 1 licence areas accordingly. However, the ACMA is not convinced that there is sufficient type 1 demand outside such centres to warrant further expansion (for example, to Australia-wide licensing), particularly given the default option of apparatus-licensing services in non-spectrum-licensed areas will facilitate access if needed.

As a result, it is the ACMA’s assessment that the spectrum space variants that best satisfy Principle 1 would be either c or d, and if a case can be made that area licences will be necessary in regional centres, the HVU would be represented by variant d.

1. **Is there likely to be sufficient demand for type 1 services in regional centres outside metropolitan areas, and if so, what centres (either explicitly listed or by population threshold) should be included in the expanded licence areas?**

### Principle 2—Enable and encourage spectrum to move to its HVU

Striking the right balance of licensing will be crucial to enabling and encouraging the 26 GHz band to move to its HVU, which as described in the discussion under Principle 1, would result from wireless broadband deployments in the band. What an optimal combination of licensing is remains an open question and depends on as yet undetermined demand and deployment models.

This paper has introduced a range of *26 GHz band* optionsthat map to different licensing combinations, and are designed to potentially accommodate up to three broad deployment models—wide-area MNO networks (type 1), smaller targeted market networks including fixed wireless broadband internet (type 2) and small private networks for business or community enterprises (type 3). Feedback has been sought on the validity of these proposed deployment models, which will help inform which of the licensing options is best placed to optimally satisfy Principle 2.

Of the five licensing options, option 1 (no change) would clearly not enable the HVU, as it would significantly constrain type 1 and 3 users’ ability to deploy wireless broadband networks. Option 2 (spectrum licensing only) would best enable the HVU if type 1 use was likely to be the sole use of the band. Option 3 would involve spectrum licensing part of the band for type 1 use in the defined area(s) and reservation of the remainder for apparatus licensing by type 2 (or other) users—however, even if there is demand for this type of use, it remains contestable as to whether dedicating spectrum for this purpose would be an overall efficient use of spectrum.

Option 4 would be optimal if it were determined that facilitating unconstrained type 1 and 3 use was considered conducive to the HVU. The conditions of the underlay class licence would need to be designed in a way that practically mutes the risk of degradation to type 1 services outside the physical boundary of a type 3 operator’s premises, and may include implementation of a registration regime for devices operating under the class licence. Option 5 combines options 3 and 4, with spectrum set aside within the defined area(s) for apparatus licensing of type 2 services, as well as an underlay class licence in place to accommodate type 3 services.

For options 3 and 5, in terms of enabling and encouraging spectrum to move to its HVU, there is the potential that dividing the 26 GHz band between two licence types within the defined area might not be optimally spectrally efficient, as it would reduce the amount of contiguous spectrum that could be spectrum licensed under options 2 or 4. However, if lot configurations for spectrum licensing do not contiguously occupy the entire band (for example, if there is ‘left over’ spectrum), for practical reasons it might be appropriate to make the remaining spectrum available for apparatus licensing. The key advantage of implementing spectrum licensing across the entire band, if possible, is that it would be more likely to result in ubiquitous, denser deployments of wireless broadband services across the entire band in the defined areas than might occur if part of the band was only available for apparatus licensing.

On the other hand, doing so might miss an opportunity to encourage more market entrants and facilitate different types of use in the band such as fixed wireless broadband, creating a richer overall ecosystem of mmWave broadband technologies and topologies. There are mitigations for this—not the least that there are other mmWave bands under consideration for type 2 use[[32]](#footnote-33), but also that the scope for third- party-authorised access to the 26 GHz band within defined areas will remain a possibility under all licensing options, as will the ability to take out apparatus licences on a coordinated basis outside those areas.

On balance, it seems that the application of a spectrum-licensing regime to the entire 26 GHz band, within the defined areas, would be the most conducive to enabling and encouraging spectrum to move to its HVU. This means that either licensing options 2 or 4 would best satisfy Principle 2. In comparing these two options, option 2 could be considered the ‘baseline’ option, as option 4 would essentially comprise all elements of option 2, but with additional provisions put in place to accommodate type 3 users. Whether these additions could be justified would likely depend on two key factors:

* Is there sufficient demand for type 3 services to justify this approach?
* Can class licence conditions under option 4 ensure type 3 operations do not significantly diminish type 1 operations?

Comment has been invited on these questions in the *5 26 GHz* band options section of this paper. If the answer to both of these questions is ‘yes’, then it follows that (as with the discussion of what constitutes HVU under Principle 1) the additional gain at little or no penalty to alternative uses would suggest that option 4 best satisfies Principle 2. At this stage these remain open questions, so the preliminary view is that either options 2 or 4 would best satisfy the Principle, pending consideration of responses to this paper.

Having established that providing access to wireless broadband services, in addition to incumbent services, represents the HVU, it can be seen that variants of options that preclude wireless broadband access in 27–27.5 GHz do not satisfy Principle 2 in this frequency range.

### Principle 3—Use the least cost and least restrictive approach to achieving policy objectives

DoCA recently released its *5G–Enabling the future economy* paper[[33]](#footnote-34), which sets out the Australian Government’s direction for 5G and included discussion on roles the government will need to play in facilitating the delivery of 5G services. This is accompanied by other useful 5G-related guidance provided by DoCA, such as the regulatory impact statement (RIS) on allocation limits for the 3.6 GHz auction, which provides an outline of the government’s policy objectives for that particular auction.[[34]](#footnote-35)

The *Enabling the future economy* paper highlighted four key areas for government action:

* making spectrum available in a timely manner
* actively engaging in international spectrum harmonisation activities
* streamlining arrangements to allow mobile carriers to deploy infrastructure more quickly

reviewing existing telecommunications regulatory arrangements to ensure they are fit-for-purpose.

While the ACMA is active in all of the above areas, it is *making spectrum available in a timely manner* that gives clear policy guidance on the objectives of this paper, noting the criticality of 26 GHz as a so-called ‘pioneer’ mmWave wireless broadband band. When considering the various replanning options for the 26 GHz band, option 1 can be dismissed as it would fail to meet this broad policy objective. Consideration of the other options against Principle 3 requires separate examination against the *least cost* and *least restrictive* aspects of the Principle.

Least cost

From a financial cost perspective, all options would require investment by licensees commensurate with the level of coverage and capacity they seek to provide, so there is no clear preferred option. Similarly, (excluding option 1) all options would result in levying of spectrum licence charges and taxes—options 3 and 5 might result in lower *overall* charges and taxes payable, but that would simply be a proportional reflection of there being less spectrum available for spectrum licensing.

Thus, the cost differentials between options that need to be considered aren’t so much financial costs, rather regulatory costs to affected operators. This most applies to incumbent users, as regulatory costs for prospective users are better described under the *least restrictive* aspect of the Principle below.

Appendix 1 provides a summary of studies of coexistence between potential wireless broadband services and incumbent services operating in the band. It underpins the ACMA’s assessment that incumbent services are unlikely to be adversely affected by wireless broadband deployments, so long as new regulations facilitating such deployments do not place new constraints on existing operations (a corollary of those studies is that such constraints are unlikely to be necessary either). It follows that, under all replanning options, the costs to incumbents are likely to be low and there are no clear preferred (or ‘not preferred’) options for meeting this criterion.

Least restrictive

In general, spectrum licensing is significantly less restrictive than device-by-device apparatus licensing for the deployment of wide-area wireless broadband networks, so option 1 can be ruled out in the first instance. Whether spectrum licensing across the whole band (as in options 2 and 4) is preferable to a combination of spectrum and apparatus licensing (options 3 and 5) depends on the case for type 2 use and the relative cost/benefits of reserving spectrum for type 2 apparatus licences versus spectrum licensing the entire band.

