Development of the 26/28 GHz band apparatus licence technical framework

Technical Liaison Group Consultation Paper

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# Version Control

|  |  |
| --- | --- |
| **Version** | **Comments** |
| Version 1.0 | Initial release |
| Version 2.0 | * Provides additional discussion on:   + The rationale for equal status of spectrum and area-wide apparatus licensed services   + The additional conditions for coexistence with FSS gateway uplinks   + The potential impact of the unwanted emission limits agreed at WRC-19   + Potentially increasing the in-band TRP limit   + The co-site distance   + the notional receiver ACS and blocking requirements   + coexistence arrangements with class licensed body scanners * Provides additional clarification on:   + the application of the SRS exclusion zones and revised minimum elevation angles   + legacy point to point services in the 28 GHz band   + the proposed system model * Indicate that RALIs MS 32 and MS 44 also will apply to 26/28 GHz area-wide apparatus licensed receivers. * Synchronisation fallback requirement:   + Move the fallback frame structure definition to RALI[new]   + Request more detail how to the frame structure should be defined * Include proposed minimum geographic area limit * Unwanted emission limits   + Proposed the frequency offset breakpoint should be based on 0.1xBW to align with 3GPP standards   + Potentially adopt WRC-19 unwanted emission limits in 23.4-24 GHz, pending further consideration   + Propose that separate limits are defined for device type (base station or UE) instead of whether or not a device needs to be registered * Change definition of ‘indoor’ to be based on a pfd limit * PFD limit at the geographic boundary:   + Increase LOP when a transmitter is using AAS   + Change receiver gain to 0 dBi   + Include additional information on how this limit is applied * Remove provision of indoor-only mobile transmitters in the 28 GHz band * Add a notional receiver and compatibility requirement * Correction of typographic errors |

# Introduction

In recent years, the 26 GHz (24.25-27.5 GHz) and 28 GHz (27.5-29.5 GHz) bands have become the focus of the roll-out of millimetre wave band wireless broadband services (also referred to as 5G).

The Australian Communications and Media Authority (the ACMA) commenced planning for wireless broadband service delivery in the 26 GHz band with a Spectrum Tune-up held in September 2017. In September 2018, we released an [options paper](https://www.acma.gov.au/theACMA/options-for-wireless-broadband-in-the-26-ghz-band), which included details on the drivers for wireless broadband access to the band, international studies and trends and planning options for the band.

The ACMA also convened the *Working Group on Inter-service Coexistence* (the 26 GHz Working Group) which drew a membership from interested industry stakeholders. The purpose of this working group was to help inform stakeholder input on some of the technical issues canvassed in the options paper, specifically, how coexistence with satellite receivers in and adjacent to the 26 GHz band could be assured.

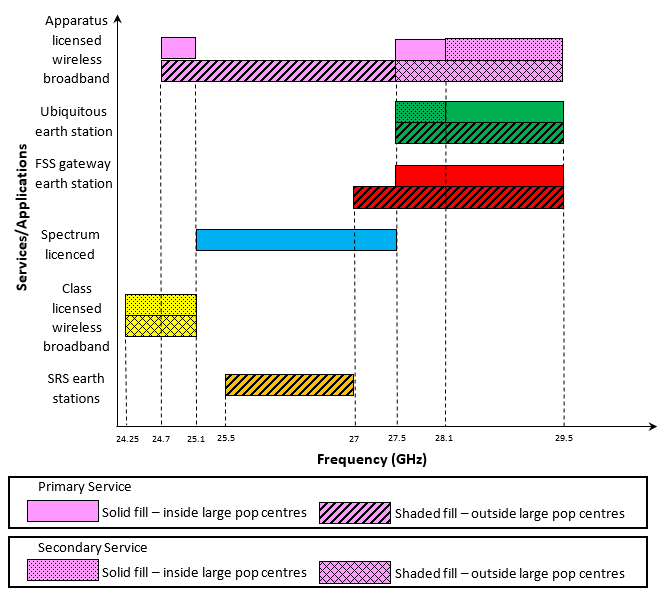
In April 2019, the ACMA released the [Future use of the 26 GHz band — planning decisions and preliminary views](https://www.acma.gov.au/theACMA/options-for-wireless-broadband-in-the-26-ghz-band) paper (the 26 GHz band decision paper). This paper outlined the ACMA’s planning decisions to introduce wireless broadband services using class, apparatus and spectrum licences in different parts of the 26 GHz band. Preliminary views on key licence conditions were also included in the decision paper, however it was noted that these conditions would be bedded down later as part of future consultation processes, such as this Technical Liaison Group (TLG) and routine consultation on updates to Radiocommunications Licensing and Assignment Instructions (RALIs) and class licences, as applicable.

Key decisions set out in the 26 GHz band decision paper included how different parts of the band would be licensed to accommodate a range of use cases. One of these was that the frequency range 25.1-27.5 GHz in areas not subject to the [*Radiocommunications (Spectrum Re-allocation—26 GHz Band) Declaration 2019*](https://www.legislation.gov.au/Details/F2019L01374) (the 26 GHz band reallocation declaration), and in 24.7-25.1 GHz would be made available for apparatus licensing. The ACMA also proposed that spectrum earmarked for apparatus licensing should be made available on an area-wide basis, possibly using a new area-based apparatus licence type (referred to at the time as spectrum-space licences).

In September 2019, the ACMA released the paper [Future use of the 28 GHz band – Planning decisions and preliminary views](https://www.acma.gov.au/sites/default/files/2019-11/Future-use-of-the-28-GHz-band-Final.docx) (the 28 GHz band decision paper). This paper outlined the ACMA’s intention to introduce new arrangements for fixed wireless access (FWA) services across the entire 28 GHz band, as well as expanded access for fixed satellite services (FSS)

The combined planning decisions in the 26 GHz and 28 GHz band are shown in Figure 1.

1. Combined 26 GHz and 28 GHz planning arrangements[[1]](#footnote-2)



### ‘Area-wide’ licence concept

The ACMA has previously indicated that it will consider an ‘area-wide’ apparatus licensing approach in the 26/28 GHz band.[[2]](#footnote-3) The purpose of this approach is to provide a technology flexible framework, where – although the framework would be optimised for the deployment of wireless broadband services – any technology or service type can be deployed within the licensed area as long as it fits within the envelope of the technical framework.

The type of apparatus licence used to deliver this proposed area-wide technical framework is yet to be determined – options include point-to-multipoint and the potential new area-wide licence (AWL) pending an ACMA decision on whether or not to make this new licence type.[[3]](#footnote-4) Until a decision on which apparatus licence option to use, this paper will the generic term area-wide apparatus licence.

### Purpose

The purpose of this paper is to develop a technical framework for apparatus licences to be issued in the range 24.7-29.5 GHz (in the combination of frequency ranges and areas not subject to the 26 GHz band reallocation declaration) – referred to in this paper as the ‘26/28 GHz bands’. The technical framework is proposed to be optimised for the deployment of wireless broadband services. This paper proposes and seeks comment on a draft technical framework for apparatus licences in the 26/28 GHz bands.

A technical framework is a collection of technical and regulatory conditions applicable to the use of radiocommunications devices. The purpose of the technical framework is to define the technical conditions and constraints under which devices may be deployed and operated within the specified geographic area and frequency band of the licence.

It is proposed that the apparatus licence technical framework for the 26/28 GHz bands will be *optimised* for the types of services and/or technologies most likely to be deployed in the band, however it is also intended to be technology-flexible. This means licensees would be able to operate any type of radiocommunications device for any purpose, provided they comply with the technical framework relevant to the licence.

## Outline

This paper has been divided into discussions of proposed coexistence arrangements with other services in the 26/28 GHz bands and on the proposed parameters that will form the area-wide apparatus licence technical framework in the 26/28 GHz bands. Draft versions of a new RALI (denoted as RALI[new] in this paper) and potential updates to a relevant licence conditions determination[[4]](#footnote-5) (LCD) made under paragraph 107(1)(f) of the Radiocommunications Act 1992 (the Act), which will form the technical framework, are also included in Appendix A and B respectively.

For simplicity, in this paper, the LCD which may be subject to the updates proposed in Appendix B is denoted as the ‘updated LCD’ – until such time as a decision is made on which apparatus licence type is to be used for wireless broadband access in the 26/28 GHz band.

The ACMA is also developing the technical framework for 26 GHz band spectrum licences (applicable to frequencies and areas subject to the 26 GHz band reallocation declaration) – see the *Development of the 26 GHz spectrum licence technical framework* TLG paper on the SharePoint site. It is proposed that parts of the spectrum licence technical framework are incorporated into the apparatus licence framework. Therefore, the spectrum licence TLG paper (and appendices) may need to be read in conjunction with this paper.

## Scope

The scope of this paper is limited to developing an apparatus licence technical framework in the range 24.7-29.5 GHz (in the frequency ranges and areas not subject to the 26 GHz band reallocation declaration). It will not consider:

* Development of new spectrum licence arrangements for wireless broadband in the 26 GHz band: the spectrum licence technical framework will be developed through a separate TLG process which will run concurrently with the 26/28 GHz band apparatus licence TLG.
* Class licence arrangements for wireless broadband in the 26 GHz band. These will be developed through separate consultation processes, having regard to the technical arrangements for other licence types in the band as agreed in the TLG.
* Coordination arrangements for FSS earth stations with primary apparatus licensed wireless broadband services which were licensed ‘first-in-time’ and the proposed expansion of spectrum access for 28 GHz band ubiquitous FSS earth stations. These arrangements will be developed though separate consultation processes.
* Development of licence fees for wireless broadband services in the 26/28 GHz bands
* Any restrictions on certain persons or types of person being authorised to access spectrum in the 26/28 GHz bands. These issues will be considered in a separate process.

## Spectrum reform

The government is reforming the spectrum management framework within Australia. The former Department of Communications and the Arts (DoCA) has provided the following information to stakeholders:

|  |
| --- |
| Rather than completely re-writing the legislation, modernising Australia’s spectrum management framework will now be pursued through a staged approach to amending the *Radiocommunications Act 1992*.  The first stage of amendments to the Act will deal with a number of priority issues to deliver tangible benefits to industry and consumers. The changes will be designed to remove unnecessary constraints in spectrum allocation and reallocation processes.   * Spectrum licence terms will be extended to a maximum of 20 years, with clearer licence renewal processes. * The arrangements for apparatus licences are also being aligned with spectrum licences to the extent possible. * There will also be changes to improve technical regulation, streamline device supply schemes and introduce graduated enforcement mechanisms for breaches of the Act. * To minimise disruption to spectrum users, existing licence types and planning arrangements will be retained at this time.   We are working towards the introduction of a draft amendment bill into the Australian Parliament in early 2020. |

Given the timeframes associated with the 26/28 GHz band project, the ACMA is proposing to develop new arrangements in this band assuming the existing regulatory regime will apply. It is acknowledged that any new arrangements for the 26/28 GHz bands may need to be accommodated under the new legislative framework, once it commences. The ACMA will take into account relevant opportunities offered by the implementation of the new legislative framework, if and when applicable.

Further information on spectrum reform is available from the Department of Infrastructure, Transport, Regional Development and Communications.

## Timeline

The ACMA is working towards apparatus licences in the 26/28 GHz being available for issue from Q4 2020. To do this the following indicative timeframe for the TLG is:

| Key steps | Proposed Date |
| --- | --- |
| TLG process   * Initial release of TLG paper * Deadline for submissions/comments on initial TLG paper * Revision to TLG paper * Deadline for submissions/comments on revised TLG paper * TLG paper Version 3.0 | Nov 2019-Mar 2020  11 Nov 2019  22 Dec 2019  30 Jan 2020  27 Feb 2020  Week beginning 16 March 2020 |
| Public consultation on the drafts of the following technical framework instruments:   * Draft updates to a LCD – which LCD that update would apply to is yet to be determined pending a decision on the type of apparatus licence to be used. * Draft RALI[new] | Q2/Q3 2020 |
| Finalisation of technical framework | Q4 2020 |

The TLG is just the first step in the process of developing a technical framework. While the aim is to complete the work in the timeframe defined, this will ultimately depend on the complexity of the issues identified. The ACMA will use the outcomes of the TLG to publicly consult on the relevant instruments that will form the 26/28 GHz band area-wide apparatus licence technical framework. This means TLG members will be able to provide comments on the technical framework both as part of the informal TLG and subsequent formal public consultation processes.

## Legal Review

The draft LCD updates in Appendix B have not undergone legal review. It is possible there could be changes to the text in the draft instruments after such a review has been conducted. Additional editorial changes may also be needed depending on which LCD the draft updates in Appendix B will be applicable to (subject to a decision on the apparatus licence type to use).

Under the currently proposed timeline, a legal review of the draft instrument will be performed after the conclusion of the TLG and finalised in time for public consultation of the draft technical framework in Q2/Q3 2020.

# Coexistence with other services

Devices operated under a 26/28 GHz band area-wide apparatus licence[[5]](#footnote-6) will need to coexist not only with other area-wide apparatus licence services, but also with services operating under another apparatus licence type or a spectrum licence in and adjacent to the 26/28 GHz band. The 26/28 GHz band area-wide apparatus licence technical framework therefore needs to include provisions to manage coexistence with the following services:

* Spectrum licensed devices operating in the frequency range 25.1-27.5 GHz in capital cities and major regional population centres[[6]](#footnote-7)
* Space research service (SRS) earth stations receiving in the frequency range 25.5-27 GHz
* Fixed satellite service (FSS) gateway uplinks operating in the frequency range 27-29.5 GHz
* Ubiquitous FSS earth stations in the frequency range 27.5-29.5 GHz[[7]](#footnote-8)
* Space-based passive earth exploration satellite services (EESS) operating in the frequency range 23.6-24 GHz
* Legacy fixed point-to-point services operating in the frequency range 27.5-28.5 GHz

Class licensed devices operating within the frequency range 24.25-29.5 GHz – including devices operating under existing class licences as well as wireless broadband services operated under a new class licence.

This chapter outlines the proposed coexistence arrangements with the services listed above. Details of how these arrangements will be incorporated into the various parts of the technical framework are also contained in subsequent chapters.

## Spectrum licensed devices operating in the 25.1-27.5 GHz band

In response to the 26 GHz band reallocation declaration, the ACMA is currently developing the technical framework for spectrum licences to be allocated in the frequency range 25.1-27.5 GHz in capital cities and regional population centres.[[8]](#footnote-9)

Spectrum licences authorise the operation of devices in a defined frequency/area combination with licence conditions to manage out-of-area and out-of-band interference. This means that interference is primarily managed at the spectrum licence boundary (frequency and area) with a reduced requirement for device-based coordination.

It is proposed that the technical framework for 26 GHz band spectrum licences will be optimised for 3GPP NR (5G) wireless broadband (fixed and mobile) services and will be in effect very similar to the proposed technical framework for 26/28 GHz band area-wide apparatus licences. This will result in reciprocal interference management arrangements at the licence boundaries between apparatus and spectrum licences.

It is proposed that coexistence between 26/28 GHz band area-wide apparatus licence and spectrum licensed services will be managed by the following:

* At the frequency boundary:
* Unwanted emission limits specified on the apparatus licence (further details in the *Unwanted emission limits* section)
* The (time division duplex) synchronisation requirement specified in the updated LCD (detailed in the *In-band emission limits* section)
* At the geographic area boundary:
* Applying the 26 GHz band spectrum licence device boundary criteria (DBC) at the geographic boundary of a 26 GHz band spectrum licence.[[9]](#footnote-10) This proposed provision would only apply to area-wide apparatus licensed services operating co-frequency with 26 GHz band spectrum licences (25.1-27.5 GHz). See draft RALI[new] in Appendix A for further details.
* The synchronisation requirement specified in the updated LCD.

At both the frequency and area boundaries the synchronisation requirement will act as a fallback (on a case-by-case basis) should interference occur which cannot be resolved through negotiation between relevant parties. It is proposed that the same synchronisation requirement will be placed on 26 GHz band spectrum licences.

Given the similarities between services expected to be operated under spectrum and area-wide apparatus licences, it is proposed that the above mechanisms will be used to manage interference in both directions across the apparatus/spectrum licence area/frequency boundaries.

Some TLG submissions disagreed with the proposed arrangements which gave equal status to both spectrum licensed and area-wide apparatus licensed services. It was suggested that spectrum licences should be protected from future area-wide apparatus licensed services, potentially meaning that some apparatus licences should not be issued until after spectrum licensed services have been deployed. It was also suggested that if interference occurred at a frequency boundary and a negotiated solution couldn’t be found, then the spectrum licensed device(s) would have priority over the apparatus licensed device(s) (i.e. the synchronisation requirement wouldn’t apply in this scenario).

It was also noted in some submissions that the requirement to negotiate and synchronise may become overly complex if there are many different licensees and networks across both licence types. Providing spectrum licensees with the higher priority would potentially reduce the number of parties required to negotiate and synchronise with.

