Review of 3.4 GHz spectrum licence technical framework

Technical liaison group paper

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# Version control

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| **Version** | **Comments** |
| Version 1.0 | Initial release to TLG |
| Version 2.0 | Final version after review by TLG |

# Introduction

In November 2019, the Australian Communications and Media Authority (ACMA) released the [*Optimising arrangements for the 3400-3575 MHz band – Planning decisions and preliminary views*](https://www.acma.gov.au/consultations/2019-08/optimising-3400-3575-mhz-band-consultation-122019) outcomes paper.Key outcomes included:

Retuning devices in regional areas operating under apparatus and spectrum licences into new unfragmented arrangements. To ensure a timely retune, we adopted a policy of only re-issuing affected apparatus licences so they expire by 30 November 2020. During this time, other spectrum in the band will be made available for affected apparatus licensees to move into.

Once retuning is complete, and subject to a decision from the Minister for Communications, Cyber Safety and the Arts, offer NBN Co spectrum licences for areas and frequency ranges where they hold apparatus licences (‘conversion’). This will allow spectrum licensees in the 3400–3575 MHz band to defragment their spectrum holdings in most areas.

Resume 75 MHz of spectrum in urban areas from NBN Co’s licences (referred to as urban excise) and make them available for use by other wireless broadband operators. This will happen after conversion and the defragmentation of spectrum holdings.

Make available:

25 MHz in major regional centres and 42.5 MHz in regional areas for spectrum licensing

35–65 MHz in regional areas and 175 MHz in remote areas for point-to-multipoint apparatus licensing.

To facilitate the conversion process and making urban excise areas available for use, the ACMA formed a [technical liaison group](https://www.acma.gov.au/spectrum-licence-technical-liaison-groups) (TLG) to review the 3.4 GHz spectrum licence technical framework. A TLG is a short-term advisory body convened by the ACMA. Its purpose is to provide advice on the development of, or possible changes to, a spectrum or apparatus licence technical framework. The TLG was formed in October 2020 and finalised its work in June 2021. Membership included 3.4 GHz spectrum licensees, the Department of Defence, equipment manufacturers, the Australian Mobile Telecommunications Association (AMTA), the Global Systems Mobile Association (GSMA), amateurs, Boeing, the Department of Infrastructure, Transport, Regional Development and Communications (DITRDC) and Inmarsat.

The purpose of this paper is to summarise the outcomes of discussions on possible changes to the 3.4 GHz technical within the TLG.

It is noted that:

The TLG is just the first step in the process of reviewing a technical framework. The ACMA will use the outcomes of the TLG to publicly consult on changes to the relevant instruments that form the 3.4 GHz band technical framework. This means TLG members are able to provide comments on the technical framework both as part of the informal TLG and subsequent formal public consultation processes.

While we strive to achieve consensus with members, the final decision on the content of, or changes to, a spectrum or apparatus licensing technical framework rests with the ACMA. This is particularly relevant in cases where consensus cannot be achieved on an issue or advice from the TLG is not provided within a reasonable time frame.

## Scope of the TLG

The scope of the TLG was to provide advice on the following issues:

Consequential changes to the [3.4 GHz band technical framework](https://www.acma.gov.au/34-ghz-technical-framework) required to support the conversion of NBN Co’s existing apparatus licences to spectrum licences (referred to as consequential changes).

Development of interference management criteria to and from urban excise areas.

Review of the [Radiocommunications (Unacceptable Levels of Interference —   
3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Details/F2018C00557) (the s.145(4) Determination).

Review the receiver spurious emission limits for Active Antenna Systems (AAS).

Review text in the [Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers — 3.4 GHz Band) 2015](https://www.legislation.gov.au/Details/F2018C00568) (the RAG Rx) relating to interference management with defence radar systems. The aim being to provide greater guidance on the issue.

# 3.4 GHz technical framework

The ACMA develops a technical framework for every band subject to spectrum licensing. Each framework is a collection of technical and regulatory conditions applicable to the use of radiocommunications devices in the spectrum-licensed band. The purpose of the technical framework is to define the technical conditions and constraints under which a device may be deployed and operated within the specified geographic area and frequency band of the licence.

Although the technical framework is optimised for technologies, or services most likely to be deployed in the band, it is intended to be technology-flexible. This means licensees can operate any type of radiocommunications device for any purpose, provided they comply with the technical framework relevant to the licence.