As discussed under Principle 2, the ACMA is not convinced that spectrum licensing the entire band would, of itself, preclude type 2 deployments, noting the potential scope for apparatus licensing outside defined areas, potential for third-party authorisations within defined areas and pending ACMA investigations of alternative spectrum arrangements for such use. Given these mitigations, it would seem that, on balance, the benefits to be gained from quarantining parts of the band for apparatus licensing would not justify the resulting restrictions on wide-area deployments. By that logic, options 2 and 4 would be *less* restrictive than options 3 and 5.

Option 4 would also introduce the ability for type 3 users to gain co-frequency (with spectrum licences) access within their private premises/estates in defined areas on a no interference/no protection basis. As with the above analyses, if it can be assured that the conditions of the class licence authorising this access will not unreasonably constrain spectrum-licensed operations, then permitting such access would represent a *least restrictive* approach.

Having established that providing access to wireless broadband services, in addition to incumbent services, satisfies Principle 3, it can be seen that variants of options that preclude wireless broadband access in 27–27.5 GHz do not satisfy Principle 3 in this frequency range.

### Principle 4—To the extent possible, promote both certainty and flexibility

Certainty

It is well-established that when comparing licence types for wide-area mobile network deployments, spectrum-licensing regimes provide significantly more investment certainty than apparatus licensing, owing to both the tenure and rights afforded under spectrum licensing.

However, in this case, this does not directly translate to options 2 and 4 being preferable to options 3 and 5. Under options 3 and 5, type 1 users holding spectrum licenses would still have certainty, they would just (as a collective) have access to less spectrum than if the entire band was to be spectrum licensed. Under these options, type 2 operators would also be able to access spectrum via apparatus licences, however, this carries a significantly lower degree of certainty for operators.

In terms of regulatory certainty, operationalisation of options 3 and 5 would carry a risk of the portion of the band available for apparatus licensing being underutilised within defined geographic areas. Considering the abovementioned mitigations (including potential alternative options) against the effects of not setting aside spectrum for apparatus licensing, raises questions as to whether or not this risk is acceptable, particularly given the 26 GHz band’s role in paving the way for mmWave wireless broadband deployments in Australia. With this in mind, and noting that options 2 and 4 are the options most likely to provide some assurance that the entire band would be used in a (spectrally) efficient way, it can be inferred that these options would also represent the greatest degree of regulatory certainty.

Flexibility

Spectrum licences are ‘technology flexible’ and they allow operators to tailor deployments to meet market demand. However, from an overall perspective, options 3 and 5 might provide additional flexibility as they would provide for an alternative use of the band, albeit at the expense of the capacity of another user to provide a service. It is not clear which of these arguments is the strongest, and much will depend on stakeholder responses to this paper; in particular, views on the need for—and validity of—quarantined spectrum arrangements to support type 2 access.

The potential for an underlay class licence to provide secondary access to private operators (under options 4 and 5) would clearly increase flexibility as it would increase the types of services that could be deployed without unreasonably restricting primary services.

With the above in mind, the options that are most likely to promote both certainty and flexibility are those that involve spectrum licensing of the entire band and support secondary access by class-licenced services—that is, all variants of option 4.

### Principle 5—Balance the cost of interference and the benefits of greater spectrum utilisation

Based on the assessment of compatibility studies contained in *Appendix 1:   
Summary of coexistence studies,* the ACMA has assessed that the cost of interference to incumbent users from proposed wireless broadband services is negligible. Therefore, consideration of options against this principle can be concentrated on balancing the interference between the potential different wireless broadband deployment models and the benefits of accommodating those deployment models. This more pertains to coexistence between type 1 and type 3 users, as type 2 users would operate in separate spectrum to type 1 users under the options that would accommodate type 2 use (options 3 and 5).

As mentioned in discussions of other Principles, whether an underlay class licence would materially degrade the ability of type 1 users to provide a service remains an open question and the ACMA is inviting comment on how these issues could be managed. However, if it is to be accepted that the class licence conditions can sufficiently protect type 1 users outside private premises serviced by type 3 users, then it could be assessed that the interference cost is negligible. In this case, the additional utilisation afforded to type 3 use (assuming there is demand for these services—views are also being sought on this) would mean that options 4 and 5 are preferable.

Since this discussion either depends on a resolution of the viability/necessity of an underlay class licence—or is independent of whether dedicated apparatus-licensed spectrum is set aside—it is not possible to make a meaningful comparison of the primary licensing options against this Principle.

It is, however, possible to coarsely rank the suitability of the spectrum/space variants’ ability to satisfy the Principle. In simple terms, given that the ACMA is satisfied that coexistence between incumbent and proposed services is feasible without degradation to those incumbent services, the ‘cost’ of interference is considered negligible. This means that the ‘cost’ is homogenous across all of the proposed spectrum space arrangements (including in 27–27.5 GHz, based on results of studies). So, it follows that arrangements that will result in higher degrees of spectrum utilisation will return a more favourable assessment against this Principle. In this case, spectrum space variant d, which comprises the largest combination of spectrum and geographic area, would result in the most spectrum utilisation.

### Summary of assessments

Table 5 provides a high-level summary of all of the above assessments of each option against each of the Principles.