The ACMA is of the view that the overall utility of the spectrum will be maximised under the proposed ‘equal status’ arrangements. Restricting the rights of area-wide apparatus licensees may have a significant impact on the viability of this spectrum. While there may potentially be large numbers of licensees operating in the broader 26 and 28 GHz band, negotiation and synchronisation would only be required if/when interference occurs and would be limited to impacted stations (not network wide) which is expected to ease the regulatory burden.

Based on the information provided, the ACMA does not believe that the proposed arrangements will be impractical to implement, therefore no change has been proposed to the coexistence arrangements detailed above. TLG members also indicated that the same technology (i.e. NR) is expected to be deploy under both area-wide apparatus licences and spectrum licences across the broader 26 and 28 GHz band. Therefore, there does not currently appear to be any technical reason why an agreed synchronisation regime similar to that used in other frequency bands could not be relied upon to resolve interference issues for both licence types.

## Coexistence with SRS earth stations in 25.5-27 GHz

Earth receive stations support space research activities in the frequency range 25.5-27 GHz and are currently restricted to two space communications facilities at New Norcia, WA, and Tidbinbilla, ACT. The 26 GHz band decision paper proposed the following measures to protect these earth stations:

* Exclusion zones where apparatus licensed devices cannot be operated
* A requirement that all licensed devices must be coordinated with these earth stations with a protection level of -156 dBW/MHz.

Rationale for the proposed exclusion zones and protection level is provided in Annex E of the 26 GHz band decision paper.

It is proposed that before a transmitter (which would operate in the range 25.5-27 GHz) is registered it must be coordinated with existing SRS earth stations – see the draft RALI[new] in Appendix A:

The ACMA maintains the view that apparatus licence exclusion zones are necessary to manage coexistence with the New Norcia and Tidbinbilla earth stations. It is proposed that exclusions should apply to the HCIS cells in Table 1 for transmitters operating in the range 25.5-27 GHz.[[10]](#footnote-11)

1. Proposed exclusion zones to protect SRS earth stations from area-wide apparatus licensed services

| Area name | HCIS |
| --- | --- |
| New Norcia | BU7K, BU7L, BU7O, BU7P, BU8E, BU8F, BU8G, BU8I, BU8J, BU8K, BU8L, BU8M, BU8N, BU8O, BU8P, BV2A, BV2B |
| Tidbinbilla | MW4H1, MW4H2, MW4H4, MW4H5, MW4H6, MW4H7, MW4H8, MW4D7, MW4L2 |

It is proposed that no area-wide apparatus licensed transmitters will be allowed to operate in the range 25.5-27 GHz inside the areas listed in Table 1. This will be implemented through:

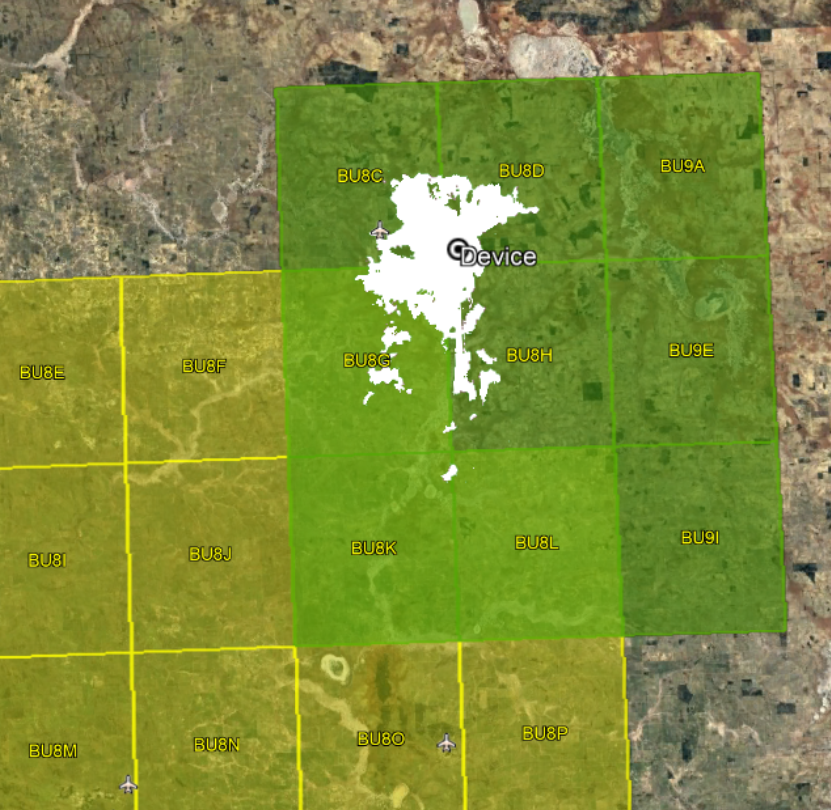
* Including the following provisions into RALI[new] – see Appendix A:
* No apparatus licences authorising operation in the frequency range 25.5-27 GHz will be issued:
* in the level 1 HCIS cells which contain the New Norcia or Tidbinbilla SRS earth stations, these being HCIS: BV2A3 and MW4H6, or
* if the licence would solely include the HCIS listed in Table 1.

Including a condition in the updated LCD that will preclude the operation of transmitters in the 25.5-27 GHz range inside the area listed in Table 1 – see the draft updates to the updated LCD in Appendix B.

Under the above proposals, area-wide apparatus licences may have constituent areas that includes those listed in Table 1 (however with a condition included in the updated LCD that will preclude the operation of transmitters in these areas). This might result in some area-wide apparatus licenses overlapping an exclusion zone but with no material increase to interference potential into SRS Earth stations. The purpose of these measures is to allow the area-wide apparatus licence PFD boundary condition[[11]](#footnote-12) to cross into these overlap areas and therefore maximise the utility of areas near, but outside, the exclusion zone.

Figure 2 shows an example of an area-wide apparatus licence area (green) overlapping the New Norcia exclusion zone (yellow) – the overlapping cells are BU8G, BU8K and BU8L. Transmitters will not be permitted to operate in the overlapping areas but the calculated PFD (white) can spill into these areas. Allowing the calculated PFD to spill into these areas removes the unnecessary deployment restrictions at the boundary of the exclusion zones without compromising the protection afforded to the New Norcia earth station (i.e. the PFD limit is based on a level of protection suitable for wireless broadband services which is higher than the SRS protection requirement).

1. Example of the PFD limit overlapping the New Norcia exclusion zone



## Coexistence with FSS gateway up-links in 27-29.5 GHz

### Interference to FSS gateway satellites

FSS gateway uplinks operate in the range 27-29.5 GHz at various locations throughout Australia. The 26 GHz and 28 GHz decision papers both outlined some preliminary views on additional conditions on wireless broadband use to safeguard coexistence with gateway uplinks.

It is proposed that the following conditions be applied to area-wide apparatus licensed devices operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5 GHz:

* Base station total radiated power (TRP) is not to exceed 25 dBm/200 MHz
* Outdoor base stations must have mechanical down tilt equal to or greater than 0˚
* Outdoor base stations operating in the range 27-27.5 GHz must not direct antenna beams (via electrical steering) to elevation angles greater than 5˚ above the horizon for more than 5% of time
* Outdoor base stations operating in the range 27.5-29.5 GHz must not direct antenna beams (via electrical steering) to an elevation angle above the horizon.

Outdoor fixed UEs, with direct line of sight to the GSO arc, must not direct their antenna beam (via electrical or mechanical steering) to within 1.5˚ of the GSO arc when the antenna beam is pointed at elevation angles of greater than or equal to 3° above the horizon.[[12]](#footnote-13)

It is proposed that the above conditions will apply to area-wide apparatus licensed devices in the range 27.5-29.5 GHz regardless of where they are located in Australia. This will provide a favourable coexistence environment for future satellite services in the band regardless of where the earth station transmitter is located.

The rationale for these proposed conditions is contained in Appendix D. Appendix D also includes the rationale for not including limitations on emissions above the horizon for mobile UEs.

The ACMA has also proposed a minor amendment to the fixed UE pointing requirements to exclude stations which do not have a direct line of sight to the GSO arc. This will remove that particular requirement for stations for which the interfering signal will be attenuated due to path obstructions.

Some TLG submissions indicated that the condition which limits base stations electrically steering above 5° for more than 5% of the time is not applicable to FWA deployments, given that UEs are not moving. It was proposed that this requirement should be changed to not electrically steering to above 0° of services in the 28 GHz band. The ACMA agrees and has incorporated those proposed changes in the above list of conditions.

Some TLG submissions also proposed that:

* The GSO separation angle of 5° for fixed UE is appropriate for services with narrow beamwidths but should be widened for wireless broadband services, given the wider beamwidth antennas expected to be used (e.g. a 4x4 array is expected to have an indicative -3 dB beamwidth of approx. 26°).
* The proposed conditions could be replaced with an elevation mask, however no further detail was provided as how such a mask could be derived. It should also be noted that the concept of an EIRP elevation mask was considered during the previous WRC study cycle and received opposition from numerous international and domestic stakeholders.
* That the final outcomes of WRC-19 should be taken into account, specifically conditions under Resolution COM4/8(WRC-19)[[13]](#footnote-14) and Article 21.5 of the Radio Regulations.

A number of TLG submissions also indicated that the proposed additional conditions are still being considered and that additional information could be provided when responding to the next version of TLG papers.

To help inform a decision about whether the GSO separation angle requirement for fixed UEs should be increased, the ACMA requests that TLG members provide further information about the expected characteristics of fixed UE antennas. A potential resolution may also involve specifying the minimum antenna requirements for fixed UEs.

To provide consistency with the WRC-19 outcomes, it is proposed that relevant provisions set out in Resolution COM4/8(WRC-19) are included in the RALI[new], limited to deployments in the range 27-27.5 GHz inside the areas listed in Appendix C. It is not currently proposed to expand the reach of the Resolution COM4/8(WRC-19) conditions to other frequencies below 27 GHz, or outside areas subject to additional conditions in the frequency range 27-27.5 GHz, given there are no potentially affected incumbent services. The proposed TRP limit detailed above also complies with Article 21.5 of the Radio Regulations

Noting that the above request for additional information, and that TLG members are still considering the proposed additional conditions, only the changes discussed above (regarding line-of-sight for fixed UEs and base stations in 27.5-29.5 GHz) are proposed at this time. Further changes may be proposed later in the TLG process pending feedback from TLG members.

The areas in which the additional conditions should apply in the range 27-27.5 GHz (detailed in Appendix C) are based on the -3 dB contours for 56 dBi spot beam antennas on satellites at longitudes of 140˚E and 145˚E pointed at each gateway earth stations currently included in the RRL in the band.

It is currently proposed that the additional conditions outlined above will be captured in the updated LCD – see Appendix B.

A potential cap on outdoor wireless broadband base station numbers within NBN gateway areas was also mooted as a possible additional condition in the 26 GHz band decision paper. However, the ACMA is currently of the view that the other proposed additional licence conditions are sufficient to safeguard coexistence and that additional device limits are not necessary.

### Interference from FSS gateway earth stations to area-wide apparatus licensed receivers

The potential for interference from FSS gateway earth stations to receivers operated under 26/28 GHz area-wide apparatus licences will depend on a number of variables, in particular geographical separation and antenna discrimination. The probability of interference to area-wide apparatus licensed receivers is low given:

* Studies undertaken by Task Group 5/1 indicate maximum separation distances of up to 7.5 km (for earth station elevation angles of at least 20˚) are required to protect IMT stations, however actual distances will depend on specific circumstances.[[14]](#footnote-15)
* The majority of existing FSS earth stations in the range 27-29.5 GHz have an elevation angle of greater than 20˚.

Noting the low potential of interference and that area-wide apparatus licensed services will be secondary in certain frequency/area combinations in the 28 GHz band[[15]](#footnote-16), it is proposed that:

* No protection will be afforded to any 26/28 GHz band area-wide apparatus licensed receivers from interference caused by an existing FSS earth station. Applications for new FSS gateway earth stations will be coordinated with existing area-wide apparatus licences covering the range 27-27.5 GHz in any area or the range 27.5-28.1 GHz in areas subject to the 26 GHz band reallocation declaration – these coordination arrangements will be developed under a separate process.

For area-wide apparatus licensed receivers in the range 28.1-29.5 GHz in any area, or in the range 27.5-28.1 GHz in areas not subject to the 26 GHz band reallocation declaration, no protection will be afforded to area-wide apparatus licensed receivers from interference caused by an existing or future FSS earth station. Applications for new FSS gateway earth stations will not need to be coordinated with existing area-wide apparatus licences in the range 28.1-29.5 GHz or in the range 27.5-28.1 GHz in areas not subject to the 26 GHz band reallocation declaration.

These requirements are proposed to be included into RALI[new] – see the draft RALI[new] in Appendix A.

Arrangements for coordinating new FSS earth stations with existing primary apparatus licensed wireless broadband services will be developed though a separate consultation process.

## Ubiquitous FSS earth stations in the frequency range 27.5-29.5 GHz

As detailed in the 28 GHz band decision paper, arrangements will be introduced for ubiquitous FSS earths station:

* On a primary basis in the range 27.5-28.1 GHz and in areas not subject to the 26 GHz band reallocation declaration, and in the range 28.1-29.5 GHz
* On a secondary basis in the range 27.5-28.1 GHz and in the areas subject to the 26 GHz band reallocation declaration.

The arrangements in the previous section (to be included in RALI[new]) will also apply for coexistence between secondary area-wide apparatus licensed services and primary ubiquitous FSS earth stations.

The ACMA will develop and consult on updates to regulatory instruments (primarily the [Radiocommunications (Communication with Space Object) Class Licence 2015](https://www.legislation.gov.au/Details/F2018C00845)) to expand current arrangements for ubiquitous FSS earth stations, as detailed in the 28 GHz band decision paper. These updates will also include appropriate protection of primary area-wide apparatus licensed services from secondary ubiquitous earth stations. These updates are outside the scope of the TLG and will be the subject of a separate consultation.

## Passive EESS satellite receivers operating in the 23.6-24 GHz band

Space-borne passive EESS services operate in the 23.6-24 GHz band. Extensive coexistence studies between IMT-2020 and passive EESS have been undertaken both internationally (notably under ITU-R Task Group 5/1 and the ECC) and domestically (in the 26 GHz Working Group).

To manage coexistence between passive EESS receivers and wireless broadband devices in the 26 GHz band, the ACMA proposed (in the 26 GHz band decision paper) unwanted out-of-band TRP limits in the range 23.6-24 GHz of -37 dBW/200MHz for base stations and -33 dBW/200MHz for user equipment. These limits are based on the agreed European limits[[16]](#footnote-17) with adjustments to account for:

* Lower population densities in Australian cities compared to Europe

A lower contribution of aggregate emissions into the passive EESS band from fixed services operating below 23.6 GHz in Australia than in Europe. In Europe, some of the EESS interference budget included contributions from fixed services – in Australia there is an existing guard band between these services.



The protection of the passive EESS band was considered in-depth at WRC-19 under agenda item 1.13, which resulted in the following emission limits into the 23.6-24 GHz band being included in ITU-R Resolution 750[[17]](#footnote-18):

* For (IMT) stations brought into use before 1 September 2027:
* For base stations, a TRP limit of -33 dBW/200 MHz
* For mobile stations, a TRP limit of -29 dBW/200 MHz
* For (IMT) stations brought into use after 1 September 2027:
* For base stations, a TRP limit of -39 dBW/200 MHz
* For mobile stations, a TRP limit of -33 dBW/200 MHz

Some TLG submissions indicated support of the above WRC-19 limits being adopted for 26/28 GHz band area-wide apparatus licensed services. These submissions suggested that adoption of these limits will allow the deployment of internationally harmonised equipment in Australia while also protecting adjacent-band passive services.

Another TLG submission indicated support of the limits the ACMA previously proposed in the 26 GHz band decision paper. A number of questions were also raised including how the ACMA’s future planning arrangement might be updated to align with WRC-19 outcomes.

WRC outcomes and the Radio Regulations play an important part in the consideration of Australia’s domestic spectrum planning arrangements. Alignment with internationally harmonised arrangements provides many benefits to Australia, in particular providing access to internationally harmonised equipment.

Careful consideration will be needed before a decision on which emission limits will apply in the passive EESS band. These considerations include the impact that the WRC-19 limits would have on the utility of the passive band, and the impact of not aligning with internationally agreed unwanted emission limits.