A technical framework consists of 3 interlocking regulatory elements provided for under the *Radiocommunications Act 1992* (the Act):

The conditions specified on the spectrum licence – in particular, the core conditions that define the spectrum space (both frequency and geographical area) and the level of emissions permitted inside and across the frequency boundaries of the licence (section 66 of the Act).

A determination of unacceptable interference for the purpose of device registration in each band (section 145 of the Act). This defines permissible levels of emissions across geographical licence boundaries and can also define various deployment constraints.

Radiocommunications advisory guidelines (RAG) that provide assistance and advice for coordination with stations in other services when and where required (section 262 of the Act). This includes detailing interference management criteria with incumbent apparatus and other spectrum licences.

A more comprehensive explanation of spectrum licence technical frameworks is provided in the document [*Spectrum licensees – know your obligations*.](https://www.acma.gov.au/publications/2012-12/guide/spectrum-licencees-know-your-obligations)

## 3.4 GHz band spectrum licence technical framework

The 3.4 GHz spectrum licence technical framework is optimised for Time Division Duplex (TDD) technologies. The relevant 3.4 GHz band technical framework instruments are:

* Spectrum licence ([current licence holders and copies of licences](https://web.acma.gov.au/rrl/browse_licences.licence_list?pSV_ID=85&pSS_ID=861))
* [Radiocommunications (Unacceptable Levels of Interference – 3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Series/F2015L00727) (the s.145(4) Determination)
* [Radiocommunications Advisory Guidelines (Managing Interference from Spectrum Licensed Transmitters — 3.4 GHz Band) 2015](https://www.legislation.gov.au/Series/F2015L00728) (the RAG Tx)

[Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 3.4 GHz Band) 2015](https://www.legislation.gov.au/Series/F2015L00729) (the RAG Rx)

Details of the TLG process (including relevant papers) that developed the current 3.4 GHz band technical framework are available on [the ACMA website](https://www.acma.gov.au/spectrum-licence-technical-liaison-groups).

## Conditions on the spectrum licence

Each spectrum licence includes both core conditions and statutory conditions specified under relevant sections of the Act. The Act also provides that other specific conditions may be included by the ACMA.

* **Core conditions –** required under section 66, these conditions define the spectrum space within which the licensee is authorised to operate radiocommunications devices under the licence, and the maximum permitted level of radio emissions inside and outside the band. These conditions are included in all spectrum licences.
* **Statutory conditions –** required under sections 67 to 69A, these conditions include information about payment of charges, use by third parties, residency, registration of transmitters and devices exempt from registration. These conditions are included in all spectrum licences.
* **Other conditions –** conditions placed on licences under section 71 generally provide for the efficient management of the spectrum and administration of the Act. These conditions may vary from one band or licence to another.

The core conditions of a spectrum licence form the fundamental building blocks for operation of a spectrum-licensed device, and for managing interference with adjacent frequency bands and geographic areas. Section 66 of the Act states spectrum licences must specify the following core conditions:

The part or parts of the spectrum in which operation of radiocommunications devices is authorised under the licence (frequency range of operation).

The maximum permitted level of radio emission, in parts of the spectrum outside the frequency range specified on the licence, that may be caused by operation of radiocommunications devices under the licence (outside-the-band emission).

The area within which operation of radiocommunications devices is authorised under the licence (geographic area of operation).

The maximum permitted level of radio emission that may be caused by the operation of radiocommunications devices under the licence (outside-the-area emission).

## Unacceptable levels of interference

Spectrum licensees are required to register a radiocommunications transmitter in the Register of Radiocommunications Licences before they may be operated under the licence. The only exception to this is if there is a condition on licences that exempts certain types of transmitters.

Subsection 145(1) of the Act gives us the power to refuse to register a radiocommunications transmitter if we are satisfied that the operation of the transmitter could cause an unacceptable level of interference to the operation of other radiocommunications devices. Under subsection 145(4) of the Act, the ACMA can make a determination (referred to as a section 145 determination) that sets out what is considered unacceptable levels of interference for each spectrum-licensed band.

A section 145 determination sets out the circumstances in which devices are deemed to cause unacceptable levels of interference. These circumstances typically include:

* If the levels of emissions from a device at the geographical boundary of a licence exceed a defined level.
* If the operation of the transmitter will cause a breach of a core condition of the licence.
* If the deployment of the device is outside any deployment constraints defined for the band.