1. Summary of assessment of options against Spectrum Management Principles

|  | Option 2—Spectrum licensing of whole (available) band in defined areas | Option 3—Part-band spectrum licensing + part band apparatus licensing in defined areas | Option 4—Spectrum licensing of whole (available) in defined areas + co-frequency class licensing of whole (available) band | Option 5—Part-band spectrum licensing + part band apparatus licensing in defined areas + co‑frequency class licensing of whole (available) band |
| --- | --- | --- | --- | --- |
| **Variant a** | * Failure to allocate in spectrum and areas that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if there is no demand for type 2 and 3 services * Low (relative) regulatory cost approach * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum licensing would deny flexibility of deployment models * Least (relative) complexity * Least optimal spectrum utilisation | * Failure to allocate in spectrum and areas that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * High (relative) regulatory cost approach (need for ongoing coordination between services) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum and apparatus licensing would reduce flexibility of deployment models * Low (relative) complexity * Least optimal spectrum utilisation | * Failure to allocate in spectrum and areas that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if there is demand for type 3, but not type 2 services * Feasibility depends on coexistence between class licenced and spectrum licenced services * Moderate (relative) regulatory cost approach (need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing would increase flexibility of deployment models. * High (relative) complexity * Low (relative) spectrum utilisation | * Failure to allocate in spectrum and areas that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if there is no demand for type 3 services and if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * Feasibility depends on coexistence between class licenced and spectrum/apparatus licenced services, and incremental benefit only worthwhile if spectrum licence lots don’t occupy the entire band * High (relative) regulatory cost approach (need for ongoing coordination between services and need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing and dedicated apparatus licenced spectrum (if beneficial) would increase flexibility of deployment models. * Highest (relative) complexity * Low (relative) spectrum utilisation |
| **Variant b** | * Failure to allocate in spectrum that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if there is no demand for type 2 and 3 services * Low (relative) regulatory cost approach * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum licensing would deny flexibility of deployment models * Least (relative) complexity * Low (relative) spectrum utilisation | * Failure to allocate in spectrum that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * High (relative) regulatory cost approach (need for ongoing coordination between services) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum and apparatus licensing would reduce flexibility of deployment models * Low (relative) complexity * Low (relative) spectrum utilisation | * Failure to allocate in spectrum that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if there is demand for type 3, but not type 2 services * Feasibility depends on coexistence between class licenced and spectrum licenced services * Moderate (relative) regulatory cost approach (need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing would increase flexibility of deployment models. * High (relative) complexity * Low (relative) spectrum utilisation | * Failure to allocate in spectrum that could be efficiently used would not achieve HVU * Will enable the band to be moved to its HVU if there is no demand for type 3 services and if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * Feasibility depends on coexistence between class licenced and spectrum/apparatus licenced services, and incremental benefit only worthwhile if spectrum licence lots don’t occupy the entire band * High (relative) regulatory cost approach (need for ongoing coordination between services and need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing and dedicated apparatus licenced spectrum (if beneficial) would increase flexibility of deployment models. * Highest (relative) complexity * Potentially high (relative) spectrum utilisation, depending on demand for type 2 services |
| **Variant c** | * Failure to allocate in areas that could be efficiently used may not achieve HVU, depending on demand in regional centres * Will enable the band to be moved to its HVU if there is no demand for type 2 and 3 services * Low (relative) regulatory cost approach * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum licensing would deny flexibility of deployment models * Least (relative) complexity * High (relative) spectrum utilisation | * Failure to allocate in areas that could be efficiently used may not achieve HVU, depending on demand in regional centres * Will enable the band to be moved to its HVU if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * High (relative) regulatory cost approach (need for ongoing coordination between services) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum and apparatus licensing would reduce flexibility of deployment models * Low (relative) complexity * Potentially high (relative) spectrum utilisation, depending on demand for type 2 services | * Failure to allocate in areas that could be efficiently used may not achieve HVU, depending on demand in regional centres * Will enable the band to be moved to its HVU if there is demand for type 3, but not type 2 services * Feasibility depends on coexistence between class licenced and spectrum licenced services * Moderate (relative) regulatory cost approach (need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing would increase flexibility of deployment models * High (relative) complexity | * Failure to allocate in areas that could be efficiently used may not achieve HVU, depending on demand in regional centres * Will enable the band to be moved to its HVU if there is no demand for type 3 services and if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * Feasibility depends on coexistence between class-licenced and spectrum/apparatus-licenced services, and incremental benefit only worthwhile if spectrum licence lots don’t occupy the entire band * High (relative) regulatory cost approach (need for ongoing coordination between services and need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing and dedicated apparatus-licenced spectrum (if beneficial) would increase flexibility of deployment models. * Highest (relative) complexity * Potentially high (relative) spectrum utilisation, depending on demand for type 2 services |
| **Variant d** | * Allocating all available spectrum and areas that could be efficiently used would best achieve HVU * Will enable the band to be moved to its HVU if there is no demand for type 2 and 3 services * Low (relative) regulatory cost approach * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum licensing would deny flexibility of deployment models * Least (relative) complexity * High (relative) spectrum utilisation | * Allocating all available spectrum and areas that could be efficiently used would best achieve HVU * Will enable the band to be moved to its HVU if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * High (relative) regulatory cost approach (need for ongoing coordination between services) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. However, limiting authorisation to spectrum and apparatus licensing would reduce flexibility of deployment models * Low (relative) complexity * Potentially high (relative) spectrum utilisation, depending on demand for type 2 services | * Allocating all available spectrum and areas that could be efficiently used would best achieve HVU * Will enable the band to be moved to its HVU if there is demand for type 3, but not type 2 services * Feasibility depends on coexistence between class-licenced and spectrum-licenced services * Moderate (relative) regulatory cost approach (need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing would increase flexibility of deployment models * High (relative) complexity * Most optimal spectrum utilisation | * Allocating all available spectrum and areas that could be efficiently used would best achieve HVU * Will enable the band to be moved to its HVU if there is no demand for type 3 services and if it is not practical to allocate the entire band by spectrum licence (dependent on lot configurations) * Feasibility depends on coexistence between class licenced and spectrum/apparatus-licenced services, and incremental benefit only worthwhile if spectrum licence lots don’t occupy the entire band * High (relative) regulatory cost approach (need for ongoing coordination between services and need to carefully define class licence conditions) * Spectrum licensing promotes certainty and technology flexibility for type 1 users. Underlay class licensing and dedicated apparatus-licenced spectrum (if beneficial) would increase flexibility of deployment models. * Highest (relative) complexity * Potentially high (relative) spectrum utilisation, depending on demand for type 2 services |

## Preferred options

Given the favourable assessments of coexistence between potential wireless broadband services and incumbent services, the service that represents the HVU of the band can remain a somewhat moot point. That is, the ‘relative’ value between services is not as important as the overall optimal value of services that the band can provide. In this context, accommodating wireless broadband, along with incumbent services, clearly represents a higher value of use than not doing so.

By extension, it is sensible to optimise the amount of spectrum and space available for this purpose, with the caveat that issuing wide-area licences in geographic areas that are unlikely to see wireless broadband coverage deployed would not be a valuable use of spectrum. The ACMA does not see any value in allocating spectrum for wireless broadband in mmWave bands on a wide-area basis outside the defined areas proposed in this paper, noting that deployments outside those areas will still be possible under apparatus licenses.

It follows that the HVU can be achieved by making the entire spectrum range under consideration, being 24.25\*–27.5 GHz, available for spectrum licensing within the defined areas proposed in this paper (again noting that existing site-based apparatus licences will be retained). This is reflected in the analysis undertaken in the previous section, which shows that the options that best satisfy the Principles for Spectrum Management are those that both make the most spectrum available in the largest areas and authorise access to the band via spectrum licence across the entire band, with co-frequency class licensing to enable coexisting type 3 services. Option 4d meets these objectives to the ‘highest’ degree, while options 2d, 3d, and 5d would also do so to a ‘high’ degree.

An important qualifier to this assessment is that achieving the HVU through releasing the entire band for spectrum licensing would only hold true if the entire band could be efficiently used by type 1 users. This would depend on lot configurations for a spectrum licence allocation, which will be informed by both advice on demand for services and technical factors (for example, carrier bandwidths as defined in relevant technical standards—see description in the *Case for* *action* section of this paper). If the lots do not ultimately occupy the entire band, there may be scope to consider making the remainder of the band available for apparatus licences to support type 2 use.

To that end, and noting that option 4d on face value returns the most favourable assessment against the Principles, from a pragmatic perspective, option 5d could be considered an alternate preferred option, depending on spectrum licence lot configurations. Where within the band the apparatus-licensed segment(s) would be located under option 5d is also an open question—for example, depending on the outcome of coexistence studies between wireless broadband and passive earth sensing services (see discussion in the *Interference management and coexistence between services* section), it may be prudent to use the lower part of the band for this purpose to reduce the cumulative out-of-band interference into passive services (based on a general assumption that the number of type 2 devices in use will naturally be lower than the number of type 1 devices).

Another qualifier on the assessment that several variants of option 4 would be optimal is the assumption that there is both an appetite for type 3 services to be accommodated in the same band as spectrum-licensed type 1 services, and that type 1 services operating outside privately-owned type 3 service areas can be adequately protected.

These both remain open propositions that the ACMA is seeking further input on, specifically *Issues for comment* 4 and 8:

* **What is the expected proliferation of—or demand for—services deployed under type 2 (apparatus-licensed) and/or 3 (class-licensed) models?**
* **If options 4 or 5 (all variants) are preferred, what conditions should be applied to a class licence to protect co-frequency spectrum-licensed operations (in defined areas)? Would it be appropriate to define a means of making class-licensed use visible (for example, through a form of voluntary device registration)?**

So, while option 4d can be considered the default preferred option, there are a range of alternate preferred options that are dependent both on responses to the above questions and how lot configurations ‘fit’ within the available spectrum.

If it is ultimately determined that the value of type 3 services operating under a class licence would not sufficiently balance out the associated potential interference management overheads, then option 2d would be the preferred option. If, however, it can be determined that co-frequency accommodation of type 3 services will add to the level of benefit that can be derived from the band with little or no impact on type 1 services, then option 4d would be preferred.

Depending on responses to these questions—and noting the uncertainty around where the lower edge of the band should be to ensure coexistence with passive EESS (the subject of *Issue for comment 2*)—the ACMA currently prefers either option 2d or 4d, but are keen to hear stakeholder views.

# Invitation to comment

The ACMA invites comments on the issues set out in this discussion paper or any other relevant issues.