Up until September 2027, the WRC-19 limits will allow unwanted emissions into the passive band to be 4 dB higher than the limits previously proposed for Australia. After that date the WRC-19 limits for IMT base stations will become 2 dB stricter than the proposed limits. Some thoughts on the impact that adopting the WRC-19 limits might have include:

* 4 dB higher unwanted emissions would theoretically mean that it would take fewer base stations to exceed the EESS passive protection limits than the previous domestic studies indicated. For example, the previously proposed limits were based on 224 base stations in the footprint of an EESS satellite (a 12x18km oval). If emissions were allowed to be 4 dB higher the maximum base station number would reduce to 89 (i.e. 89 base stations would need to be deployed in the footprint area before an aggregate interference level equivalent to the previously proposed limit would be reached).
* Any impact to the passive band, in comparison with the previously proposed limits, would only materialise over time as IMT stations are deployed.
* Given that the WRC-19 limits apply to devices over the entire 24.25-27.5 GHz range, and that the frequency separation between area-wide apparatus licensed devices and the passive band would be at least 700 MHz, unwanted emissions into the passive band from area-wide apparatus licensed devices manufactured to meet the WRC-19 limits are likely to be less than those limits.
* The WRC-19 limits are expected to be widely adopted internationally. If this is the case, would there be any benefit in prescribing stricter limits in Australia, even if the 700 MHz guard band for area-wide apparatus licences means that equipment manufactured in accordance with the WRC-19 limits would likely be able to meet a stricter limit?

After September 2027, the WRC-19 limits will offer more protection to passive EESS than the previously proposed limits.

Some initial ACMA thoughts on the impact of *not* adopting the WRC-19 limits (i.e. adopting the more stringent, previously-proposed limit) follow:

* Before September 2027:
* As the previously proposed limits are stricter than the WRC-19 limits, there is a risk that internationally harmonised equipment would be unable to be deployed in Australia without modification, or that operators might need to operate at reduced power levels which may impact coverage and/or throughput.
* However, given the minimum 1.1 GHz separation between area-wide apparatus licensed services above 25.1 GHz and the passive band, there is the potential that unwanted emissions in the passive band from standard equipment above 25.1 GHz may still meet the stricter, previously proposed limits, potentially resulting in minimal impact to area-wide apparatus licensees (this may not benefit apparatus licensees operating in the range 24.7-25.1 GHz).
* After September 2027, there is expected to be no impact given available equipment would comply with both the previously proposed limits and the stricter WRC-19 limits.

As is evident above, there are a range of issues which will require further consideration. The ACMA is interested in the views of TLG members on these issues.

On balance, the optimal solution would be one which would allow both the use of internationally harmonised equipment while also providing a high level of protection to the passive EESS band.

For example, if it is assumed that:

* Internationally harmonised devices in 25.1-27.5 GHz, due to the 1.1 GHz separation from the passive band, would meet the previously proposed limits, and

Internationally harmonised devices in 24.7-25.1 GHz couldn’t meet the previously proposed limits due to insufficient filter roll-off at the smaller frequency separation from the passive band.

Then a potential solution could be:

* Adopt the WRC-19 limits across the entire 24.7-27.5 GHz range

Implement base station deployment restrictions in 24.7-25.1 GHz to ensure that the aggregate interference levels are equivalent to what would result from the previously proposed limits, noting that the 1.1 GHz guard band for spectrum and apparatus licensed devices operating above 25.1 GHz is expected sufficiently account for the 4 dB difference in prescribed limits.

The ACMA sees merit in the above proposal as it both allows the deployment of internationally harmonised equipment while continuing to meet our objective of protecting passive EESS.

It is proposed that:

* The TLG consider the impacts of adopting (or not adopting) the WRC-19 unwanted emission limits into the band 23.6-24 GHz.
* In the meantime, the draft technical framework be updated with the following requirements:
* Devices deployed before 1 September which operate in the range 24.7-27.5 GHz are to meet the following unwanted emission limits in the 23.6-24 GHz band:
* For base stations, a TRP limit of -33 dBW/200 MHz
* For mobile stations, a TRP limit of -29 dBW/200 MHz
* Devices deployed on or after 1 September which operate in the range 24.7-27.5 GHz are to meet the following unwanted emission limits in the 23.6-24 GHz band:
* For base stations, a TRP limit of -39 dBW/200 MHz
* For mobile stations, a TRP limit of -33 dBW/200 MHz
* Apply the deployment density limits in Table 2 to the 24.7-25.1 GHz range. The density limits in Table 2 are based on 2.5 times (4 dB) fewer base stations than assumed for the previously proposed limit . This base station density is halved to account for unconstrained co-frequency deployments under a class license ().

|  |  |
| --- | --- |
| 26/28 GHz band area-wide apparatus licensed transmitter operating frequency range | Maximum number of outdoor area-wide apparatus licensed transmitters within a 9km radius |
| 24.7-24.9 GHz | 44 |
| * + - 1. GHz | 44 |

1. Proposed deployment density limits in 24.7-25.1 GHz

The ACMA notes that some TLG submissions proposed changes to simplify the application of the previously-proposed deployment constraints. These will be considered further when a decision is made on whether or not to implement these deployment density limits.

1. **What are the potential impacts of adopting (or not adopting) the WRC-19 unwanted emission limits into the band 23.6-24 GHz?**
2. **Would unwanted emissions into 23.4-24 GHz from equipment manufactured to meet WRC-19 limits and operating in 25.1-27.5 GHz be at least 4 dB lower than those limits, as a result of the 1.1 GHz frequency separation?**
3. **Are the deployment density limits in Table 2 appropriate to ensure that the aggregate interference into 23.4-24 GHz from devices complying with WRC-19 limits will be consistent with aggregate interference that would have resulted from the previously proposed (stricter) limits?**

## Point-to-point services

As detailed in the 28 GHz band decision paper, no new point-to-point services are to be assigned in the 28 GHz band. Legacy point-to-point services will be able to continue to operate for a minimum of 7 years with a possibility of continued operation beyond this timeframe (subject to further review). During this time, area-wide apparatus licensed services will need to coexist with existing point-to-point services.

It is proposed to include coordination provisions in RALI[new] to protect existing point-to-point services from area-wide apparatus licensed transmitters. The proposed provisions are similar to those detailed in RALIs MS33 and MS34 for coexistence with fixed services. The proposed protection ratios in RALI[new] have been derived by adjusting the co-channel protection ratios in RALI FX3 using the proposed unwanted emission limits (see the *Unwanted emission limits* section) and aim to provide an equivalent level of protection as given by RALI FX3.

It is further proposed that area-wide apparatus licensed receivers will not be afforded protection from existing point-to-point links. In planning deployments under an area-wide apparatus licence the licensee should take account of existing point-to-point transmitters and plan their services accordingly.

For more detail see the draft RALI[new] in Appendix A.

Some TLG submissions suggested that existing point-to-point services should vacate the 28 GHz band at the end of the 7 year period and there should be no possibility of allowing these services to remain in the band after this date.

Given their low deployment numbers, it is expected that 28 GHz band point-to-point services will have minimal impact on wireless broadband services in the 26 and 28 GHz bands. This impact will be better understood at the end of the 7 year period and will inform a decision on whether it is appropriate for point-to-point services to remain in the band. With this in mind it is appropriate to allow the possibility of an extension for the time being.

## Class licensed devices

### Existing class licensed devices

Various class licensed devices currently operate in the 24.25-27.5 GHz range, including:

* Aviation security body scanning devices operating in the frequency range 24.25-30 GHz, authorised under the [Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018](https://www.legislation.gov.au/Details/F2018L01583)
* Devices authorised under the [Radiocommunications (Low Interference Potential Devices) Class Licence 2015](https://www.legislation.gov.au/Details/F2018C00500) (the LIPD class licence) including:
* Radiofrequency identification transmitters operated in the frequency range 24.1-26.5 GHz
* Radiodetermination transmitters operating in the frequency range 24.05-26.5 GHz
* Ultra-wideband short-range vehicle radar systems operating in the range 22-26.5 GHz

As detailed in the decision papers, the ACMA is of the view that these class licensed devices can coexist with 26/28 GHz band area-wide apparatus licensed services without the need for specific licence conditions or coordination requirements. This is owing to the short-range nature of these services, or the requirements for them to be operated in shielded enclosures or directed towards solid structures (wall/ground).

In some situations, effective site management may be needed to help manage coexistence (for example when operating in the vicinity of airport body scanning devices). A requirement to manage co-sited interference is proposed to be included on 26/28 GHz band area-wide apparatus licences via the updated LCD — a similar requirement is included in all spectrum licence technical frameworks (see the *Other conditions* section) — and would also be effective in limiting the (already unlikely) potential for instances of interference between devices operated under existing class licences and area-wide apparatus licensed services.

In addition, to avoid the need for changes to body scanner operating requirements, in the unlikely event that there is interference between body scanners and area-wide apparatus licensed devices (in either direction) it is proposed the area-wide apparatus licensee will be responsible for resolving any such issues.

It is proposed that the above provision be included in an update to the updated LCD — see Appendix B.

Some TLG submissions raised concerns that it is inappropriate that class licensed body scanners are provided a higher status than apparatus licensed services and it is contrary to the ‘no-interference/no-protection’ condition placed on body scanners by the [Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018](https://www.legislation.gov.au/Details/F2018L01583).

As detailed in the decision papers, the risk of interference between body scanners and apparatus licensed wireless broadband services is expected to be very low and would only occur if services were deployed in very close proximity. In addition, the class licence places significant restrictions on who is permitted to operate a body scanner, which will limit their proliferation and further reduce the risk that interference will occur. The ACMA therefore remains of the view that the proposed arrangements are appropriate.

### Class licensed wireless broadband devices

As detailed in the 26 GHz band decision paper, the ACMA is planning to introduce new class licensed arrangements for wireless broadband services in the frequency range 24.25-25.1 GHz. These deployments are intended to be limited to private premise or property and arrangements are proposed to be included in a future update to the LIPD class licence.

The updated LIPD will also include provisions to allow the coexistence of class licensed devices operating co-frequency with apparatus licensed services in the range 24.7-25.1 GHz. Class licensed wireless broadband services will operate on a no-interference, no-protection basis with apparatus licensed services.

The update of the LIPD class licence is outside the scope of this TLG and will be consulted on in a separate process.

## Coexistence with earth station protection zones and the Radio Quiet Zone

Devices operated under a 26/28 GHz band area-wide apparatus licence will also need to comply with other RALIs, including MS 32 (coordination with the Radio Quite Zone) and MS 44 (coordination with the earth station protection zones). This is standard practice across all licenced services.

It is proposed to include a reference of other relevant RALIs in RALI[new].

# Discussion of proposed technical framework

An area-wide approach to apparatus licencing in the 26/28 GHz bands is a new concept first raised in the 26 GHz and 28 GHz decision papers. Broadly speaking, the technical framework underpinning these licences is intended to operate in a similar manner to spectrum licences, where it is a technology flexible regime with coexistence primarily managed via boundary conditions (at both the frequency and area boundaries). A key difference between an area-wide apparatus licence framework and a spectrum licence framework is how the technical framework itself is specified. Whereas a spectrum licence technical framework consists of three interlocking regulatory elements provided for under the Act (i.e. core conditions, a determination of unacceptable interference and radiocommunications advisory guidelines), these building blocks are not directly available under an apparatus licence regime (although some elements can be incorporated by reference).

The main components of an apparatus licence technical framework are:

* Licence Condition Determinations made under paragraph 107(1)(f) of the Act.[[18]](#footnote-19)
* Conditions on the face of the individual apparatus licence. A transmitter must not be operated if it does not comply with the conditions specified on its licence and in any relevant LCDs. If a licence contains conditions which are contrary to a relevant LCD, then the licence condition takes precedence.
* Policy documents usually in the form of (RALIs) – these may contain specific instructions and guidance regarding coordination and coexistence between proposed and existing services. The ACMA may also adopt and publish instructions about the issuing of licences (for example, if any allocation limits or restrictions apply). RALIs are not a mandatory component of an apparatus licence technical framework and are generally only developed for frequency bands where additional guidance and instruction is required to improve the efficient use of spectrum. RALIs may also stipulates that certain conditions be placed on the face of licences when issued.

This section of the paper considers the development of each of these components.

## International Developments

There has been extensive work undertaken internationally relevant to the introduction of wireless broadband services into the 26/28 GHz bands. This section provides an outline of this work. The documents listed below have been taken into account in developing an area-wide apparatus licence technical framework for the 26/28 GHz bands.

### ITU-R studies

The 26 GHz band is one of a number of bands being considered by the ITU-R for IMT-2020 under agenda item 1.13. As at the release date of this paper, further consideration, including decisions on potential changes to the ITU-R Radio Regulations, is being made at WRC-19 – the TLG will be able to consider outcomes of these considerations as they become available.

In November 2015, Study Group 5 of the ITU-R established a dedicated task group, TG 5/1, to conduct sharing and compatibility studies relevant to WRC-19 agenda item 1.13. This work included studies on coexistence between wireless broadband and existing services in and adjacent to the 26 GHz band. The following documents contain studies which are relevant to coexistence with existing services operating in Australia:

* Annex 1 to Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en): Systems parameters and propagation models to be used in sharing and compatibility studies
* Attachment 2 of Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en): Sharing and compatibility of passive services in adjacent frequency bands and IMT operating in the 24.25-27.5 GHz frequency range
* Attachment 3 of Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en): Sharing and compatibility of the FSS and IMT operating in the 24.25-27.5 GHz frequency range

Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en): Characteristics for the terrestrial component of IMT in the frequency range between 24.25 GHz and 86 GHz..

### WRC-19 outcomes

WRC-19 was held in Sharm el-Sheikh, Egypt from 28 October to 22 November 2019 – the [Provisional Final Acts](https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf) are available on the ITU-R website. Consideration of IMT in the 26 GHz band was included under agenda item 1.13. The following outcomes are relevant to the 26 GHz band:

* A new footnote (currently 5.A113) which identifies the 24.25-27.5 GHz band for administrations wishing to implement the terrestrial component for IMT. The new Resolution COM4/8 (WRC-19) applies to this identification.
* Resolution COM4/8 (WRC-19) was made to support the implementation of IMT in the 26 GHz band and includes a number of provisions for coexistence with FSS.

Resolution 750 was updated to include unwanted emission limits in the passive EESS band 23.6-24 GHz (these were discussed in the *Passive EESS satellite receivers operating in the 23.6-24 GHz band* section).

### Electronic Communications Committee (ECC) outcomes

The ECC has also been active in developing arrangements for wireless broadband services in the 26 GHz band and have produced the following documents:

* [ECC Decision (18)06](https://www.erodocdb.dk/document/3361): ECC Decision of 69 July 2018 on the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25-27.5 GHz, corrected 26 October 2018

[CEPT Report 68](https://www.erodocdb.dk/document/3358): Harmonised technical conditions for the 24.25-27.5 GHz (’26 GHz’) frequency band.

### 3GPP standards

Bands n258 and n257 (consisting of the frequency ranges 24.25-27.5 GHz and 26.5-29.5 GHz respectively) are standardised by 3GPP for New Radio (NR) technologies (also referred to as 5G). The 3GPP has developed a range of standards and technical papers in relation to NR, including:

* 3GPP [TS 38.101-2](https://www.3gpp.org/DynaReport/38101-2.htm): NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone
* 3GPP [TS 38.104](https://www.3gpp.org/DynaReport/38104.htm): NR; Base Station radio transmission and reception.

## System model

System models are used to simplify the development of the technical framework. This section outlines the proposed system model for the 26/28 GHz band area-wide apparatus licence technical framework.

Given the international developments outlined in the previous section, the choice in technology type that has formed the basis of this technical framework is limited to fixed and mobile wireless broadband services. However, this does not exclude the use of other technologies under the licence or the operation of systems using different parameters than those specified in this paper, so long as they fit within the technical framework

The specific technology being considered in the development of the new technical framework is 3GPP NR (3GPP 38-series). TLG submissions indicated that this is the only technology that is expected to be used under an area-wide apparatus licence in the 26/28 GHz bands.

It is proposed that the technical framework is optimised for TDD operation, which aligns with 3GPP standards and international developments.

Based on TLG submissions, a broad range of deployment types are expected in the band, ranging from dense ‘hot-spot’ deployments proving high capacity services in highly populated areas to macro deployments (fixed and mobile) providing high capacity broadband access over a wide area.

The following two deployment models are assumed as the ‘deployment extremes’ and are used to help define aspects of the technical framework (this does not restrict other deployment types under a 26/28 GHz area-wide apparatus licence):

* ‘Hot-spot’ type deployments to provide high capacity in highly populated areas.
* Typical maximum coverage per base station approx. 100-200m.
* Typically (but not limited to) low base station antenna heights (e.g. light pole mounted) at heights below 6m above ground level and typically (but not always) immersed in local clutter.
* User equipment (UE) antenna height typically around 1.5m above ground (but could be higher is some cases).
* Macro deployment
* Could be either a mobile (limited to below 27.5 GHz) or fixed (point-to-multipoint) wireless broadband network
* Base station antenna heights positioned to get above local clutter and maximise coverage, typically 15m above ground level (but could be higher in the range 30-50m).
* In a fixed network:
* Path to user terminals is typically clutter free.
* UE antennas typically mounted on the external surface of a building (e.g. roof, eave), at a height of around 5m above ground.
* In a mobile network (limited to below 27.5 GHz):
* Clutter loss is expected along some paths between base station and user terminal
* UE antenna height typically around 1.5m above ground (but could be higher in some cases).