## Making a submission

* **[Online submissions](http://www.acma.gov.au/theACMA/Consultations/Consultations)**—submissions can be made via the comment function or by uploading a document. The online consultation page provides details.
* Submissions by post—can be sent to:

The Manager, Spectrum Planning Section

Spectrum Planning and Engineering Branch

Communications Infrastructure Division

PO Box 78, Belconnen, ACT 2616

**The closing date for submissions is COB, Friday 2 November 2018.**

Electronic submissions in Microsoft Word or Rich Text Format are preferred.

Enquiries

Media enquiries can be directed to Emma Rossi on 02 9334 7719 or by email to [media@acma.gov.au](mailto:media@acma.gov.au).

Effective consultation

The ACMA is working to enhance the effectiveness of its stakeholder consultation processes, which are an important source of evidence for its regulatory development activities. To assist stakeholders in formulating submissions to its formal, written consultation processes, it has developed [Effective consultation—a guide to making a submission](http://www.acma.gov.au/theACMA/About/Corporate/Responsibilities/acma-evidenceinformed-regulation-and-effective-consultation). This guide provides information about the ACMA’s formal written public consultation processes and practical guidance on how to make a submission.

Publication of submissions

In general, the ACMA publishes all submissions it receives. The ACMA prefers to receive submissions that are not claimed to be confidential. However, the ACMA accepts that a submitter may sometimes wish to provide information in confidence. In these circumstances, submitters are asked to identify the material over which confidentiality is claimed and provide a written explanation for the claim.

The ACMA will consider each confidentiality claim on a case-by-case basis. If the ACMA accepts a claim, it will not publish the confidential information unless authorised or required by law to do so.

Release of submissions where authorised or required by law

Any submissions provided to the ACMA may be released under the [Freedom of Information Act 1982](https://www.comlaw.gov.au/Series/C2004A02562) (unless an exemption applies) or shared with various other government agencies and certain other parties under Part 7A of the [Australian Communications and Media Authority Act 2005](https://www.comlaw.gov.au/Series/C2005A00044). The ACMA may also be required to release submissions for other reasons including for the purpose of parliamentary processes or where otherwise required by law (for example, under a court subpoena). While the ACMA seeks to consult submitters of confidential information before that information is provided to another party, the ACMA cannot guarantee that confidential information will not be released through these or other legal means.

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The [Privacy Act 1988](http://www.comlaw.gov.au/Series/C2004A03712) imposes obligations on the ACMA in relation to the collection, security, quality, access, use and disclosure of personal information. These obligations are detailed in the [Australian Privacy Principles](http://www.oaic.gov.au/privacy/privacy-resources/privacy-fact-sheets/other/privacy-fact-sheet-17-australian-privacy-principles).

The ACMA may only collect personal information if it is reasonably necessary for, or directly related to, one or more of its functions or activities.

The purposes for which personal information is being collected (such as the names and contact details of submitters) are to:

* contribute to the transparency of the consultation process by clarifying, where appropriate, whose views are represented by a submission

enable the ACMA to contact submitters where follow-up is required or to notify them of related matters (except where submitters indicate they do not wish to be notified of such matters).

The ACMA will not use the personal information collected for any other purpose, unless the submitter has provided their consent or the ACMA is otherwise permitted to do so under the Privacy Act.

Submissions in response to this paper are voluntary. As mentioned above, the ACMA generally publishes all submissions it receives, including any personal information in the submissions. If a submitter has made a confidentiality claim over personal information that the ACMA has accepted, the submission will be published without that information. The ACMA will not release the personal information unless authorised or required by law to do so.

If a submitter wishes to make a submission anonymously or use a pseudonym, they are asked to contact the ACMA to see whether it is practicable to do so in light of the subject matter of the consultation. If it is practicable, the ACMA will notify the submitter of any procedures that need to be followed and whether there are any other consequences of making a submission in that way.

Further information on the Privacy Act and the ACMA’s privacy policy is available at [www.acma.gov.au/privacypolicy](http://www.acma.gov.au/privacypolicy). The privacy policy contains details about how an individual may access personal information about them that is held by the ACMA, and seek the correction of such information. It also explains how an individual may complain about a breach of the Privacy Act and how the ACMA will deal with such a complaint.

# Glossary

| **Term** | **Definition** |
| --- | --- |
| 26 GHz band | Refers to either the 24.25-27 GHz or 24.25-27.5 GHz band, pending outcomes of this consultation |
| 3.6 GHz band | Refers to the 3575–3700 MHz frequency range |
| 3GPP | 3rd Generation Partnership Project  An international body responsible for the standardisation of (cellular) mobile (including broadband) telecommunications, including the 2G, 3G, 4G and (soon) 5G technology standards. |
| (Spectrum or Service) Allocation | For the purposes of radiofrequency spectrum planning, an allocation is a specific range of frequencies allocated to use by one or more radiocommunications services within a band plan or spectrum plan. |
| Apparatus licence | An apparatus licence authorises, under the *Radiocommunications Act 1992*, the use of a radiocommunications device under a particular service type, in a particular frequency range and at a particular geographic location for a period of up to five years. |
| ARSP | *Australian Radiofrequency Spectrum Plan 2017* |
| ASMG | Australian Spectrum Map Grid  Used to define geographical areas over which spectrum licences are issued. The HCIS is used to define the cells that make up the ASMG. The ASMG is described in detail in the document [The Australian spectrum map grid 2012](http://archive.acma.gov.au/webwr/_assets/main/lib410188/australian_spectrum_map_grid_28feb2012.docx).  *See also* HCIS. |
| BS | (Cellular) base station |
| Cellular network | A network of radiocommunications services distributed over land areas called cells. Each cell is serviced by a base station, each of which is interconnected via a core network. User devices connected to cellular networks can be seamlessly passed between cells.  2G, 3G and 4G mobile networks are examples of cellular networks. |
| CEPT | (Translated) European Conference of Postal and Telecommunications Administrations |
| Class licence | A standing authorisation for the operation of an unlimited number of devices operating within a set of conditions specified within the authorisation. |
| Coordination | The process of assessing the interference potential existing licensed services and a proposed new service will have on each other. Coordination is deemed to fail if the level of interference exceeds the specified protection criteria for the services involved. |
| ECC | CEPT Electronic Communications Committee |
| EESS | Earth exploration satellite service |
| EIRP | Effective isotropic radiated power |
| Embargo | A spectrum embargo is a policy notice of intent by the ACMA to restrict the allocation of new licences in a particular frequency range to support replanning of that frequency range. Spectrum may still be able to be accessed on an exceptions basis through an application for an exemption to the embargo. |
| EME | Electromagnetic energy |
| FCC | US Federal Communications Commission |
| FSS | Fixed satellite service |
| HCIS | Hierarchical Cell Identification Scheme  A naming convention developed by the ACMA that applies unique ‘names’ to each of the cells of the ASMG. Each five-minute of arc square cell in the ASMG is assigned a unique identifier, derived from the cell’s position in a hierarchically arranged grouping of cells. The hierarchy has four levels. A detailed description of the HCIS is available on the [ACMA website](http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/Current-APs-info-and-resources/3-4-ghz-auction-2000-applicant-information-package).  *See also* ASMG*.* |
| HVU | Highest value use  When applied to spectrum, is the use for which spectrum can provide the greatest incremental value to economic welfare. The value provided to the economy by spectrum is typically due to reduced costs for spectrum users to provide services, or the ability to provide new services that would not be possible without the use of particular spectrum. |
| IMT-2020 | International mobile telecommunications-2020  The ITU designation for 5th generation mobile technologies |
| International spectrum harmonisation | The generally desirable outcome where radiocommunications services operate throughout the world in similar spectrum bands. Among other benefits, harmonisation facilitates lower-cost equipment through economies of scale. |
| International Telecommunication Union (ITU) | A specialised agency of the United Nations that is responsible for issues that concern information and communication technologies. The ITU coordinates the shared global use of radio spectrum and assists in the development of spectrum harmonisation arrangements. |
| IoT | Internet of Things |
| LTE | Long Term Evolution  A 4th Generation 3GPP technology standard for [wireless](http://en.wikipedia.org/wiki/Wireless) communications including high-speed data for mobile devices. |
| MBB | Mobile broadband  The variety of ways an internet service is delivered via a mobile network, typically comprising mobile wireless internet services provided via a dongle, USB modem or data card service, or mobile phone handset internet services. |
| MIMO | Multiple input, multiple output (antenna system). A means of increasing channel capacity through the creation of multiple simultaneous physical channels. Channel diversity is achieved by transmitting and receiving from multiple spatially-diverse antennas and differentiating based on the resultant ‘environmental coding’ imposed by the physical (clutter) environment. MIMO antennas can also be combined in a beam-forming arrangement although (depending on the number of beams) this has less to do with improving capacity than improving coverage. |
| MNO | Mobile network operator |
| MBB strategy | Mobile broadband strategy  The ACMA has developed a [set of strategies](http://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/mobile-broadband-strategy-and-work-plan) to address the growth in demand for mobile broadband capacity. A key part of these strategies is the articulation of a spectrum management process for the release of additional spectrum for mobile broadband. |
| PFD | Power flux density |
| Principles for Spectrum Management | Developed by the ACMA to guide its approach to spectrum management. The key theme of the principles is that maximising the overall public benefit from use of the radiofrequency spectrum requires balanced application of both regulatory and market mechanisms. Details of the principles are available on the [ACMA website](http://www.acma.gov.au/theACMA/About/The-ACMA-story/Facilitating/decisionmaking-process-fyso-25-1). |
| PSD | Power spectrum density |
| Re-allocation of spectrum | Under section 153B of the *Radiocommunications Act 1992*, the minster can re-allocate specific frequencies and areas for the issue of spectrum (or apparatus) licences. A result of this process is the cancellation of incumbent apparatus licences in the identified areas at the end of a defined timeframe known as the re‑allocation period. |
| Re-allocation period | The period of time before incumbent apparatus licenses that fall wholly or partially within the frequencies and areas to be re-allocated under section 153B of the *Radiocommunications Act 1992* will be cancelled. The re‑allocation period is required to be a minimum of two years. |
| SISO | Single input, single output  A conventional single antenna transmit/receive system (as distinct from MIMO). |
| Spectrum licence | Issued under the *Radiocommunications Act 1992* and authorises the use of a particular frequency band within a particular geographic area for a period of up to 15 years. The geographic area can vary in size, up to and including the entire country. |
| TLG | Technical liaison group |
| UE | User equipment (mobile devices/terminals in a cellular network) |
| UWB | Ultra wideband |
| WISP | Wireless Internet Service Provider |

# Appendix 1— Summary of coexistence studies

This appendix provides a summary of ITU-R sharing studies undertaken for the 24.25–27.5 GHz band between IMT-2020 and incumbent services.

In November 2015, Study Group 5 of the ITU-R created a dedicated tasks group, TG 5/1, to conduct sharing and compatibility studies under WRC-19 agenda item 1.13. These studies are to assess the potential coexistence between IMT-2020 and the following incumbent services, with a summary of these studies—from the most recent meeting of TG 5/1 in May 2018—provided in Table 6:

* Fixed satellite service (earth-space)—abbreviated to: FSS (E-s)
* Earth exploration satellite service (space-earth) and space research service—abbreviated to: EESS/SRS (s-E)
* Inter-satellite service (ISS)
* Fixed service (FS)
* Passive services (adjacent-band)
* EESS satellite services
* RAS earth stations

Australia has also made a number of contributions to TG 5/1 in relation to coexistence between IMT-2020 and FSS (E-s).[[35]](#footnote-36) These contributions include a statistically-based sharing study, which considers the aggregate effect of IMT-2020 deployments at all locations across parts of the Earth that are visible to a satellite.

The results of this Australian study indicate that the aggregate interference level will be at least 31 dB below the satellite system noise level, indicating that coexistence is feasible. These results are generally in line with other studies considering IMT-2020/FSS coexistence (as detailed in Table 6 below).

1. Summary of ITU-R sharing studies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Service | Allocation(s) | Interference path | Latest version | Results | Comments |
| FSS (E-s) | 24.65–25.25 GHz and 27–27.5 GHz | IMT-2020 transmitters to FSS satellite receivers | Attachment 3 to Annex 3 to Document [5-1/406](https://www.itu.int/md/R15-TG5.1-C-0406/en) | All studies, except for one, show that levels of aggregate interference will be at least 18 dB below the noise floor.[[36]](#footnote-37) | The clear majority of studies show that coexistence between IMT-2020 and FSS (E-s) is possible given the low calculated interference levels. Any conditions that are needed to facilitate coexistence can be implemented domestically. |
| EESS/SRS (s-E) | 25.5–27 GHz | IMT-2020 transmitter to EESS/SRS earth station receiver | Attachment 1 to Annex 3 to Document [5-1/406](https://www.itu.int/md/R15-TG5.1-C-0406/en) | Results indicate the need for geographical separation in the range less than 1km (with clutter/terrain losses) to 92 km (without clutter/terrain losses) between IMT-2020 transmitters and EESS/SRS Earth stations. | Maintaining geographical separation can be implemented domestically through licensing conditions. |
| ISS | 24.24–24.75 GHz and 25.25–27.5 GHz | IMT-2020 to ISS satellite receiver | Attachment 4 to Annex 3 to Document [5-1/406](https://www.itu.int/md/R15-TG5.1-C-0406/en) | The majority of studies show calculated interference levels in the range 9.5–46 dB below the protection criteria. | – |
| FS | 24.25–27.5 GHz | IMT-2020 to FS receiver | Attachment 5 to Annex 3 to Document [5-1/406](https://www.itu.int/md/R15-TG5.1-C-0406/en) | Results show geographical separation of between 0.75–70 km between IMT-2020 and FS. | Maintaining geographical separation can be implemented domestically through licensing conditions. |
| Passive services | 23.6–24 GHz | IMT-2020 transmitters to EESS satellite receivers | Attachment 2 to Annex 3 to Document [5-1/406](https://www.itu.int/md/R15-TG5.1-C-0406/en) | EESS satellite services—majority of studies show that the protection level is exceeded by approximately 9-30 dB (for the most sensitive EESS sensor). Incompatibility is caused by unwanted emissions from IMT-2020 stations in the passive band. | Reduced unwanted emission levels in the passive band, in addition to other deployment constraints, may be required to allow coexistence with passive services. Further international consideration of this issue is ongoing (see *Interference management and coexistence between services* for more information). |
| IMT-2020 transmitters to RAS earth stations | RAS earth stations—studies show geographical separation between IMT-2020 and RAS earth stations in the range 3–70 km. | Maintaining geographical separation can be implemented domestically through licensing conditions. |

# Appendix 2— Geographical area description

As described in the *Considerations* section, the ACMAs current thinking is that the type 1 style deployment model is most likely to be in higher population centres such as metropolitan areas and possibly major regional centres. The HCIS descriptors for these potential areas—also shown in Figure 4—are provided in Table 7 (for metro areas) and Table 8 (for large regional centres). These areas align with those for the 3.4 GHz band as detailed in Schedule 1 of the [Radiocommunications (Spectrum Re-allocation) Declaration 2000](http://auction.acma.gov.au/auction_results/3.4ghz_results_page/34_pdf/aip_pdf/re-allocation.pdf), with the inclusion of Darwin.