It is proposed that the system model detailed in Table 3 be used in the development of the 26/28 GHz band technical framework.

1. System model

|  |  |  |
| --- | --- | --- |
|  | Base station | User station |
| Channel bandwidth | Standard channel sizes 50, 100, 200, 400 MHz. Carrier aggregation is possible | |
| Duplex method | TDD | |
| TRP | Minimum (based on indoor base station)[[19]](#footnote-20): 20 dBm/200 MHz  Maximum: TBD | Max. 23 dBm (mobile)  Max. 35 dBm (fixed) |
| Antenna gain | 23 dBi (8x8 array) | 17 dBi (4x4 array) possibly higher in fixed deployments |
| Antenna height | 6-50m | 1.5m (typical for mobile)  5m (typical for fixed) |
| Noise Figure | 10 dB | |
| Reference sensitivity (note 1) | -89 dBm/50 MHz | - |
| Minimum wanted level (note 1) | -83 dBm/50 MHz | - |
| ACS @ 50 MHz (note 1) | -61.3 dBm/50 MHz  21.7 dB | - |
| Blocking (note 1) | -56 dBm/50 MHz  27 dB | - |
| Intermodulation rejection (dBm/occupied bandwidth) (note 1) | -64 dBm | - |

Note 1: These values are at the input of the receiver and are based on a local area base station as detailed in 3GPP TS 38.104. See the *Managing interference to spectrum-licensed receivers* section of the Development of the 26 GHz spectrum licence technical framework V2 TLG paper for details on how absolute values are derived. Relative values are based on the minimum wanted level.

1. **Is the proposed system model suitable for the development of the 26/28 GHz band area-wide apparatus licence technical framework?**

## Assignment conditions

This section provides an outline of the proposed conditions dealing with the allocation of area-wide apparatus licences in the 26/28 GHz bands. These conditions would apply if area-wide apparatus licence in the 26/28 GHz band are administratively allocated.

It is proposed that area-wide apparatus licences are designed to be scalable (in both frequency and area) to suit the needs of individual licensees.[[20]](#footnote-21) However, it is necessary to specify some assignment conditions to help enable the efficient and effective use of spectrum:

* The area/frequency combination of an area-wide apparatus licence is large enough to support a service (i.e. the area and/or bandwidth authorised by the licence is not too small to make the licence unusable)
* Improve spectrum efficiency:
* Spectrum can be more efficiently used if the same licensee holds co-frequency licences on both sides of geographic boundaries (e.g. across the spectrum/apparatus licence boundary in the 26 GHz band). Having contiguous geographic holdings will allow a licensee to more effectively manage in-band interference between adjacent cells
* An ordered frequency assignment priority will reduce the instances of small unusable ‘pockets’ of spectrum being left unlicensed in-between frequency adjacent licensees.

This section discusses proposals to address the above issues.

### Minimum area and bandwidth limits

The smallest geographic ‘building-block’ used in spectrum licences (referred to as a standard trading unit or STU) is a geographic area equal to a Level 1 HCIS cell of the 2012 Australian Spectrum Map Grid (ASMG)[[21]](#footnote-22) – which is 5x5 minutes in size (approximately 9×9 kilometre). In consideration of the new use cases that 5G is expected to facilitate and given the relatively short propagation distances in the 26/28 GHz range, it may be beneficial to introduce a smaller HCIS level. For example, smaller cell sizes of 1x1 minute (approximately 1.8x1.8 km), or 15x15 seconds (approximately 500mx500m).

The ACMA is seeking views from TLG members if a smaller ASMG grid size should be developed for use with 26/28 GHz band area-wide apparatus licences – noting that the ACMA is still exploring if a smaller grid would be feasible to implement in its licensing business system (Spectra). A smaller grid would also need to be compatible with the HCIS structure of the ASMG.

A smaller map grid could provide a finer geographic resolution (i.e. smaller ‘building-blocks’) so that area-wide apparatus licences can be designed to more accurately match the needs to individual licensees. A smaller map grid would also allow a licence to be issued for a smaller area, which may be useful for small localised wireless broadband networks (e.g. an industrial 5G network in a factory).

Feedback from the TLG suggested that the minimum geographic area on an apparatus licence should be a single HCIS level 1 cell. This was proposed due to a combination of the proposed increased in-band TRP limit and the expectation that multiple base stations would be deployed under an area-wide apparatus licence, so a smaller area is not necessary. It was also noted that allowing smaller areas could lead to geographic fragmentation of licences which may result in boundary coexistence issues.

However, a submission also noted that a smaller cell dimension could be suitable in major metropolitan areas, for example for the deployment of small cells at commercial premises.

The ACMA is of the view that a minimum area of 9x9km (a single HCIS level 1 cell) will be too large for some use cases which may be deployed in these bands. Defining a smaller minimum area would allow licensed areas to more accurately align with planned deployments while at the same time not preclude the issue of licences which cover larger areas.

It is therefore proposed that the minimum geographic area should be 15x15 seconds (approximately 500mx500m). Should this proposal be adopted the ACMA will undertake additional work to develop the new HCIS levels and update the ASMG accordingly.

1. **Are the proposed minimum geographic areas appropriate, noting that there will be a range of potential network types in the 26/28 GHz bands?**

All spectrum licences are subject to a minimum bandwidth requirement (known as the minimum contiguous bandwidth – or MCB), which is enforced when spectrum is traded on the secondary market.[[22]](#footnote-23) The difference with a area-wide apparatus licence is that, for administratively issued licences, a minimum allocation bandwidth needs to be specified to help limit unnecessary segmentation of the band at the allocation stage.

The minimum allocation bandwidth should be set at the minimum amount of spectrum needed to provide a viable service. The minimum channel bandwidth of the technology likely to be deployed under a 26/28 GHz band area-wide apparatus licence, 3GPP NR (see the *System model* section), is 50 MHz. However, more efficient use of spectrum is achievable if channels sizes in multiples of 100 MHz are used, indicating that 100 MHz may be the minimum bandwidth for an “efficient” service.

Based on the above, an appropriate minimum allocation bandwidth for the 26/28GHz bands could be 50 or 100 MHz. Given that 50 MHz is the minimum channel size, and that this amount of spectrum can still provide a viable service, it is proposed that the minimum allocation bandwidth for the 26/28 GHz bands should be set at 50 MHz. It is proposed that RALI[new] includes a provision that an area-wide apparatus licence in the 26/28 GHz band cannot be administratively issued if the bandwidth is smaller than 50 MHz. A minimum bandwidth of 50 MHz also received support from some TLG members

### Maximum area and bandwidth limits

The are no maximum bandwidth limits proposed by this framework at this time, however it should be noted that the potential for restrictions on certain persons or types of person being authorised to access spectrum in the 26/28 GHz bans may be subject to further consideration outside of the TLG.

It is also proposed that 26/28 GHz band area-wide apparatus licences can consist of an aggregation of any number of HCIS cells (of all levels) with no maximum geographic area limit.

### Assignment rules

The following assignment rules are proposed to be included in RALI[new] which aim to improve the efficient allocation and use of spectrum as well as aiding coexistence with incumbent services. These rules would apply for licences which are administratively allocated.

* Frequency assignments must follow a 50 MHz channel raster, where multiple channels can be aggregated (maximum aggregated bandwidth limits are still under consideration outside of the TLG).
* Only a single apparatus licence can be issued for a frequency range in a particular geographic area.
* The geographic area authorised by an area-wide apparatus licence must consist of only whole HCIS cells of a specified minimum size (see above in the *Minimum area and bandwidth limits* section).
* Where possible, the frequency range of a new apparatus licence should align with an existing 26/28 GHz band (either spectrum or apparatus licensed) licence held by the licensee. This aims to help manage adjacent-area interference.
* If the licensee does not already hold 26/28 GHz band spectrum, channels are to be assigned according to the assignment priority detailed in Table 3.
* An apparatus licence which includes the range 25.5-27 GHz is not to be issued in the following HCIS cells: MW4H6 and BV2A3, or if it only contains HCIS cells in Table 4 – see *Coexistence with SRS earth stations in 25.5-27 GHz.*

1. Proposed channel assignment priority

|  |  |
| --- | --- |
| Frequency range (GHz) | Channel assignment direction |
| 24.7-25.1 | Descending order |
| 25.1-27.5 | Ascending order |
| 27.5-29.5 | Ascending order |

TLG submissions indicated that 26 GHz spectrum licence holders should be given priority to co-frequency apparatus licences in adjacent geographic areas, similar to arrangements in RALIs MS33 and MS34. This arrangement would ease coexistence issues at geographical area boundaries.

The proposed arrangements above aim to align the frequency of licences across different geographic boundaries and would apply to both spectrum and area-wide apparatus licences (see section 4.3.1 of draft RALI[new]). Given that 26 GHz band spectrum licence holdings are not yet known, the proposed arrangements may be revisited after the 26 GHz spectrum licence auction has concluded.

## Recording device details in the RRL

To aid in the management and resolution of interference issues, it is proposed that the details of certain types of transmitters operated under a 26/28 GHz band area-wide apparatus licence are required to be included in the RRL before they are operated (for simplicity, this is referred to ‘registration’ in this paper). This is a similar approach used under the spectrum licensing regime.

Given that the risk of interference is not the same for all types of transmitters operated under a 26/28 GHz band area-wide apparatus licence, it is proposed that some transmitters be exempt for the registration requirements.

User terminals, both fixed and mobile, are the most obvious devices that need to be exempt from registration due to their nomadic/mobile nature and ubiquitous deployment. Table 5 lists the maximum TRP and EIRP limits from ITU-R Working Party 5D and 3GPP.

1. User equipment output power limits.

|  |  |  |  |
| --- | --- | --- | --- |
| **User terminal type** | **Max TRP (dBm)** | **Max EIRP (dBm)** | **Source** |
| Handheld UE | 22 | 39[[23]](#footnote-24) | ITU-R WP 5D – see Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en) |
| 23 | 43 | 3GPP (TS 38.101-2) |
| Fixed wireless access UE | 35 | 55 | 3GPP (TS 38.101-2) |

While it is not considered ideal to require user terminals to be registered, it is not desirable to exempt devices which meet the limits for fixed wireless access devices in Table 5, given these limits would also exempt base stations (and would not be permitted by the proposed in-band limit of 30 dBm/200 MHz – see the *Maximum in-band limit* section).

It is proposed that any device operating with a TRP less than or equal to 23 dBm per occupied bandwidth be exempt from registration. This value will allow handheld UEs compliant with 3GPP standards to be registration exempt. Although this value is 1 dB higher than the TRP used in ITU-R sharing studies for the 26 GHz band, the fact that UEs will in most cases operate with transmit powers well below this level (due to adaptive power control) means that this 1 dB increase is expected to have a negligible impact on other services.

This proposed registration exemption would require power class 1 devices to be registered, however it is expected that not all fixed applications would require the use of high powered user terminals. It may be feasible for fixed wireless access networks to use power class 3 devices in many cases (potentially with the use of higher gain antennas). The ACMA seeks views on the suitability of the proposed registration exemption limit.

There was support for the registration exemption limit to be set at 23 dBm per occupied bandwidth in TLG submissions, however it was also indicated that class 1 CPE (TRP up to 35 dBm) are likely to be deployed. This led to concerns that requiring customer equipment to be registered may result in additional regulatory burden and increased costs. There were also suggestions that high powered fixed CPE posed a low risk of interference as it wasn’t moving.

The ACMA remains of the view there is an increased interference risk from high powered UEs and that the additional regulatory burden of registering these devices is outweighed by the interference management benefits of registration . In addition, requiring high powered UEs to meet all the pre-registration requirements (e.g. the requirements in the s.145 Determination) will provide a favourable coexistence environment with adjacent services.

It is also proposed to exempt all indoor devices from registration (base stations and UEs). The high building entry loss at frequencies in the 26/28 GHz bands (based on Recommendation ITU-R P.2109) is expected to reduce the risk of interference from indoor devices and negate the need for these devices to be registered.

Some TLG submissions suggested that the proposed ‘indoor’ definition (i.e. 2 metres from an external surface) would be difficult to manage and enforce, and it is not practical for self-installed CPE. Other suggested definitions included specifying a pfd limit or a minimum building penetration loss. A required building loss value is difficult to specify as it will depend on the transmit power (i.e. a high power transmitter will require more building loss to ensure the same external signal level as a lower powered transmitter).

A potential pfd limit, based on the interference risk from an outdoor UE with a TRP of 23 dBm, is:

* Pfd limit at 2 metres for the external surface of the enclosed space, modelled on a notional UE with: TRP = 23 dBm, antenna gain = 17 dBi, path loss at 2m (for f=24.7 GHz) = 66 dB

= = -7 dBW/m²/occupied bandwidth[[24]](#footnote-25)

The ACMA’s view is that exempting all indoor transmitters which have the same interference potential was transmitter with a TRP ≤ 23 dBm, reduces regulatory burden with minimal increase in interference risk. Therefore, the above pfd limit is proposed to replace the previous indoor definition.

The proposed devices exempt from the registration requirement is as follows:

**Recording devices in the Register**

(1) Subject to (2), a licensee must not operate a radiocommunications transmitter under this licence unless;

(a) the requirements under Part 3.5 of the Act relating to registration of the transmitter have been met; and

(b) the transmitter complies with the details about it that have been entered in the Register.

(2) Subsection (1) does not apply to the following kinds of radiocommunications transmitters:

(a) a transmitter that operates with a maximum total radiated power of less than or equal to 23 dBm per occupied bandwidth; or

(b) an indoor transmitter.

***Indoor transmitter*** means a transmitter located in an enclosed space where the power flux density from the transmitter and measured at 2 metres from the outside surface of the enclosed space is less than or equal to -7 dBW/m² per occupied bandwidth.

It is proposed that there be no requirement to record receivers operated under a 26/28 GHz band area-wide apparatus licence in the RRL. However, in order to gain protection (which is often provided on a first-in-time registered basis), it is recommended that these devices be included in the RRL.

1. **Are the proposed exemption from registration requirements suitable?**
2. **Is an ‘indoor’ definition based on a pfd limit appropriate? Is it practical to implement?** **Is the proposed pfd limit suitable?**

## Geographic boundary conditions

In the 26 GHz and 28 GHz decision papers, the ACMA proposed that the application of boundary conditions may be needed to manage coexistence between adjacent services, for example specifying a power flux density (PFD) limit at the geographic boundary.

This section outlines the rationale for the proposed PFD limit. As indicated in the *Coexistence with other services* chapter it is proposed that the 26 GHz band spectrum licence DBC is used to manage coexistence (in both directions) at the geographic boundary between 26/28 GHz area-wide apparatus licences and 26 GHz band spectrum licences).[[25]](#footnote-26) Therefore the proposed PFD limit would be applicable at all area boundaries of an area-wide apparatus licence except boundaries with spectrum licences.

### Receive antenna height and gain

As detailed earlier, it is proposed to optimise the 26/28 GHz band area-wide apparatus licence technical framework for TDD operation and that a fall-back synchronisation requirement will manage interference between base stations operated by adjacent licensees. Therefore, the device boundary criteria will need to manage interference from base station to UE across the geographic boundary.

It is proposed that the receive antenna height be set to 5m based on the typical UE antenna height in fixed broadband networks – this is also consistent with the antenna height used in the 3.4 GHz band technical framework.[[26]](#footnote-27)

Although UEs are expected to use high gain beamforming antenna’s (e.g. 17 dBi for a 4x4 antenna array) it is likely that the antenna gain in the direction of an adjacent area base station will be low because:

* UEs will be electronically steering their antenna beams towards their own base station
* A relatively narrow beamwidth (approx. 29˚ for a 4x4 array when it is not being electronically steered)
* UEs located at (or near) the geographic boundary will be steering their antenna beam away from the boundary (i.e. its base station will need to be further away from the boundary in order to meet the boundary condition).

Some TLG submissions suggested that a receiver gain based on a front-to-back ratio of 25 dB (i.e. -8 dBi) may be overly optimistic considering that in some cases the antenna may be pointing parallel to the area boundary. It was further suggested that a receiver gain of 0 dBi may be more appropriate.

Considering the above points, it is proposed to use an antenna gain of 0 dBi. This value is also consistent with the value used in the 3.4 GHz band.

### Level of protection

The level of protection (LOP) is the benchmark protection given to receivers from co-channel emissions of transmitters operating in adjacent geographic licence areas. The level of protection is a compromise between the level of emissions over the geographic boundary of the licence and the protection requirements of receivers (i.e. more protection afforded to receivers will mean more restriction on transmitters).

It was suggested in the TLG that a higher LOP could be specified when a transmitter is using beam steering, to account for the reduced probability of direct antenna beam alignment. A beam alignment probability gain of 8 dB was proposed to be added to LOP when a transmitter is using beam steering. This addition would result to two LOP values.