1. HCIS description of metro areas

| Sub-area name | HCIS |
| --- | --- |
| **Adelaide** | IW3J, IW3K, IW3L, IW3N, IW3O, IW3P, IW6B, IW6C, IW6D, IW6F, IW6G, IW6H, IW3E5, IW3E6, IW3E8, IW3E9, IW3F4, IW3F5, IW3F6, IW3F7, IW3F8, IW3F9, IW3G4, IW3G5, IW3G6, IW3G7, IW3G8, IW3G9, IW3H4, IW3H5, IW3H6, IW3H7, IW3H8, IW3H9, IW3I2, IW3I3, IW3I5, IW3I6, IW3I8, IW3I9, IW3M2, IW3M3, IW3M5, IW3M6, IW3M8, IW3M9, IW6A2, IW6A3, IW6A5, IW6A6, IW6A8, IW6A9, IW6E2, IW6E3, IW6E5, IW6E6, IW6E8, IW6E9, JW1E4, JW1E7, JW1I1, JW1I4, JW1I7, JW1M1, JW1M4 |
| **Brisbane** | NT9, NT5G, NT5H, NT5K, NT5L, NT5O, NT5P, NT6E, NT6F, NT6G, NT6H, NT6I, NT6J, NT6K, NT6L, NT6M, NT6N, NT6O, NT6P, NT8C, NT8D, NT8G, NT8H, NT8K, NT8L, NT8O, NT8P, NU3A, NU3B, NU3C, NU3D, NU3F, NU3G, NU3H, NT5C4, NT5C5, NT5C6, NT5C7, NT5C8, NT5C9, NT5D4, NT5D5, NT5D6, NT5D7, NT5D8, NT5D9, NT6A4, NT6A5, NT6A6, NT6A7, NT6A8, NT6A9, NT6B4, NT6B5, NT6B6, NT6B7, NT6B8, NT6B9, NT6C4, NT6C5, NT6C6, NT6C7, NT6C8, NT6C9, NT6D4, NT6D5, NT6D6, NT6D7, NT6D8, NT6D9, NU2C1, NU2C2, NU2C3, NU2D1, NU2D2, NU2D3, NU2D5, NU2D6, NU2D8, NU2D9, NU2H2, NU2H3, NU3E1, NU3E2, NU3E3, NU3E5, NU3E6, NU3E8, NU3E9, NU3I2, NU3I3, NU3J1, NU3J2, NU3J3, NU3K1, NU3K2, NU3K3, NU3L1, NU3L2, NU3L3. |
| **Canberra** | MW4D, MW4H, MW4L, MW5A, MW5B, MW5E, MW5F, MW5I, MW5J, MW1P4, MW1P5, MW1P6, MW1P7, MW1P8, MW1P9, MW2M4, MW2M5, MW2M6, MW2M7, MW2M8, MW2M9, MW2N4, MW2N5, MW2N6, MW2N7, MW2N8, MW2N9, MW4P1, MW4P2, MW4P3, MW5M1, MW5M2, MW5M3, MW5N1, MW5N2, MW5N3 |
| **Melbourne** | KX3J, KX3K, KX3L, KX3N, KX3O, KX3P, KX6A, KX6B, KX6C, KX6D, KX6E, KX6F, KX6G, KX6H, KX6I, KX6J, KX6K, KX6L, LX1I, LX1M, LX1N, LX1O, LX4A, LX4B, LX4C, LX4E, LX4I, KX3E9, KX3F5, KX3F6, KX3F7, KX3F8, KX3F9, KX3G1, KX3G2, KX3G4, KX3G5, KX3G6, KX3G7, KX3G8, KX3G9, KX3H4, KX3H5, KX3H6, KX3H7, KX3H8, KX3H9, KX3I3, KX3I6, KX3I8, KX3I9, KX3M2, KX3M3, KX3M4, KX3M5, KX3M6, KX3M7, KX3M8, KX3M9, LX1E4, LX1E7, LX1E8, LX1E9, LX1J1, LX1J4, LX1J5, LX1J6, LX1J7, LX1J8, LX1J9, LX1K4, LX1K7, LX4F1, LX4F2, LX4F4, LX4F5, LX4F7, LX4F8, LX4J1, LX4J2, LX4J4, LX4J5, LX4J7, LX4J8 |
| **Perth** | BV1I, BV1J, BV1K, BV1L, BV1M, BV1N, BV1O, BV1P, BV2I, BV2J, BV2M, BV2N, BV4A, BV4B, BV4C, BV4D, BV4E, BV4F, BV4G, BV4H, BV4I, BV4J, BV4K, BV4L, BV5A, BV5B, BV5E, BV5F, BV5I, BV5J, BV1E7, BV1E8, BV1E9, BV1F7, BV1F8, BV1F9, BV1G7, BV1G8, BV1G9, BV1H7, BV1H8, BV1H9, BV2E7, BV2E8, BV2E9, BV2F7, BV2F8, BV2F9, BV4M1, BV4M2, BV4M3, BV4N1, BV4N2, BV4N3, BV4O1, BV4O2, BV4O3, BV4P1, BV4P2, BV4P3, BV5M1, BV5M2, BV5M3, BV5N1, BV5N2, BV5N3 |
| **Sydney** | MV9I, MV9J, MV9K, MV9L, MV9M, MV9N, MV9O, MV9P, MW3C, MW3D, MW3G, MW3H, MW3K, MW3L, NV4N, NV4O, NV4P, NV5M, NV5N, NV5O, NV5P, NV7B, NV7C, NV7D, NV7E, NV7F, NV7G, NV7H, NV7I, NV7J, NV7K, NV7L, NV7M, NV7N, NV7O, NV7P, NW1A, NW1B, NW1C, NW1D, NW1E, NW1F, NW1G, NW1H, NW1I, NW1J, NW1K, NW1L, MV9D6, MV9D9, MV9E4, MV9E5, MV9E6, MV9E7, MV9E8, MV9E9, MV9F4, MV9F5, MV9F6, MV9F7, MV9F8, MV9F9, MV9G4, MV9G5, MV9G6, MV9G7, MV9G8, MV9G9, MV9H3, MV9H4, MV9H5, MV9H6, MV9H7, MV9H8, MV9H9, MW3B2, MW3B3, MW3B5, MW3B6, MW3B8, MW3B9, MW3F2, MW3F3, MW3F5, MW3F6, MW3F8, MW3F9, MW3J2, MW3J3, NV4I5, NV4I6, NV4I8, NV4I9, NV4J4, NV4J5, NV4J6, NV4J7, NV4J8, NV4J9, NV4K4, NV4K5, NV4K6, NV4K7, NV4K8, NV4K9, NV4L4, NV4L5, NV4L6, NV4L7, NV4L8, NV4L9, NV4M2, NV4M3, NV4M5, NV4M6, NV4M8, NV4M9, NV5I4, NV5I5, NV5I6, NV5I7, NV5I8, NV5I9, NV5J4, NV5J5, NV5J6, NV5J7, NV5J8, NV5J9, NV5K4, NV5K5, NV5K6, NV5K7, NV5K8, NV5K9, NV5L4, NV5L5, NV5L6, NV5L7, NV5L8, NV5L9, NV7A2, NV7A3, NV7A4, NV7A5, NV7A6, NV7A7, NV7A8, NV7A9, MW3O1, MW3O2, MW3O3, MW3P1, MW3P2, MW3P3, NW1M1, NW1M2, NW1M3, NW1N1, NW1N2, NW1N3, NW1O1, NW1O2, NW1O3, NW1P1, NW1P2, NW1P3 |

1. HCIS description of large regional centres

| Sub-area name | HCIS |
| --- | --- |
| **Albury** | LW5P, LW6M, LW8D, LW8H, LW9A, LW9E, LW5O2, LW5O3, LW5O5, LW5O6, LW5O8, LW5O9, LW8C2, LW8C3, LW8C5, LW8C6, LW8C8, LW8C9, LW8G2, LW8G3, LW8G5, LW8G6, LW8G8, LW8G9 |
| **Ballarat, Bendigo** | KW9I, KW9J, KW9M, KW9N, KX2G, KX2H, KX2K, KX2L, KX3A, KX3B, KW8H6, KW8H9, KW8L3, KW8L6, KW8L9, KW8P3, KW8P6, KW8P9, KW9E4, KW9E5, KW9E6, KW9E7, KW9E8, KW9E9, KW9F4, KW9F5, KW9F6, KW9F7, KW9F8, KW9F9, KW9G4, KW9G5, KW9G7, KW9G8, KW9K1, KW9K2, KW9K4, KW9K5, KW9K7, KW9K8, KW9O1, KW9O2, KW9O4, KW9O5, KW9O7, KW9O8, KX2C7, KX2C8, KX2C9, KX2D3, KX2D6, KX2D7, KX2D8, KX2D9, KX2O1, KX2O2, KX2O3, KX2O4, KX2O5, KX2O6, KX2P1, KX2P2, KX2P3, KX2P4, KX2P5, KX2P6, KX3C1, KX3C2, KX3C4, KX3C5, KX3C7, KX3C8, KX3E1, KX3E2, KX3E3, KX3E4, KX3E5, KX3E6, KX3E7, KX3E8, KX3F1, KX3F2, KX3F3, KX3F4, KX3I1, KX3I2, KX3I4, KX3I5, KX3I7, KX3M1 |
| **Bendigo** | KW9I5, KW9I6, KW9I8, KW9I9, KW9M2, KW9M3, KW9M5, KW9M6, KW9N1, KW9N2, KW9N3, KW9N4, KW9N5, KW9N6, KW9J4, KW9J5, KW9J6, KW9J7, KW9J8, KW9J9 |
| **Cairns** | MW4D, MW4H, MW4L, MW5A, MW5B, MW5E, MW5F, MW5I, MW5J, MW1P4, MW1P5, MW1P6, MW1P7, MW1P8, MW1P9, MW2M4, MW2M5, MW2M6, MW2M7, MW2M8, MW2M9, MW2N4, MW2N5, MW2N6, MW2N7, MW2N8, MW2N9, MW4P1, MW4P2, MW4P3, MW5M1, MW5M2, MW5M3, MW5N1, MW5N2, MW5N3 |
| **Darwin** | GO7C, GO7D, GO7G, GO7H, GO7K, GO7L, GO8A, GO8E, GO8I |
| **Hobart** | LY8L, LY8P, LY9I, LY9J, LY9K, LY9L, LY9M, LY9N, LY9O, LY9P, LZ2D, LZ2H, LZ3A, LZ3B, LZ3C, LZ3D, LZ3E, LZ3F, LZ3G, LZ3H, LY8H4, LY8H5, LY8H6, LY8H7, LY8H8, LY8H9, LY9E4, LY9E5, LY9E6, LY9E7, LY9E8, LY9E9, LY9F4, LY9F5, LY9F6, LY9F7, LY9F8, LY9F9, LY9G4, LY9G5, LY9G6, LY9G7, LY9G8, LY9G9, LY9H4, LY9H5, LY9H6, LY9H7, LY9H8, LY9H9, LZ2L1, LZ2L2, LZ2L3, LZ3I1, LZ3I2, LZ3I3, LZ3J1, LZ3J2, LZ3J3, LZ3K1, LZ3K2, LZ3K3, LZ3L1, LZ3L2, LZ3L3 |
| **Launceston** | LY5C, LY5D, LY5G, LY5H, LY6A, LY6B, LY6E, LY6F, LY5K1, LY5K2, LY5K3, LY5K4, LY5K5, LY5K6, LY5L1, LY5L2, LY5L3, LY5L4, LY5L5, LY5L6, LY6I1, LY6I2, LY6I3, LY6I4, LY6I5, LY6I6, LY6J1, LY6J2, LY6J3, LY6J4, LY6J5, LY6J6 |
| **Rockhampton** | MS6A, MS6B, MS6C, MS6D, MS6E, MS6F, MS6G, MS6H, MS6I, MS6J, MS6K, MS6L |
| **Toowoomba** | NT7H, NT7L, NT8E, NT8F, NT8I, NT8J, NT7G2, NT7G3, NT7G5, NT7G6, NT7G8, NT7G9, NT7K2, NT7K3, NT7K5, NT7K6, NT7K8, NT7K9, NT7O2, NT7O3, NT7O5, NT7O6, NT7P1, NT7P2, NT7P3, NT7P4, NT7P5, NT7P6, NT8M1, NT8M2, NT8M3, NT8M4, NT8M5, NT8M6, NT8N1, NT8N1, NT8N2, NT8N3, NT8N4, NT8N5, NT8N6 |
| **Townsville** | LR2C, LR2D, LR2G, LR2H, LQ8N8, LQ8N9, LQ8O7, LQ8O8, LQ8O9, LQ8P7, LQ8P8, LQ8P9, LR2B2, LR2B3, LR2B5, LR2B6, LR2B8, LR2B9, LR2F2, LR2F3, LR2F5, LR2F6, LR2F8, LR2F9, LR2J2, LR2J3, LR2J5, LR2J6, LR2K1, LR2K2, LR2K3, LR2K4, LR2K5, LR2K6, LR2L1, LR2L2, LR2L3, LR2L4, LR2L5, LR2L6, LR3A1, LR3A2, LR3A4, LR3A5, LR3A7, LR3A8, LR3E1, LR3E2, LR3E4, LR3E5, LR3E7, LR3E8, LR3I1, LR3I2, LR3I4, LR3I5 |

# Appendix 3— Working Group on Inter-Service Coexistence Proposed Terms of Reference

Function

The working group work will consider technical coexistence matters at the edges of the 26 GHz band, specifically:

* Lower frequency boundary of the 26 GHz band, having regard to coexistence with passive earth exploration satellite services (EESS). This work would consider possible Australian specific technical and licensing factors to facilitating coexistence with EESS (passive) compared to factors influencing international conclusions.

Upper frequency boundary of the 26 GHz band (specifically whether it should be 27 or 27.5 GHz), having regard to coexistence with FSS (earth-to-space). The group would also consider the necessity for (and if required the nature of) possible domestic regulatory arrangements to facilitate coexistence between wireless broadband and FSS uplinks in the 27–27.5 GHz band (if the upper edge of the band was considered to be 27.5 GHz).

Purpose

The purpose of the working group is to inform stakeholder responses to the options paper on 26 GHz (specifically question 2), which will ultimately assist the Authority in its deliberations.

Working methods and accountability

The working group will:

* be chaired by the Executive Manager, Spectrum Planning and Engineering Branch, ACMA
* form two sub-working groups (chaired by ACMA officers) to separately consider the upper and lower boundary questions

undertake its activities predominantly via correspondence, although physical meetings will be held as required. It is expected that two meetings will be held—first, to set up these two groups and second, to conclude the group’s work.

The group’s deliberations should help inform individual stakeholder submissions on inter-service coexistence issues to the 26 GHz options paper.

Membership

Membership of the working group is open to all interested stakeholders, though attendance at physical meetings may need to be limited for capacity reasons.

Nominations for membership should be forwarded to [freqplan@acma.gov.au](mailto:freqplan@acma.gov.au) by **COB 26 September 2018**.

Review

The working group’s Terms of Reference will be considered and finalised at the first meeting of the working group.

Working group cessation

The working group will cease to operate after its report has been delivered on or before **24 October** **2018**, or as otherwise determined by the ACMA. This means the group will run concurrently with the consultation period for the options paper.