It is proposed that the LOP is based on a protection criterion of I/N = -6 dB – this is consistent with the protection level set by WP 5D.[[27]](#footnote-29) Using a noise figure (NF) of 10dB[[28]](#footnote-30), receiver noise is calculated as:

Therefore, noting the proposed antenna gain of 0 dBi, the proposed LOP (for protection from non-beam forming transmitters) is:

; and

the proposed LOP for protection from transmitters using beam steering is:

The above LOP values can then be converted to a PFD as follows:[[29]](#footnote-31)

/MHz for transmitters using beam steering

/MHz for transmitters not using beam steering.

This PFD level may also be applicable to non-spectrum licensed services (such as FSS gateways) when coordinating with existing area-wide apparatus licensed areas.

Some TLG submissions have indicated a preference for the boundary PFD limit to be specified as a pre-registration requirement, as opposed to a condition of operation (i.e. a condition specifying that a transmitter cannot be operated if it exceeds the defined PFD limit). A few submissions also asked for additional information on where this limit should apply and how it should be calculated.

Based on this feedback, the following provisions are proposed to be included in RALI[new]:

* The PFD limit will be included as a pre-registration condition. Details of a transmitter are not to be included in the RRL if the PFD level at the geographic boundary of the licence would exceed the specific limit.
* The PFD limit is to be met at all points along the geographic boundary. Higher calculated PFD levels which fall beyond the geographic boundary can be ignored. See the draft RALI[new] at Appendix A for further examples.
* The PFD limit applies to each transmitter, not an aggregate limit.
* The PFD limit does not apply:
* When the distance from the proposed transmitter to the licence boundary exceeds a specified minimum distance. The draft RALI[new] provides a graph detailing minimum distances based on EIRP levels and free space loss. This exemption provides a simplified approach to assess compliance.
* At a boundary with a 26 GHz spectrum licence (as discussed above), and
* At the boundary of HCIS cells MW4H6 and BV2A3 (these cells contain the Canberra Deep Space Communications Complex and New Norcia SRS earth receive stations). The protection provided by the proposed PFD limit is based on wireless broadband technologies with synchronised TDD operation and will not provide adequate protection to SRS earth stations. As previously discussed, protection of SRS earth station is proposed to be provided by an exclusion zone and a coordination requirement. Therefore, omitting the PFD limit from the boundary of these HCIS cells will not impact coexistence between SRS and spectrum licensed devices.



1. **Is it practical to specify two different PFD limits at the geographic boundary of a licence (depending on transmit antenna type)? Are the proposed PFD limits suitable?**
2. **Is the proposed receive antenna gain of 0 dB (used to determine the PFD limit) appropriate?**
3. **Should the proposed PFD limits also apply when coordinating other transmitters (i.e. those which are not authorised under a spectrum or area-wide apparatus licence, such as FSS earth stations) with area-wide apparatus licensed services?**
4. **Are the proposed requirements dealing with the PFD boundary condition in RALI[new] suitable?**

## In-band emission limits

### Maximum in-band power limit

In the 26 GHz band decision paper, the ACMA proposed an in-band total radiated power (TRP) limit of 30 dBm/200 MHz. This was based on the transmit power level specified by WP 5D[[30]](#footnote-33) to be used in sharing studies (25 dBm/200 MHz) plus an additional 5 dB margin to provide some flexibility in the framework for higher power base stations. The ECC has not specified an in-band power limit.[[31]](#footnote-34)

Some TLG submissions indicated that a TRP limit of 30 dBm/200 MHz may restrict future deployments and use cases, and that a TRP in the range 40-45 dBm/200 MHz would be more suitable.

Transmit power limits were also discussed at WRC-19, specifically with regard to the applicability of Article 21.5 of the ITU-R Radio Regulations, and it was agreed that more studies would be required prior to WRC-23. [[32]](#footnote-35)

While an increased TRP limit might improve flexibility it would also increase the risk of interference to other services. The ACMA is open to further consideration of a higher in-band TRP limit than previously proposed and requests further input from the TLG regarding an appropriate limit. Any such consideration will continue to have regard to the need for coexistence with other services and ongoing studies related to Article 21.5 – indeed the unresolved nature of those studies will imply an upper bound on the potential range of values to be considered.

Note that an additional TRP restriction is proposed for transmitters operating in 27-27.5 GHz (within defined areas) and in 27.5-29.5 GHz – see the *Interference to FSS gateway satellites* subsection.

### Managing adjacent channel interference

As outlined in the *System model* section, it is proposed that the 26/28 GHz band area-wide apparatus licence technical framework be optimised for TDD operation. This is consistent with 3GPP standards and ITU-R sharing studies. The most critical interference scenario that might result between adjacent TDD networks is interference from base station transmitter to base station receiver when they are operating at the same time. There are two options which have been used in other bands to manage this interference scenario:

1. Use of a ‘restricted block’ at the frequency boundary adjacent to another licence. A lower in-band emission limit would be specified in the restricted block which, together with a more restrictive unwanted emission limit, would manage adjacent channel interference.
2. Requiring adjacent networks to synchronise their operation if interference occurs.

Either option could be specified as a fall-back, which is only applied when interference occurs and an agreement to manage the interference cannot be reached between affected parties.

Both options have been used domestically in licensing arrangements applicable to other frequency bands. For example, a restricted block arrangement was implemented in the original 3.4 GHz band spectrum licence technical framework. However, concerns were raised in the development of the 3.6 GHz band framework that this approach is not spectrally efficient, particularly for 5G technologies making use of AAS.

One possible problem with the restricted block approach might be that the ‘additional unwanted emission limit’ would only apply when needed to manage interference. This could be something that is known to apply at the time of planning a network or it may not apply until sometime in the future when an adjacent band licensee deploys a service. The latter scenario could be problematic for 5G systems, as it may not be possible to apply additional RF filtering to an AAS base station post manufacture, given the integrated nature of the antenna and RF unit. It is therefore preferable that unwanted emission limits between spectrum licensees be static, although again, this can be inefficient.

Given the above concerns, the synchronisation approach was ultimately implemented in the 3.4/3.6 GHz bands. It is proposed to use a similar synchronisation approach as a fallback if needed to manage adjacent band interference between 26/28 GHz band area-wide apparatus licensed services. The proposed requirements are:

* When interference exceeds a specified limit, licensees will be required to synchronise services.
* Synchronisation would only be required between affected devices, not network- wide.
* Licensees would also be free to negotiate alternative arrangements on a case-by-case basis.

The proposed requirements will require the fall-back synchronisation frame structure to be defined. In the 3.6 GHz band technical framework a frame structure based on LTE technology (from 3GPP TS 36.211) was defined. The ACMA is seeking advice from the TLG on an appropriate frame structure to be codified in the 26/28 GHz band area-wide apparatus licence technical framework as a fallback if/when required.

Synchronisation may, depending on the final parameters adopted, result in the inability of operators to implement some low latency options and/or flexible/dynamic UL/DL sequencing. However, it also negates the need for guard bands or restricted blocks, reducing the requirement for (and costs associated with) additional filtering and potentially mitigates the effect of dead zones that might occur when managing cross-border interference.

TLG members indicated general support for a synchronisation fallback mechanism to manage adjacent band interference. However it was also noted that due to the evolving nature of mmWave 5G use cases, it may be too early to define a fallback frame structure. It was also proposed that the frame structure should be defined in a RAG or RALI instead of as a licence condition to make it easier to update in the future if required.

The ACMA’s preliminary view is that the additional flexibility to vary the frame structure in the future would be a benefit to licensees and proposes to define the frame structure in RALI[new] – noting that the ACMA would still consult before making any future changes. The synchronisation requirement will still be included as a licence condition.

It is therefore proposed to include the below synchronisation condition in the updated LCD (noting that the frame structure, which is still to be determined, will be defined in RALI[new]) – also see Appendix B. The proposed synchronisation procedure would be invoked as necessary for interference management purposes with other 26/28 GHz band area-wide apparatus licensed services as well as with devices operated under a 26 GHz band spectrum licence.

TLG members also suggested that synchronisation may not eliminate all cases of interference. The ACMA is of the view that the proposed synchronisation fallback requirement is a tool which would resolve the majority of interference issues, while also providing flexibility by applying it only when/where needed and allowing affected parties to negotiate other solutions where appropriate.

The ACMA will have a strong regard to the synchronisation fallback requirement when dealing with an interference resolution dispute. There are also other mechanisms to aid the resolution of interference which may still occur even though services are synchronised. These include consideration of first-in-time status and provisions provided in the Act (e.g. the conciliation process in Division 3 of the Act).

**Synchronisation requirement**

If:

1. interference occurs between:

(i) a radiocommunications device (the ***first device***) operated under this licence; and

(ii) a radiocommunications device (the ***other device***) operated under another area-wide apparatus licence in the frequency range 24.7 GHz to 29.5 GHz or a 26 GHz band spectrum licence (the ***other licence***);

1. the level of interference to the first device or to any other devices exceeds the compatibility requirement set out in the *Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 26 GHz Band) 2020,* as in force from time to time;
2. either the licensee or the holder (or authorised third party) of the other licence wishes to resolve the interference; and
3. no agreement between the licensee and each person operating one or more other devices can be reached on how to manage the interference;

then the licensee is required to manage the interference by:

1. either:

(i) operating the first device with a frame structure that is defined in RALI[new]; or

(ii) operating the first device using a sequence and duration of radio emissions that is consistent with those configurations (disregarding any time at which the device is not making a radio emission); and

1. synchronising the timing of the frame structure or other sequence of radio emissions of the first device with the timing of the frame structure or other sequence of radio emissions of each of the other devices (disregarding any device at a time at which the device is not making a radio emission).

Note: The synchronisation requirement only applies when an interference issue occurs and where there is no other measure agreed to between the licensees to resolve the interference. This means synchronisation can be done on a site/cell specific basis. During any period in which the licensee and other licensee are taking steps to resolve the interference issue or synchronise, the ACMA will generally give priority to the device registered first in time in any interference dispute, meaning that the device or devices registered later-in-time will generally be required to accept any interference or cease causing interference during this time.

Some TLG submissions suggested that a different frame structure may be needed in 25.1-27.5 GHz compared to 24.7-25.1 GHz and 27.5-29.5 GHz. The rationale being that different technologies and/or use cases may be operated in these different frequency ranges.

Based on TLG submissions, the only technology expected to be operated in the range 24.7-29.5 GHz, under either an area-wide apparatus licence or a spectrum licence, is 3GPP NR (3GPP 38-series). This indicates that synchronising between spectrum and apparatus licensed services (across the 25.1 GHz and 27.5 GHz boundaries) will be feasible. Of course there will be a range of different use cases and network types deployed across the 26/28 GHz bands, however the ACMA remains of the view that a single fallback frame structure (which would also apply across the 25.1 GHz and 27.5 GHz boundaries) is the best way to manage adjacent band interference – again noting that other frame structures could be bilaterally agreed.

Two TLG submissions provided some example fallback frame structures:

* DDDSU (4:1) with S = 10:2:2
* DDSU.

These were suggested as they are commonly adopted and offer reasonable latency and flexibility. While the ACMA does not at this point have a strong view on which fallback frame structure should ultimately be specified, it is important that is accurately described in the technical framework. We seek additional information to fully describe the frame structure, including:

* Duration of the frame and subframes;
* Definition of the ‘S’ subframe and the duration of subparts within the ‘S’ subframe; and
* Reference to the applicable 3GPP specifications, if applicable.

1. **Can TLG members provide additional rationale for an increased in-band TRP limit?**
2. **What is an appropriate fallback frame structure? Can TLG members provide more detail on how to fully describe the fallback frame structure?**
3. **Is it appropriate to detail the synchronisation fallback frame structure in RALI[new]? Should the ACMA consider updating this frame structure in the future to better align with deployed use cases (subject to public consultation)?**

The ACMA will continue to work with stakeholders regarding appropriate wording and definition of the synchronisation requirement.

## Unwanted emission limits

When defining unwanted emission limits (both out-of-band and spurious), consideration has been given to the following documents:

* 3GPP TS 38.104 (NR base station)
* 3GPP TS 38.101-2 (NR user equipment)
* Attachment 2 to Document 5-1/36 (details IMT-2020 characteristics to be used in sharing studies)
* ECC Decision (18)06

Like the 3.6 GHz band spectrum licence technical framework, the ACMA proposes to specify the unwanted limit as a total radiated power (TRP). This acknowledges that NR (also referred to as 5G) equipment will typically utilise antenna arrays which are integrated into the base station, meaning it will be difficult to undertake conducted power measurements. A TRP specification is suitable for both AAS and non-AAS devices.

It is proposed that the unwanted emission limits detailed in this section be included in the updated LCD, so that they apply to all area-wide apparatus licences issued in the 26/28 GHz band – see Appendix B.

In consideration of the proposed registration exemption requirements (see the *Recording device details in the RRL* section) there is potential that base stations may be exempt from registration (e.g. if they are indoors) and some UEs might be required to be registered (e.g. located outdoors with a TRP > 23 dBm). Therefore, it is proposed to define separate unwanted emission limits depending on type of device (either base station or UE), rather than whether or not the device needs to be registered.

This is a deviation from how unwanted emission limits have traditionally been specified in spectrum licensed bands. However, the purpose of doing so is to align the technical framework more closely with international equipment standards and more accurately reflect how agreed emissions limits into the 23.4-24 GHz are defined.

The proposed definitions of base station and user equipment station are below (noting that these definitions are yet to be legally reviewed):

* Base station means a radiocommunications device which is connected to a telecommunications network and supplies a service to one or more user equipment stations

User equipment station means a radiocommunications device which is not a base station.

### Base station unwanted emission limits

Figure 3 provides a comparison of the different base station unwanted limit specifications derived from the documents listed above. As the frequency offsets for the application of unwanted emission limits in 3GPP standards vary depending on channel bandwidth, Figure 3 includes 3GPP limits applicable to the smallest (50 MHz) and largest (400 MHz) channels. The WP 5D[[33]](#footnote-36) and 3GPP limits are dependent on the transmit power level. A transmit power level of 30 dBm (equal to the proposed in-band limit) is used to derive the limits shown in Figure 3.

1. Comparison of unwanted emission limits – base station

It is proposed that unwanted emissions should not be higher than those necessary to deploy a service. The ECC limits would allow higher levels of unwanted emissions at certain offsets than necessary for 3GPP standardised equipment. While lower unwanted emission levels would better ensure coexistence with adjacent services, specifying limits below the 3GPP standardised levels may adversely impact on device availability and/or manufacturing costs. However, from a practical perspective, it is also noted that unwanted emission levels decrease as the wanted transmit power decreases.

Feedback from the TLG suggests that unwanted emission limits should be based on 3GPP limits and not the WP 5D limits, so as to ensure equipment is readily available.

The frequency offset break-point for unwanted emission limits for base stations in 3GPP TS 38.104 (Table 9.7.4.3.2-1) is specified as: , where BWcontiguous is defined as the contiguous transmission bandwidth (i.e. the bandwidth from the lowest frequency edge of the lowest transmitted channel to the highest frequency edge of the highest transmitted channel).

A few TLG submissions indicated an interest in being able to operate contiguous bandwidths of up to 800 MHz (2x400 MHz channels). It is proposed to align this frequency offset break-point definition with 3GPP. This means the unwanted emission limits will vary depending on transmitter bandwidth which will allow 3GPP compliant equipment wider than 400 MHz to be deployed without modification or additional filtering. This will also provide stricter limits for channel bandwidths less than 400 MHz which would better ensure coexistence with adjacent services.

The proposed unwanted emission limits for registered devices are shown in Tables 6 and 7 (based on out-of-band and spurious emission limits in 3GPP TS 38.104), excluding emissions in the range 23.6-24 GHz.

Note that the limits in Table 6 work well when adjacent band systems are using the same technology and have synchronised operation. As discussed previously, it is assumed that when required to manage interference, licensees will either synchronise their services or negotiate an alternative solution, so it has been deemed that a definition of stricter unwanted emission limits to manage interference or unsynchronised operation will not be necessary.

1. Proposed transmitter unwanted emission limit at offsets less than or equal to 0.1 x BWoccupied[[34]](#footnote-37) from the licence frequency boundary – base stations.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 0 MHz ≤ foffset ≤ 0.1 x BWoccupied | -5 | 1 MHz |

1. Transmitter unwanted emission limits at offsets greater than 0.1 x BWoccupied from the licence frequency boundary (excluding the 23.6-24 GHz band) – base stations.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 30 MHz ≤ f < 1 GHz | -13 | 100 kHz |
| 1 GHz ≤ f ≤ 59 GHz | -13 | 1 MHz |

As discussed in the *Coexistence with other services* chapter, additional unwanted emission limits into the 23.6-24 GHz band are proposed for devices in the 26 GHz band to protect passive EESS. These limits are consistent with the outcomes of WRC-19 and are pending further consideration by the TLG.

The proposed unwanted emission limits in the range 23.6-24 GHz (for base stations) are provided in Table 8 – for consistency with other emission limits the TRP value has been converted from dBW to dBm. The proposed limit into the 23.6-24 GHz band for 28 GHz band transmitters aligns with the spurious limits in relevant 3GPP standards.

1. Proposed transmitter unwanted emission limits within the 23.6-24 GHz frequency band – base stations.

|  |  |  |
| --- | --- | --- |
| **26/28 GHz band area-wide apparatus licensed transmitter operating frequency range** | **Total Radiated Power (dBm) in 23.6-24 GHz** | **Measurement Bandwidth** |
| 24.7-27.5 GHz (note 1) | -3 | 200 MHz |
| 24.7-27.5 GHz (note 2) | -9 | 200 MHz |
| 27.5-29.5 GHz | -13 | 1 MHz |

Note 1: This limit applies to base stations deployed before 1 September 2027

Note 2: This limit applies to base stations deployed on or after September 2027

### User equipment unwanted emission limits

UE unwanted emission limits from 3GPP TS 38.101-2 are shown in Table 9. The unwanted emission limits specified by WP 5D[[35]](#footnote-38) reflect the 3GPP limits for a 200 MHz channel shown in Table 9.

1. NR unwanted emission limits from 3GPP TS 38.101-2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Spectrum emission limit (dBm)/ Channel bandwidth | | | | | |
| foffset  (MHz) | 50  MHz | 100  MHz | 200  MHz | 400  MHz | Measurement bandwidth |
| ± 0-5 | -5 | -5 | -5 | -5 | 1 MHz |
| ± 5-10 | -13 | -5 | -5 | -5 | 1 MHz |
| ± 10-20 | -13 | -13 | -5 | -5 | 1 MHz |
| ± 20-40 | -13 | -13 | -13 | -5 | 1 MHz |
| ± 40-100 | -13 | -13 | -13 | -13 | 1 MHz |
| ± 100-200 |  | -13 | -13 | -13 | 1 MHz |
| ± 200-400 |  |  | -13 | -13 | 1 MHz |
| ± 400-800 |  |  |  | -13 | 1 MHz |

To ensure that all of the available standardised channels sizes can be deployed under the 26/28 GHz band area-wide apparatus licence framework, it is proposed that the unwanted emission limits for user equipment align with the 400 MHz channel emission limits shown in Table 9.

The proposed unwanted emission limits are shown in Tables 10 and 11 (based on out-of-band and spurious limits in 3GPP TS 38.101-2), excluding emissions in the range 23.6-24 GHz.

1. Transmitter unwanted emission limit at offsets less than or equal to 40 MHz from the licence frequency boundary – user equipment.

|  |  |  |
| --- | --- | --- |
| **Frequency Range (foffset)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 0 MHz ≤ foffset ≤ 40 MHz | -5 | 1 MHz |

1. Transmitter unwanted emission limits at frequencies greater than 40 MHz from the licence frequency boundary (excluding 23.6-24 GHz) — user equipment.

|  |  |  |
| --- | --- | --- |
| **Frequency Range**  **(f)** | **Total Radiated Power (dBm)** | **Measurement Bandwidth** |
| 30 MHz ≤ f < 1 GHz | -36 | 100 kHz |
| 1 GHz ≤ f < 12.75 GHz | -30 | 1 MHz |
| 12.75 GHz ≤ f < 23.6 GHz | -13 | 1 MHz |
| 24 GHz ≤ f ≤ 59 GHz | -13 | 1 MHz |

As discussed in the *Coexistence with other services* chapter, additional unwanted emission limits into the 23.6-24 GHz band are proposed for area-wide devices in the 26 GHz band to protect passive EESS. These limits are consistent with the outcomes of WRC-19, and are pending further consideration by the TLG.

The proposed limits for user equipment are provided in Table 12. For consistency with other emission limits the TRP values has been converted from dBW to dBm. The proposed limit into the 23.6-24 GHz band for 28 GHz band transmitters aligns with the spurious limits in relevant 3GPP standards.

1. Proposed transmitter unwanted emission limits into the 23.6-24 GHz frequency band – user equipment.

|  |  |  |
| --- | --- | --- |
| **26/28 GHz band area-wide apparatus licensed transmitter operating frequency range** | **Total Radiated Power (dBm) in 23.6-24 GHz** | **Measurement Bandwidth** |
| 24.7-27.5 GHz (note 1) | 1 | 200 MHz |
| 24.7-27.5 GHz (note 2) | -5 | 200 MHz |
| 27.5-29.5 GHz | -13 | 1 MHz |

Note 1: This limit applies to base stations deployed before 1 September 2027

Note 2: This limit applies to base stations deployed on or after September 2027

1. **Are the unwanted emission limits proposed in this paper appropriate?**
2. **Do TLG members agree that separate unwanted emission limits should be specified depending on device type (base station or UE) instead of whether or not a device is required to be registered?**

## Other conditions

It is proposed that the 26/28 GHz area-wide apparatus licence technical framework include additional conditions to manage coexistence with other services. Noting the intention for the 26/28 GHz band area-wide apparatus licences to operate in a similar manner to a spectrum licence, some of these proposed additional conditions are standard inclusions on spectrum licences. The proposed additional conditions relate to:

* The distance between devices which are considered co-sited (for interference management purposes)
* Responsibility to manage interference between devices operated under licences held by the same licensee
* Management of interference from devices exempt from registration
* Restriction on the operation of mobile transmitters in the range 27.5-29.5 GHz

See the draft updated LCD in Appendix B for further details.

***Co-sited devices***

Interference between devices that are located within a few hundred metres of each other can be difficult to model and can require the implementation of unnecessarily stringent requirements to cover all possible cases. As a result, spectrum licences include additional conditions on the licence so that licensees can work together to resolve any interference caused between radiocommunications devices where the phase centre of each antenna is separated by a specified distance. It is proposed that a similar condition is included on 26/28 GHz band area-wide apparatus licences.

The technical framework for all spectrum licensed bands other than the 3.4 GHz band define co-sited devices as being within 200m. 500m is used in the 3.4 GHz owing to the technical framework being optimised for TDD operation and lower receiver blocking requirement.

Although the 26/28 GHz band area-wide apparatus licence technical framework is proposed to be optimised for TDD, the relatively high propagation attenuation in the band and the use of AAS is expected to present a lower risk of co-sited interference than in the 3.4 GHz band. Therefore, it is proposed to define devices within 200m as being co-sited for interference management purposes.

Some TLG submissions suggested that the proposed co-site distance needs further consideration, noting:

* The possibility of macro-site deployments in the band (suggesting that a larger distance may be needed), and

small-cell base stations which are expected to be located much closer to each other (e.g. 25-50m), suggesting that a smaller distance may be needed.

A distance needs to be determined that is appropriate for the broad range of deployment types expected in the band. However, as this provision is intended to aid the resolution of site based out-of-band interference issues (e.g. cause by blocking, intermods, harmonics etc), it should be more heavily weighted towards base stations that are more likely to cause, or receive, these types of interference.

It is anticipated that macro base stations will have a higher risk for causing/receiving site-base interference due to having higher transmit power and lower sensitivity levels. Therefore, it is the ACMAs view that a co-site distance should be based on macro deployments, which historically have been set in the range 200m-500m. Although these distances are likely to include many small-cell base stations, the impact is expected to be minimal given this provision is only triggered as needed (i.e. when all devices are operating within their licence conditions and site-based interference is still occurring).

Given the proposed maximum in-band TRP in the 26/28 GHz bands is expected to be lower than that of the 3.4 GHz band (max proposed by TLG members is 45 dBm/200 MHz compared to 48 dBm/5 MHz in the 3.4 GHz band), and taking into account the higher propagation loss at 26 GHz, the risk of out-of-band interference caused by a 26/28 GHz band transmitter is likely to be limited to a smaller area than would typically be the case in the 3.4 GHz band. Considering the above, the ACMA is of the view that a co-site distance set at the lower end of the 200m-500m range is appropriate.

Subsequently, it is proposed that the following condition be included in the updated LCD:

|  |
| --- |
| **Co-sited devices**  If:  (a) interference occurs between a radiocommunication device:  (i) operated under this licence; and  (ii) operated under another licence (the ***other licence***);  when the measured separation between the phase centre of the antenna used with each device is less than 200 metres; and  (b) that interference is not the result of operation of a radiocommunications device in a manner that does not comply with the conditions of the relevant licence; and  (c) either the licensee or the holder (or authorised third party) of the other licence wishes to resolve the interference;  the licensee of this licence must manage interference with:  (d) the holder of the other licence; or  (e) if a site manager is responsible for managing interference at that location, that site manager. |

***Responsibility to manage interference***

It is proposed to include the following condition in the updated LCD which will provide certainly for a licensee dealing with interference between devices operated under licences held by the same licensee:

|  |
| --- |
| **Responsibility to manage interference**  The licensee must manage interference between:  (a) radiocommunications devices operated under this licence; and  (b) radiocommunications devices operated under this licence and under another licence held by the licensee. |

***Management of interference from devices exempt from registration***

The risk of interference from devices exempt from registration (see *the Recording device details in the RRL* section) is low because of their low-power and/or nomadic nature, or because of their indoor operation. However, to provide certainty in managing an unlikely case of interference from these devices it is proposed that the following provision be included in the updated LCD:

|  |
| --- |
| The licensee must ensure that the operation of a radiocommunications transmitter that is a kind included in 5(2) does not cause harmful interference to other radiocommunications devices operated under a different spectrum or apparatus licence. |

***Restriction on mobile transmitters in the range 27.5-29.5 GHz***

The 28 GHz band decision paper proposed that wireless broadband services in the range 27.5-29.5 GHz band be restricted to fixed wireless access services (i.e. mobile 5G would not be permitted).

A number of TLG submissions opposed any mobile stations (including indoor-only stations) in the 28 GHz band, Concern was raised that it would be difficult ensure that indoor-only mobile stations remained indoors, therefore there would be an increased interference risk.

Therefore, the proposed condition to be included in the updated LCD is:

|  |
| --- |
| The licensee must not operate a radiocommunications transmitter in the frequency range 27.5-29.5 GHz while it is in motion on land, on water or in the air. |

***Notional receiver and compatibility requirement***

Similar to technical frameworks for spectrum licences, it is proposed to include a notional receiver and compatibility requirement for 26/28 GHz band area-wide apparatus licences.

The aim of the notional receiver is to provide a baseline for operators of transmitters to coordinate their services against. While adherence to the notional receiver is optional, the ACMA will have regard to it when settling interference disputes. For this reason, it is recommended that all base station receivers operating under a 26/28 GHz band area-wide apparatus licences have a performance level equal to – or better than – the defined notional receiver.

Given that the 26/28 GHz band area-wide apparatus licences technical framework is being optimised for 5G NR, it is proposed that the same notional receiver is specified for both 26/28 GHz band area-wide apparatus licences and 26 GHz spectrum licences. See RALI[new] at Appendix A for further details.

1. **Do TLG members have any concerns or alternative proposals for the proposed additional conditions?**
2. **Do TLG members agree that a notional receiver and compatibility requirement should be included in the technical framework for 26/28 GHz band area-wide apparatus licences? Should the notional receiver and compatibility requirement parameters be identical to those set for 26 GHz band spectrum licences?**

# Appendix A – Draft RALI[new]

Refer to attachment on SharePoint

# Appendix B – Draft Licence Conditions Determination (LCD) updates

Refer to attachment on SharePoint

The specific LCD that these proposed conditions would be included into will be determined pending a decision on the apparatus licence type to be used for wireless broadband services in the 26/28 GHz band.

# Appendix C – Areas subject to additional conditions

The proposed areas to be subject to additional constraints for wireless broadband services in the range 27-27.5 GHz are contained in Table 13. These areas are consistent with those proposed in the decision paper and are based on the -3 dB footprint of a 56 dBi antenna on GSO satellites at longitudes of 140°E and 145°E for beams pointed at each of the 10 NBN gateway earth stations.