1. Noting that the lower limit of the band may higher than 24.25 GHz depending on the outcome for the EESS coexistence issues discussed above. [↑](#footnote-ref-2)
2. Note: Responses to this question will be considered in the establishment of a domestic technical study group to identify the lower frequency boundary of the 26 GHz band. [↑](#footnote-ref-3)
3. As explained in *Replanning options*, variants are used to describe sub-options that contain differing frequency ranges for each of the primary planning options. [↑](#footnote-ref-4)
4. ACMA [*Corporate plan 2018–19*](https://www.acma.gov.au/theACMA/acma-corporate-plan) [↑](#footnote-ref-5)
5. Available on the [ACMA website](http://www.acma.gov.au/Industry/Spectrum/Spectrum-planning/About-spectrum-planning/principles-for-spectrum-management). [↑](#footnote-ref-6)
6. Area-wide apparatus licences can also be issued. [↑](#footnote-ref-7)
7. Technical details and limitations include maximum power, frequency range, out-of-band emissions limits, and geographical licence area. [↑](#footnote-ref-8)
8. <https://www.fcc.gov/document/fcc-adopts-rules-facilitate-next-generation-wireless-technologies> [↑](#footnote-ref-9)
9. <https://www.fcc.gov/document/fcc-takes-next-steps-facilitating-spectrum-frontiers-spectrum> [↑](#footnote-ref-10)
10. <https://www.ecodocdb.dk/document/3361> [↑](#footnote-ref-11)
11. <https://www.ofcom.org.uk/consultations-and-statements/category-2/5g-access-at-26-ghz> [↑](#footnote-ref-12)
12. The [draft 2018–22 FYSO](https://www.acma.gov.au/theACMA/draft-five-year-spectrum-outlook-2018-22) details the current status of work in the 28 GHz and 60 GHz bands, as well as providing a list of bands currently at the *monitoring* stage. [↑](#footnote-ref-13)
13. The full list of frequency bands that were at the *monitoring* stage is contained in the [2016–2020 FYSO](https://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/five-year-spectrum-outlook-2016-20). [↑](#footnote-ref-14)
14. A spectrum-focussed forum for exchange of information between the ACMA and stakeholders. [↑](#footnote-ref-15)
15. MIPS, [5G: What is the buzz all about?](https://www.mips.com/blog/5g-what-is-the-buzz-all-about/) [↑](#footnote-ref-16)
16. Distribution of UE’s within a cell, used in ITU-R sharing studies, can be found in Annex 1 of the [TG 5/1 chairman’s report](https://www.itu.int/md/R15-TG5.1-C-0406/en). [↑](#footnote-ref-17)
17. See *Glossary* for definition. [↑](#footnote-ref-18)
18. 5G specifications are available on the [3GPP website](http://www.3gpp.org/). [↑](#footnote-ref-19)
19. As detailed in the [draft 2018–22 FYSO](https://www.acma.gov.au/theACMA/draft-five-year-spectrum-outlook-2018-22), the ACMA intends to progress its investigation into the suitability of the 28 GHz band for use by apparatus-licensed fixed wireless broadband outside of metropolitan areas. [↑](#footnote-ref-20)
20. AUS87 specifies that: *Radio astronomy facilities operated by the CSIRO at the Paul Wild Observatory Narrabri (latitude 30° 18' 46.40" S, longitude 149° 33' 0.44" E), the Parkes Observatory (latitude 32° 59' 54.25" S, longitude 148° 15' 48.65" E) and the Mopra Observatory Coonabarabran (latitude 31° 16' 04.12" S, longitude 149° 05' 58.72" E) and by the University of Tasmania at the Mount Pleasant Observatory Hobart (latitude 42° 48' 12.92" S, longitude 147° 26' 25.86" E) and the Ceduna Observatory (latitude 31° 52' 03.69" S, longitude 133° 48' 35.40" E), and at the Canberra Deep Space Communication Complex (latitude 35° 23' 54.46" S, longitude 148° 58' 39.66" E) conduct passive observations in the frequency bands 1.2–1.8 GHz, 2.2–2.7 GHz, 4.5–6.7 GHz, 8–10 GHz and 16–26 GHz using receivers that are highly sensitive to interference. The Paul Wild and Mopra observatories also operate in the bands 30–50 GHz and 75–115 GHz.* [↑](#footnote-ref-21)
21. For example, see submissions from [GSMA](https://cept.org/Documents/ecc/44687/ecc-18-078_gsma-technical-conditions-in-26-ghz-ecc-decision) and [GSA](https://cept.org/Documents/ecc/44734/ecc-18-091_gsa-26-ghz-passive-services-protection) to the 48th ECC plenary meeting in Rome. [↑](#footnote-ref-22)
22. See the [Open letter from the mobile industry on the technical conditions of the 26GHz band in Europe](https://www.gsma.com/gsmaeurope/wp-content/uploads/2018/06/CTO-high-level-letter-26-GHz-technical-conditions.pdf). [↑](#footnote-ref-23)
23. Based ITU-R studies from France and the United Kingdom (updated in documents [5-1/419](https://www.itu.int/md/R15-TG5.1-C-0419/en) and [5-1/442](https://www.itu.int/md/R15-TG5.1-C-0442/en) respectively), an additional attenuation of 20 dB will enable compliance with the ECC limits. In a [contribution](ftp://ftp.3gpp.org/tsg_ran/WG4_Radio/TSGR4_85/Docs/R4-1712718.zip) to 3GPP, Ericsson have indicated that a 1.5 GHz frequency separation in needed for additional filtering to be able to provide an additional 20 dB attenuation. [↑](#footnote-ref-24)
24. Power flux density/power spectral density. [↑](#footnote-ref-25)
25. The HCIS descriptors for these areas are provided in *Appendix 2— Geographical area description*. [↑](#footnote-ref-26)
26. 400 MHz is the largest channel size in the current version of 3GPP 38.104, available on the [3GPP website](http://www.3gpp.org/). [↑](#footnote-ref-27)
27. See the [*draft 2018–22 FYSO*](https://www.acma.gov.au/theACMA/draft-five-year-spectrum-outlook-2018-22). [↑](#footnote-ref-28)
28. 50, 100, 200 and 400 MHz channels are currently included in 5G standards for the 26 GHz band. [↑](#footnote-ref-29)
29. See the [*Variation to the LIPD Class Licence—Response to submissions*](https://www.acma.gov.au/theACMA/variations-to-the-lipd-class-licence-2) paper and the [draft 2018–22 FYSO](https://www.acma.gov.au/theACMA/draft-five-year-spectrum-outlook-2018-22). [↑](#footnote-ref-30)
30. <https://exchange.telstra.com.au/world-first-5g-trial-data-call-over-26ghz-mmwave-spectrum/> [↑](#footnote-ref-31)
31. For example, in its [response](https://www.acma.gov.au/-/media/Spectrum-Review-Implementation-Taskforce/Issue-for-comment/IFC-12-2018/Nokia---FYSO-submission-pdf.pdf) to the draft 2018–22 FYSO, Nokia indicated that ‘*[t]he 5G NR mmWave ecosystem supporting 26 GHz will be ready in 2018 with commercialization commencing from 2019’*. [↑](#footnote-ref-32)
32. For example, the ACMA is considering the upper-adjacent 28 GHz band for wireless broadband services, as described in the [*draft 2018–22 FYSO*](https://www.acma.gov.au/theACMA/draft-five-year-spectrum-outlook-2018-22). [↑](#footnote-ref-33)
33. See <https://www.communications.gov.au/documents/5g-enabling-future-economy>. [↑](#footnote-ref-34)
34. See <https://ris.pmc.gov.au/2018/07/23/allocation-limits-36-ghz-spectrum-auction>. [↑](#footnote-ref-35)
35. The latest contribution is Document [5-1/290](https://www.itu.int/md/R15-TG5.1-C-0290/en). [↑](#footnote-ref-36)
36. At the time of writing, the agreed FSS protection requirement had not been incorporated into ITU-R studies, therefore the aggregate interference level relative to the nose floor is shown in Table 6. [↑](#footnote-ref-37)