1. Proposed areas to be subject to additional constraints for wireless broadband services in the range 27–27.5 GHz

| Nbn gateway | HCIS |
| --- | --- |
| Bourke | LU4F, LU4G, LU4H, LU4J, LU4K, LU4L, LU4M, LU4N, LU4O, LU4P, LU5E, LU5F, LU5I, LU5J, LU5K, LU5M, LU5N, LU5O, LU7A, LU7B, LU7C, LU7D, LU7F, LU7G, LU7H, LU7J, LU7K, LU7L, LU7P, LU8A, LU8B, LU8C, LU8E, LU8F, LU8G, LU8I, LU8J, LU8M, LU4B9, LU4C5, LU4C6, LU4C7, LU4C8, LU4C9, LU4D4, LU4D5, LU4D6, LU4D7, LU4D8, LU4D9, LU4E6, LU4E9, LU4I2, LU4I3, LU4I5, LU4I6, LU4I8, LU4I9, LU5A4, LU5A5, LU5A6, LU5A7, LU5A8, LU5A9, LU5B7, LU5B8, LU5G4, LU5G7, LU5G8, LU5L7, LU5P1, LU5P4, LU5P7, LU7E2, LU7E3, LU7E5, LU7E6, LU7E8, LU7E9, LU7I3, LU7N2, LU7N3, LU7O1, LU7O2, LU7O3, LU7O4, LU7O5, LU7O6, LU7O9, LU8D1, LU8D4, LU8D7, LU8H1, LU8H4, LU8H7, LU8K1, LU8K2, LU8K3, LU8K4, LU8K5, LU8K6, LU8K7, LU8K8, LU8N1, LU8N2, LU8N3, LU8N4, LU8N5, LU8N6, LU8O1 |
| Carnarvon | AS8C, AS8D, AS8F, AS8G, AS8H, AS8I, AS8J, AS8K, AS8L, AS8M, AS8N, AS8O, AS8P, AS9A, AS9B, AS9E, AS9F, AS9G, AS9I, AS9J, AS9K, AS9M, AS9N, AS9O, AT1D, AT1H, AT2A, AT2B, AT2C, AT2D, AT2E, AT2F, AT2G, AT2H, AT2I, AT2J, AT2K, AT3A, AT3B, AT3E, AS5P9, AS6M7, AS6M8, AS8A9, AS8B5, AS8B6, AS8B7, AS8B8, AS8B9, AS8E2, AS8E3, AS8E4, AS8E5, AS8E6, AS8E7, AS8E8, AS8E9, AS9C4, AS9C5, AS9C7, AS9C8, AS9H4, AS9H7, AS9L1, AS9L4, AS9L7, AS9P1, AT1C2, AT1C3, AT1C5, AT1C6, AT1C8, AT1C9, AT1G2, AT1G3, AT1G5, AT1G6, AT1G8, AT1G9, AT1K3, AT1L1, AT1L2, AT1L3, AT1L4, AT1L5, AT1L6, AT1L9, AT2L1, AT2L2, AT2L3, AT2L4, AT2L5, AT2L6, AT2L7, AT2L8, AT2M3, AT2N1, AT2N2, AT2N3, AT3C1, AT3C2, AT3C3, AT3C4, AT3C5, AT3C7, AT3F1, AT3F2, AT3F3, AT3F4, AT3F5, AT3F7, AT3I1, AT3I2, AT3I3, AT3I4 |
| Ceduna | HV4, GV6D, GV6H, HV1F, HV1G, HV1H, HV1I, HV1J, HV1K, HV1L, HV1M, HV1N, HV1O, HV1P, HV2E, HV2I, HV2J, HV2M, HV2N, HV5A, HV5B, HV5E, HV5F, HV5I, GV3L3, GV3L6, GV3L8, GV3L9, GV3P2, GV3P3, GV3P4, GV3P5, GV3P6, GV3P7, GV3P8, GV3P9, GV6L1, GV6L2, GV6L3, GV6L4, GV6L5, GV6L6, GV6L8, GV6L9, GV6P2, GV6P3, GV6P6, HV1B8, HV1B9, HV1C7, HV1C8, HV1C9, HV1D7, HV1D8, HV1D9, HV1E5, HV1E6, HV1E7, HV1E8, HV1E9, HV2A7, HV2A8, HV2A9, HV2F1, HV2F4, HV2F5, HV2F7, HV2F8, HV2F9, HV2K1, HV2K4, HV2K7, HV2O1, HV2O2, HV2O4, HV2O5, HV2O7, HV2O8, HV5C1, HV5C2, HV5C4, HV5C5, HV5C7, HV5C8, HV5G1, HV5G4, HV5G7, HV5J1, HV5J2, HV5J3, HV5J4, HV5J5, HV5J6, HV5J7, HV5J8, HV5M1, HV5M2, HV5M3, HV5M4, HV5M5, HV5M6, HV5M7, HV5M8, HV5N1 |
| Geeveston | LY8B, LY8C, LY8D, LY8E, LY8F, LY8G, LY8H, LY8I, LY8J, LY8K, LY8L, LY8M, LY8N, LY8O, LY8P, LY9A, LY9E, LY9F, LY9G, LY9I, LY9J, LY9K, LY9M, LY9N, LY9O, LY9P, LZ2A, LZ2B, LZ2C, LZ2D, LZ2E, LZ2F, LZ2G, LZ2H, LZ2I, LZ2J, LZ2K, LZ2L, LZ2N, LZ2O, LZ2P, LZ3A, LZ3B, LZ3C, LZ3D, LZ3E, LZ3F, LZ3G, LZ3H, LZ3I, LZ3J, LZ3K, LZ3L, LZ3M, LZ3N, LZ3O, LY5N9, LY5O7, LY5O8, LY5O9, LY5P7, LY5P8, LY5P9, LY6M7, LY6M8, LY6M9, LY7H9, LY7L3, LY7L5, LY7L6, LY7L8, LY7L9, LY7P2, LY7P3, LY7P5, LY7P6, LY7P8, LY7P9, LY8A6, LY8A8, LY8A9, LY9B1, LY9B2, LY9B4, LY9B5, LY9B6, LY9B7, LY9B8, LY9B9, LY9C4, LY9C7, LY9C8, LY9H4, LY9H7, LY9L1, LY9L2, LY9L4, LY9L5, LY9L7, LY9L8, LY9L9, LZ1D2, LZ1D3, LZ1D5, LZ1D6, LZ1D8, LZ1D9, LZ1H2, LZ1H3, LZ1H5, LZ1H6, LZ1H9, LZ1L3, LZ1L6, LZ2M1, LZ2M2, LZ2M3, LZ2M5, LZ2M6, LZ2M9, LZ3P1, LZ3P2, LZ3P3, LZ3P4, LZ3P5, LZ3P6, LZ3P7, LZ3P8, MZ1A1, MZ1A4, MZ1A7, MZ1E1, MZ1E4, MZ1E7, MZ1I1, MZ1I4 |
| Kalgoorlie | DU7, CU9H, CU9K, CU9L, CU9O, CU9P, CV3B, CV3C, CV3D, CV3G, CV3H, CV3L, DU8A, DU8E, DU8I, DU8M, DV1A, DV1B, DV1C, DV1D, DV1E, DV1F, DV1G, DV1H, DV1I, DV1J, CU9D3, CU9D5, CU9D6, CU9D7, CU9D8, CU9D9, CU9G3, CU9G5, CU9G6, CU9G7, CU9G8, CU9G9, CU9J3, CU9J6, CU9J8, CU9J9, CU9N2, CU9N3, CU9N5, CU9N6, CU9N7, CU9N8, CU9N9, CV3F1, CV3F2, CV3F3, CV3F5, CV3F6, CV3F8, CV3F9, CV3J3, CV3K1, CV3K2, CV3K3, CV3K4, CV3K5, CV3K6, CV3K8, CV3K9, CV3P2, CV3P3, DU4M8, DU4M9, DU4N4, DU4N5, DU4N6, DU4N7, DU4N8, DU4N9, DU4O4, DU4O5, DU4O6, DU4O7, DU4O8, DU4O9, DU4P4, DU4P5, DU4P6, DU4P7, DU4P8, DU4P9, DU5M7, DU5M8, DU8B4, DU8B7, DU8B8, DU8F1, DU8F2, DU8F4, DU8F5, DU8F7, DU8F8, DU8J1, DU8J2, DU8J4, DU8J5, DU8J7, DU8J8, DU8N1, DU8N2, DU8N4, DU8N5, DU8N7, DV1K1, DV1K2, DV1K3, DV1K4, DV1K5, DV1K6, DV1K7, DV1L1, DV1M1, DV1M2, DV2A1, DV2A2, DV2A3, DV2A4, DV2A5, DV2A6, DV2A7, DV2A8, DV2B1, DV2E1, DV2E2, DV2E4 |
| Moonyoonooka | AU2L, AU2P, AU3C, AU3D, AU3E, AU3F, AU3G, AU3H, AU3I, AU3J, AU3K, AU3L, AU3M, AU3N, AU3O, AU3P, AU6A, AU6B, AU6C, AU6D, AU6E, AU6F, AU6G, AU6H, AU6I, AU6J, AU6K, BU1A, BU1B, BU1C, BU1E, BU1F, BU1G, BU1I, BU1J, BU1K, BU1M, BU1N, BU1O, BU4A, BU4B, BU4E, AT9O6, AT9O7, AT9O8, AT9O9, AT9P4, AT9P5, AT9P6, AT9P7, AT9P8, AT9P9, AU2H6, AU2H8, AU2H9, AU2K6, AU2K9, AU2O2, AU2O3, AU2O5, AU2O6, AU2O8, AU2O9, AU3A6, AU3A8, AU3A9, AU3B2, AU3B3, AU3B4, AU3B5, AU3B6, AU3B7, AU3B8, AU3B9, AU6L1, AU6L2, AU6L3, AU6L4, AU6L5, AU6L6, BT7M4, BT7M5, BT7M6, BT7M7, BT7M8, BT7M9, BT7N4, BT7N5, BT7N6, BT7N7, BT7N8, BT7N9, BT7O7, BT7O8, BU1D4, BU1D7, BU1H1, BU1H2, BU1H4, BU1H5, BU1H7, BU1H8, BU1L1, BU1L2, BU1L4, BU1L5, BU1L7, BU1L8, BU1P1, BU1P4, BU4C1, BU4C2, BU4C3, BU4C4, BU4C5, BU4C7, BU4F1, BU4F2, BU4F3, BU4F4, BU4F5, BU4I1, BU4I2 |
| Nugee | JV2L, JV2P, JV3B, JV3C, JV3D, JV3E, JV3F, JV3G, JV3H, JV3I, JV3J, JV3K, JV3L, JV3M, JV3N, JV3O, JV3P, JV5D, JV5H, JV6A, JV6B, JV6C, JV6D, JV6E, JV6F, JV6G, JV6H, JV6I, JV6J, JV6K, JV6L, KV1E, KV1I, KV1M, KV1N, KV4A, KV4E, JU9N8, JU9N9, JU9O7, JU9O8, JU9O9, JU9P7, JV2D6, JV2D8, JV2D9, JV2G9, JV2H2, JV2H3, JV2H4, JV2H5, JV2H6, JV2H7, JV2H8, JV2H9, JV2K3, JV2K6, JV2K8, JV2K9, JV2O2, JV2O3, JV2O5, JV2O6, JV2O8, JV2O9, JV3A2, JV3A3, JV3A4, JV3A5, JV3A6, JV3A7, JV3A8, JV3A9, JV5C2, JV5C3, JV5C5, JV5C6, JV5C9, JV5G3, JV5G6, JV5L1, JV5L2, JV5L3, JV5L5, JV5L6, JV5L9, JV6M1, JV6M2, JV6M3, JV6N1, JV6N2, JV6N3, JV6N4, JV6N5, JV6N6, JV6O1, JV6O2, JV6O3, JV6O4, JV6O5, JV6O6, JV6P1, JV6P2, JV6P3, JV6P4, KV1A4, KV1A5, KV1A7, KV1A8, KV1A9, KV1F1, KV1F4, KV1F7, KV1F8, KV1J1, KV1J2, KV1J4, KV1J5, KV1J7, KV1J8, KV1J9, KV4B1, KV4B2, KV4B3, KV4B4, KV4B5, KV4B6, KV4B7, KV4B8, KV4F1, KV4F2, KV4F4, KV4F5, KV4F7, KV4I1, KV4I2, KV4I3, KV4I4, KV4I5, KV4I6, KV4I7, KV4I8, KV4J1 |
| Roma | MT1O, MT1P, MT2M, MT4B, MT4C, MT4D, MT4E, MT4F, MT4G, MT4H, MT4I, MT4J, MT4K, MT4L, MT4N, MT4O, MT4P, MT5A, MT5B, MT5E, MT5F, MT5I, MT5J, MT5K, MT5M, MT5N, MT5O, MT7B, MT7C, MT7D, MT7H, MT8A, MT8B, MT8E, MT1K7, MT1K8, MT1K9, MT1L7, MT1L8, MT1L9, MT1M9, MT1N2, MT1N3, MT1N4, MT1N5, MT1N6, MT1N7, MT1N8, MT1N9, MT2I7, MT2N4, MT2N5, MT2N7, MT2N8, MT2N9, MT4A2, MT4A3, MT4A4, MT4A5, MT4A6, MT4A7, MT4A8, MT4A9, MT4M1, MT4M2, MT4M3, MT4M4, MT4M5, MT4M6, MT4M8, MT4M9, MT5C1, MT5C4, MT5C7, MT5C8, MT5G1, MT5G2, MT5G4, MT5G5, MT5G6, MT5G7, MT5G8, MT5G9, MT7A2, MT7A3, MT7A6, MT7A9, MT7F1, MT7F2, MT7F3, MT7F6, MT7G1, MT7G2, MT7G3, MT7G4, MT7G5, MT7G6, MT7G8, MT7G9, MT8C1, MT8C2, MT8C4, MT8C5, MT8C7, MT8F1, MT8F2, MT8F3, MT8F4, MT8F5 |
| Waroona | AV9D, AV9H, AV9L, BV4D, BV4F, BV4G, BV4H, BV4I, BV4J, BV4K, BV4L, BV4M, BV4N, BV4O, BV4P, BV5A, BV5B, BV5C, BV5E, BV5F, BV5G, BV5H, BV5I, BV5J, BV5K, BV5L, BV5M, BV5N, BV5O, BV5P, BV7A, BV7B, BV7C, BV7D, BV7E, BV7F, BV7G, BV7H, BV7I, BV7J, BV7K, BV7L, BV8A, BV8B, BV8C, BV8E, BV8F, BV8I, AV9C3, AV9C6, AV9C9, AV9G3, AV9G6, AV9G9, AV9K3, AV9P2, AV9P3, BV1P8, BV1P9, BV2M7, BV2M8, BV2M9, BV2N4, BV2N5, BV2N6, BV2N7, BV2N8, BV2N9, BV2O7, BV2O8, BV2O9, BV2P7, BV4B8, BV4B9, BV4C2, BV4C3, BV4C4, BV4C5, BV4C6, BV4C7, BV4C8, BV4C9, BV4E6, BV4E8, BV4E9, BV5D1, BV5D2, BV5D4, BV5D5, BV5D6, BV5D7, BV5D8, BV5D9, BV6A7, BV6E1, BV6E4, BV6E7, BV6E8, BV6I1, BV6I2, BV6I4, BV6I5, BV6I7, BV6M1, BV6M4, BV7M1, BV7M2, BV7M3, BV7M4, BV7M5, BV7M6, BV7N1, BV7N2, BV7N3, BV7N4, BV7N5, BV7N6, BV7O1, BV7O2, BV7O3, BV7O4, BV7O5, BV7O6, BV7P1, BV7P2, BV7P3, BV7P4, BV7P5, BV8D1, BV8D2, BV8D3, BV8D4, BV8D5, BV8D7, BV8G1, BV8G2, BV8G3, BV8G4, BV8G5, BV8G6, BV8G7, BV8G8, BV8H1, BV8J1, BV8J2, BV8J3, BV8J4, BV8J5, BV8J7, BV8M1, BV8M2 |
| Wolumla | MW8, MW5N, MW5O, MW5P, MW7L, MW9A, MW9B, MW9E, MW9F, MW9I, MW9J, MW9K, MW9M, MW9N, MW9O, MX2A, MX2B, MX2C, MX2D, MX2E, MX2F, MX2G, MX2H, MX2K, MX2L, MX3A, MX3B, MX3C, MX3E, MX3F, MX3G, MX3I, MX3J, MW5M5, MW5M6, MW5M7, MW5M8, MW5M9, MW6M1, MW6M4, MW6M5, MW6M6, MW6M7, MW6M8, MW6M9, MW6N7, MW7D3, MW7D6, MW7D8, MW7D9, MW7H2, MW7H3, MW7H5, MW7H6, MW7H7, MW7H8, MW7H9, MW7P1, MW7P2, MW7P3, MW7P5, MW7P6, MW7P8, MW7P9, MW9C7, MW9G1, MW9G2, MW9G4, MW9G5, MW9G7, MW9G8, MW9G9, MW9L7, MW9P1, MW9P4, MW9P7, MX1D2, MX1D3, MX1D5, MX1D6, MX1D9, MX1H3, MX2I2, MX2I3, MX2I6, MX2J1, MX2J2, MX2J3, MX2J4, MX2J5, MX2J6, MX2J8, MX2J9, MX2N3, MX2O1, MX2O2, MX2O3, MX2P1, MX2P2, MX2P3, MX2P5, MX2P6, MX3D1, MX3D4, MX3D7, MX3K1, MX3K2, MX3K4, MX3M1, MX3M2, MX3M3, MX3M4, MX3N1, MX3N2 |

# Appendix D – Coexistence with FSS uplinks

This appendix outlines the rationale for the inclusion of additional licence conditions on wireless broadband services to safeguard coexistence with FSS gateway uplinks. These conditions relate to limitations on base station TRP and antenna beams above the horizon and restrictions on fixed outdoor UEs pointing antenna beams at the GSO arc.

**Limitation on base station TRP**

It is proposed to place a TRP limit of 25 dBm/200 MHz on area-wide apparatus licensed devices operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5 GHz. This TRP level is consistent with the base value used in international and domestic studies which considered coexistence with FSS uplinks.

**Limitation on base station emissions above the horizon**

To date, domestic and international sharing studies have assumed that user devices will always be below the base station – this means that base stations will always be directing their antenna beams below the horizon. While it is expected that base station antennas will predominantly be higher the UEs, the ACMA acknowledges that there may be a limited number of instances when UEs will be higher, for example when a UE in a building is connected to a street level base station (e.g. mounted on a light pole).

Placing a limit on the percentage of time base stations can direct their main antenna beams above the horizon will provide additional certainty that the aggregate interference limit into FSS satellite receivers will not be exceeded.

Table 14 provides the results of a study considering a satellite located at 145°E pointing at the NBN’s Waroona (WA) earth station.[[36]](#footnote-39) This study used methodology consistent with Australian contributions to ITU-R studies where the aggregate interference from all wireless broadband stations ‘visible’ to the satellite is summed with the aggregate interference from wireless broadband stations within the nbn’s -3 dB gateway footprint. This is to ensure that the interference from wireless broadband stations in the satellite main beam is not diluted in the averaging process.[[37]](#footnote-40) The wireless broadband station numbers in the -3 dB gateway footprint were calculated using the geographic areas of cities within the gateway footprint and using the equations and assumed deployment density figures in relevant ITU-R studies.

Table 14 also provides results of a sensitivity analysis which assumed that some UEs are located above the base station height – meaning that for 5 per cent of the time a base station would be directing its antenna beam greater the 5° above the horizon. As shown in Table 14, this would result in a 3.4 dB erosion in aggregate interference margin.

1. Impact of base station beams steered above the horizon

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **100% of base station antenna beams below horizon** | | **Base station antenna beams greater than 5° above the horizon of 5% of time** | |
| Satellite G/T | 30 dB/K | 25.2 dB/K | 30 dB/K | 25.2 dB/K |
| Satellite antenna gain | 56 dBi | | 56 dBi | |
| Interferer locations | Visible earth plus cities within 3 dB beamwidth (total city area = 1682 km²)[[38]](#footnote-41) | | | |
| I/N | -10.5 dB | | -10.5 dB | |
| Noise temp | 400 K | 1200 K | 400 K | 1200 K |
| Body Loss | 4 dB | | 4 dB | |
| Polarisation isolation | 3 dB | | 3 dB | |
| Calculated I/N | -31.9 dB | -36.7 dB | -28.5 dB | -33.3 dB |
| FSS interference margin (interference level below I/N criteria) | 21.4 dB | 26.2 dB | 18 dB | 22.8 dB |

The ACMA is of the view that a potential 3.4 dB erosion into the large interference margin is acceptable. Providing provisions which allows base stations to occasionally direct their beams above the horizon will provide flexibility in how wireless broadband networks can be deployed and operated. Therefore, to provide a balance between safeguarding coexistence with FSS gateway uplinks and not being overly restrictive on wireless broadband deployments, it is proposed to include the following licence conditions on wireless broadband stations operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5:

* Outdoor base stations:
* must not direct antenna beams (via electrical steering) to elevation angles greater than 5° above the horizon for more than 5% of time, and
* must have an antenna mechanical down tilt equal to or greater than 0°,

**Limitation of UE emissions above the horizon**

NBN has previously raised concerns about the risk of interference from UE emissions above the horizon.[[39]](#footnote-42) In particular, NBN was of the view that only a small number of UEs, with their maximum EIRP directed simultaneously towards a satellite, could cause unacceptable interference.

The following considerations were made in assessing the risk of interference from UE emissions above the horizon:

* adaptive power control will mean that UEs will predominately be operating at transmit levels below the maximum.
* Elevation angles to NBN satellite will be within the range 40°-50° above the horizon for the majority of gateway footprint areas.[[40]](#footnote-43) For a base station to be directly between the satellite and UE (so that the UE would be directing its beam directly towards both the base station and satellite) the UE would need to be located close to the base station (e.g. 4-5m from a 6m base station, or 24-34m from a 30m base station) – see Figure 4. At these distances the UE transmit power would likely be well below maximum. Simulations conducted by the ACMA (results contained in Attachment A of this appendix) indicate that:[[41]](#footnote-44)
* UEs located 4 to 5 metres from the base station would always be at least 29.5 dB below maximum transmit power.
* For UEs located 24 to 34 metres from the base station, 95% would be operating below maximum transmit power. The UEs at these distances from their base station and operating at (or close to) maximum power would be doing so to overcome clutter losses on the path to the base station (the only UEs operating at maximum power where those located indoors which also needed to overcome building entry loss) – this same clutter (and building entry loss) would also apply to the interference path, resulting in lower interference to the satellite. Based on these simulations, the average clutter and building entry losses at these distances was found to be 28 dB.
* The only instance when a UE might be operating close to maximum power would be when there was clutter in the path to the base station. This clutter would also proportionally reduce the level of interference to the satellite. In situations where there is no clutter loss, UEs would always be at least 20 dB below the maximum transmit power.
* The main beam of the UE would not only have to have the correct elevation angle, but also be oriented azimuthally towards the satellite’s equatorial longitude for the maximum EIRP to be directed towards it. The probability of this occurring is very low.

1. Geometry of direct alignment between a UE and a satellite, for a 6m base station (top) and a 30m base station (bottom) – diagrams not to scale



40°

1.5m

50°

4m

6m

5m



1.5m

30m

34m

24m

50°

40°

Table 15 shows that the number of UEs which all need to be operating in a worst-case (and unlikely) configuration at the same time to cause interference to the satellite using the UE power level discussed above. The results in Table 15 are based on UEs all operating in a worst-case (and unlikely) configuration (pointing at the satellite with no clutter or body loss) at the same time.

1. Deterministic study on number of UE needed to exceed interference threshold

|  |  |  |
| --- | --- | --- |
| Satellite G/T | - | |
| Satellite antenna gain | 56 dBi | |
| Path loss | 212.8 dB (FSL + P.676) | |
| Clutter loss | 0 dB (worst-case) | |
| Polarisation loss | 0 dB (worst-case) | |
| Body Loss | 0 dB (worst-case) | |
| I/N[[42]](#footnote-45) | -6 dB (for 0.6% of the time) | |
| Noise temp[[43]](#footnote-46) | 400 K | 1200 K |
| Aggregate interference threshold | -38.2 dBm/MHz | -43 dBm/MHz |
| Max IMT EIRP density | UE: 1 dBm/MHz (20 dB below maximum power of 22 dBm – from Attachment A (Figure 6), on paths with no clutter UE power will be at least 20 dB below maximum) | |
| Number of UE required to exceed interference threshold | 5271 | 15,814 |

Based on the above simulation, it is shown that it would take in excess of 5000 UEs, all within the same -3 dB footprint and simultaneously directing their beam towards the satellite, without any clutter losses for the interference threshold to be exceeded. It can then be concluded that the risk of interference due to emissions above the horizon from mobile UEs is very low given their transient nature.

It is acknowledged that the interference potential from fixed UE is likely to be higher than mobile UE owing to the static nature of fixed UE stations (i.e. interference will be long-term). To further mitigate the risk posed by fixed UEs it is proposed that the following condition be placed on wireless broadband devices operating in the range 27-29.5 GHz, limited to HCIS areas listed in Appendix C for the frequency range 27-27.5 GHz:

Outdoor fixed UEs must not direct their main antenna beam within 1.5° of the GSO arc when the antenna beam is pointed at elevation angles of greater than or equal to 3° above the horizon.

The above pointing restriction is only proposed to apply for UE antenna pointing elevation angles of 3° and greater above the horizon to account for the location of current and future FSS satellite. The 3° elevation angle is based on Article 21.14 of the ITU Radio Regulations.

### Attachment A to Appendix D – UE transmit power statistics

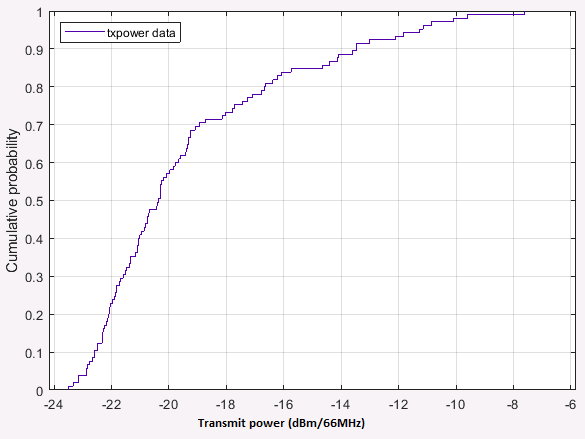
This attachment to Appendix D contains the statistical results of simulations for UE transmit powers at set distances from the base station.

For the majority of NBN gateway footprints the elevation angle to a satellite a 145°E will be between 40° and 50°. For a UE to be pointing at this elevation angle it would need to be situated at the following distances from its base station:

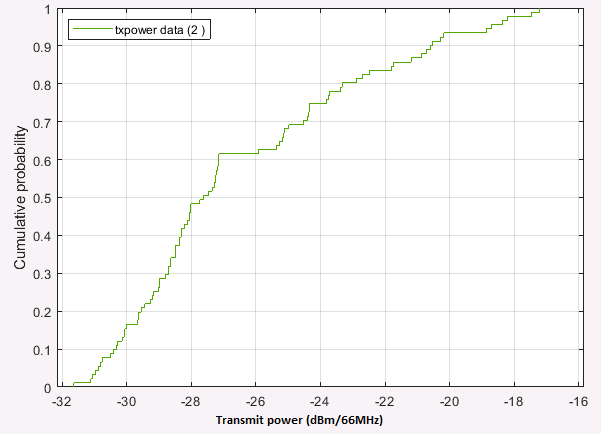
* For a 6m high base station:
* 4m for an elevation angle of 50°
* 5m for an elevation angle of 40°
* For a 30m high base station:
* 24m for an elevation angle of 50°
* 34m for an elevation angel of 40°

The following figures provide cumulative distribution function curves for UE transit powers for the above cases. Figures 5 and 7 include clutter in the signal path between UE and BS, while Figures 6 and 8 assume no clutter. The only scenario when a UE would reach maximum power would be when connected to a 30m high base station when there is clutter in the signal path. However, in this scenario, only 5% of UEs would be at the maximum power of 22 dBm/66MHz and these would be located indoors.[[44]](#footnote-47)

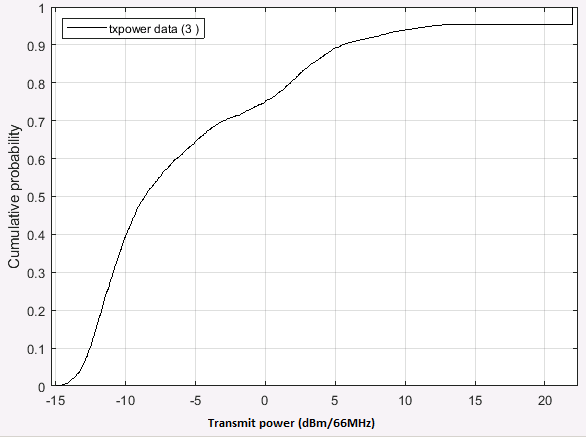
1. Transmit power for BS height = 6m, UE distance from BS = 4 to 5m, with clutter (assuming urban/suburban UE distribution model)



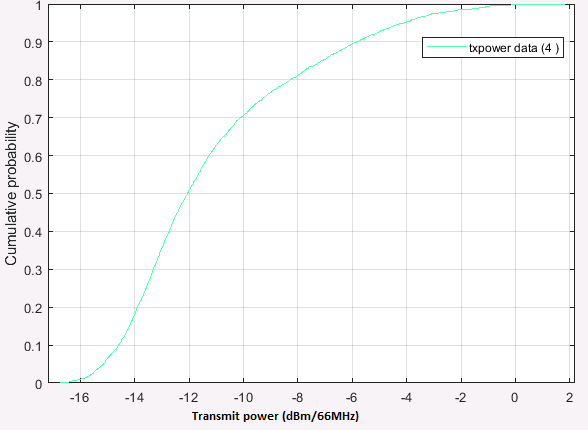
1. Transmit power for BS height = 6m, UE distance from BS = 4 to 5m, without clutter (assuming urban/suburban UE distribution model)



1. Transmit power for BS height = 30m, UE distance from BS = 24 to 34m, with clutter (assuming suburban – open space UE distribution model)



1. Transmit power for BS height = 30m, UE distance from BS = 24 to 34m, without clutter (assuming suburban – open space UE distribution model)



1. Class licensed services are also authorised to operate across the 26/28 GHz bands under the [Radiocommunications (Body Scanning – Aviation Security) Class Licence 2018](https://www.legislation.gov.au/Details/F2018L01583) and the [Radiocommunications (Low Interference Potential Devices) Class Licence 2015](https://www.legislation.gov.au/Details/F2018C00500). [↑](#footnote-ref-2)
2. This is indicated in both the 26 GHz band and 28 GHz band decision papers. [↑](#footnote-ref-3)
3. In June 2019, the ACMA released a [consultation paper](https://www.acma.gov.au/consultations/2019-08/proposed-area-wide-apparatus-licence-consultation-192019) which proposed the introduction of a new area-wide transmitter and receiver licence type. The ACMA is currently considering submissions to this process and is expected to make an announcement in the short term. [↑](#footnote-ref-4)
4. Which LCD will ultimately be updated to include the proposed technical conditions will depend on the which type of apparatus licence is used. [↑](#footnote-ref-5)
5. In this paper, area-wide apparatus licence is the generic term used for the proposed technical framework which could apply to either a point-to-multipoint licence type or a potential new area-wide licence (AWL) pending an ACMA decision on whether or not to make this new licence type. [↑](#footnote-ref-6)
6. Geographical areas are contained in 26 GHz band reallocation declaration [↑](#footnote-ref-7)
7. This frequency range assumes ubiquitous FSS arrangements have been expanded as detailed in the 28 GHz decision paper. [↑](#footnote-ref-8)
8. See the *Development of the 26 GHz spectrum licence technical framework* TLG paper on the SharePoint site. [↑](#footnote-ref-9)
9. The details of the proposed 26 GHz band DBC are contained in *Development of the 26 GHz spectrum licence technical framework* TLG paper, available on the TLG SharePoint website. [↑](#footnote-ref-10)
10. The HCIS in Table 1 are the exclusion areas proposed in the decision paper which are not subject to spectrum licensing. [↑](#footnote-ref-11)
11. The PFD boundary condition is a proposed provision used to manage interference at the geographic boundary of area-wide apparatus licences (i.e. an area-wide apparatus licensed transmitter cannot be operated if the calculated PFD at the geographic area boundary of the licence exceeds the specified limit. See the *Geographic boundary conditions* section for more details. [↑](#footnote-ref-12)
12. The fixed outdoor UE pointing restriction is only proposed to apply for UE antenna pointing elevation angles of 3° and greater above the horizon to account for the location of current and future FSS satellites. The 3° elevation angle is based on Article 21.14 of the ITU Radio Regulations. [↑](#footnote-ref-13)
13. See the [Provisional Final Acts](https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf) are available on the ITU-R website [↑](#footnote-ref-14)
14. See studies B and O in Attachment 3 to Annex 3 of Document [5-1/478](https://www.itu.int/md/R15-TG5.1-C-0478/en). [↑](#footnote-ref-15)
15. From the 28 GHz band decision paper, wireless broadband services will be secondary (with regards to FSS) in 27.5-28.1 GHz outside of areas subject to the 26 GHz reallocation declaration and in 28.1-29.5 GHz Australia wide. [↑](#footnote-ref-16)
16. See ECC Decision (18)06 [↑](#footnote-ref-17)
17. See the [Provisional Final Acts](https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf) are available on the ITU-R website [↑](#footnote-ref-18)
18. Existing LCDs are available on the Federal Register of Legislation [website](https://www.legislation.gov.au/Browse/Results/ByTitle/LegislativeInstruments/InForce/Ra/0/0/Principal). [↑](#footnote-ref-19)
19. See Attachment 2 to Document 5-1/36 [↑](#footnote-ref-20)
20. For licences which have been aggregated over time (i.e. the frequency bandwidth and/or area authorised by the licence has changed), frequency and area boundary conditions will apply at the ‘outer’ boundary of the licence. [↑](#footnote-ref-21)
21. Available on the [ACMA website](https://www.acma.gov.au/sites/default/files/2019-10/The%20Australian%20spectrum%20map%20grid%202012.PDF). [↑](#footnote-ref-22)
22. These rules are contained in the [*Radiocommunications (Trading Rules for Spectrum Licences) Determination 2012*](https://www.legislation.gov.au/Details/F2018C00564)(trading determination). [↑](#footnote-ref-23)
23. Assuming a 4x4 antenna array with an element gain of 5 dBi. [↑](#footnote-ref-24)
24. Equation adapted from Recommendation ITU-R P.525 [↑](#footnote-ref-25)
25. Using the spectrum licence DBC at these boundaries will make interference management across this boundary identical in both directions. [↑](#footnote-ref-26)
26. See [*Radiocommunications (Unacceptable Levels of Interference — 3.4 GHz Band) Determination 2015*](https://www.legislation.gov.au/Details/F2018C00557)*.* [↑](#footnote-ref-27)
27. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-29)
28. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-30)
29. Equation adapted from Recommendation ITU-R P.525, results are rounded to nearest integer [↑](#footnote-ref-31)
30. See Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-33)
31. See [Commission Implementing Decision 2019/784](https://eur-lex.europa.eu/eli/dec_impl/2019/784/oj) [↑](#footnote-ref-34)
32. Article 21.5 provides a transmitter power limit of +10 dBW. [↑](#footnote-ref-35)
33. See Attachment 2 to Document 5-1/36 [↑](#footnote-ref-36)
34. BWoccupied is the occupied bandwidth of the radiocommunications transmitter operated under the licence. [↑](#footnote-ref-37)
35. In Attachment 2 to Document [5-1/36](https://www.itu.int/md/R15-TG5.1-C-0036/en). [↑](#footnote-ref-38)
36. The Waroona earth station was used in this analysis as, being the closest NBN earth station to a major capital city, it will be the footprint most susceptible to interference from metro wireless broadband deployments. [↑](#footnote-ref-39)
37. Whilst this could be considered as ‘double dipping’ on interference sources where the 3dB footprint overlaps the visible earth case, the ‘averaged’ interference from that overlap area in the visible earth case is not significant and doesn’t appreciably add to the aggregate (i.e. the assessed aggregate interference could be considered an over-estimate, but only very slightly). [↑](#footnote-ref-40)
38. Cities considered are Perth and Bunbury – areas obtained from Demographia World Urban Areas. This assumes that the nbn beam is directed slightly north of the Waroona (WA) earth station. It is noted that if the beam centred on the earth station then only approximately half of the Perth metropolitan area would be in the 3 dB footprint. [↑](#footnote-ref-41)
39. See NBN’s submission to the ACMA options paper ‘*Wireless broadband in the 26 GHz band ‘* available on the ACMA [website](https://www.acma.gov.au/theACMA/options-for-wireless-broadband-in-the-26-ghz-band). [↑](#footnote-ref-42)
40. Elevation angles will be higher than 50° in the remainder of nbn gateway footprint areas. [↑](#footnote-ref-43)
41. Simulated deployment characteristics and propagation modules used were consistent with those agreed by ITU-R Task Group 5/1. [↑](#footnote-ref-44)
42. Given the low probability that this scenario will occur, it is considered that the shore-term protection criteria from ITU-R Document [5-1/411](https://www.itu.int/md/R15-TG5.1-C-0411/en) is appropriate. The more conservative shore-term limit (for 0.6% of the time) is used. [↑](#footnote-ref-45)
43. NBN indicated that their satellite network operates with a G/T value of 30 dB/K, which equates to a noise temperature of 400 K for a 56 dBi antenna. NBN’s quoted noise temperature value is at odds with the noise temperatures of 800 K and 1200 K listed on their 26 GHz band satellite network filings – For example, nbn filings CR/C 4574 (published 19 March 2018) and CR/C 2926 (published 22 August 2011) have noise temperatures of 800 K and 1200 K respectively. Noting this ambiguity, this analysis uses both noise temperature values of 400 K and 1200 K to provide the upper and lower limits. [↑](#footnote-ref-46)
44. The UE emission bandwidth in this annex is 66 MHz based on the Task Group 5/1 assumption that 3 UE’s will be simulations operating in a 200 MHz channel with an equal spectral allocation (ie. 66 MHz each). [↑](#footnote-ref-47)