## Radiocommunications advisory guidelines

Further guidance on interference management with other licensed services is provided in Radiocommunications Advisory Guidelines (RAGs) made under section 262 of the Act. RAGs can refer to any aspect of radiocommunications or radio emissions.

Generally, RAGs include provisions to help assess the possible interference between spectrum-licensed devices and services operating under spectrum, apparatus or class licences. Potentially affected services are identified in the RAGs to enable licensees to assess and mitigate the risk of interference between these services.

It is important to note that where a case of interference arises between a spectrum-licensed device and another licensed device, the ACMA will refer to the provisions of the RAGs in resolving the matter. In general, affected licensees also have the ability to negotiate their own arrangements in order to manage interference. Such arrangements will also be taken into account when resolving any interference disputes.

# Changes to the 3.4 GHz technical framework

This section provides details on the outcomes of discussion with the TLG regarding the items for review in the 3.4 GHz technical framework identified in the [Scope of the TLG](#_Scope_of_the) section.

## Consequential changes

The TLG identified the following consequential changes to the [3.4 GHz band technical framework](https://www.acma.gov.au/34-ghz-technical-framework) and [RALI MS44](https://www.acma.gov.au/node/847) to support the conversion of NBN Co’s existing apparatus licences to spectrum licences:

Proposed amendments to the s.145(4) Determination

|  |  |
| --- | --- |
| Item | Detail of amendment |
| 3.4 GHz definition | Change to 3400–3700 MHz |

Proposed amendments to the RAG Rx

|  |  |
| --- | --- |
| Item | Detail of amendment |
| 3.4 GHz definition | Change to 3400–3700 MHz (or point to the definition in the  s.145(4) Determination)  Delete definition of ‘restricted block’ as it is no longer used |
| Clause 3.1 (2) and (5)  Managing in-band interference from apparatus licences (except Radiodetermination services) | Add a clause (c) as follows:   1. the 3400–3425 MHz and 3492.5–3542.5 MHz frequency bands caused by radiocommunications transmitters operating under an apparatus licence issued before [Date Minister makes designation notice] |

Proposed amendments to the RAG Tx and RALI MS44

|  |  |
| --- | --- |
| Item | Detail of amendment |
| RALI MS 44 changes | As detailed in the outcomes paper, it is intended to include those parts of the 3400–3575 MHz band not currently subject to spectrum licensing or proposed for conversion to spectrum licensing, to the list of frequencies offered protection at existing earth station protection zones (ESPZs) as well as the Uralla earth station facility.  This involves extending the Moree and Roma ESPZs as well as Uralla earth station facility to include the frequency ranges  3400–3442.5 MHz and 3475–3542.5 MHz. This represents the frequencies of the 3400–3575 MHz band that are:  Not currently subject to spectrum licensing (spectrum licences in the 3442.5–3475 MHz and 3542.5–3575 MHz bands were first allocated in the year 2000).  Not intended to be converted to spectrum licences for NBN Co.  There will be no changes to the frequency ranges covered by the Quirindi ESPZ. This is because the spectrum is either covered by current spectrum licences or mostly covered by the proposed areas to be converted to spectrum licensing for NBN Co. |
| 3.4 GHz definition | Change to 3400–3700 MHz (or point to the definition in the  s.145(4) Determination). |
| Clause 10.2  Uralla earth station facility | Amend text to indicate that co-channel protection is also afforded in the 3400–3442.5 MHz and 3475–3542.5 MHz as detailed in proposed updates to RALI MS 44.  Changes to clause 10.2 are a result of changes that will be made to [RALI MS44](https://www.acma.gov.au/node/847). |

Proposed amendments to 3.4 GHz spectrum licences

|  |  |
| --- | --- |
| Item | Detail of amendment |
| Clause 3, 3.4 GHz definition | Change to 3400–3700 MHz (or point to the definition in the  s.145(4) Determination)  This definition affects devices that are exempt from registration and protection of ESPZs. It does not affect the synchronisation condition. Consequently, in the first instance it could be limited to those licences that occupy any part of the 3400–3425 MHz and  3492.5–3542.5 MHz band. Any subsequent variations to  3.4 GHz spectrum licences would then include this change. |

## Development of interference management criteria to and from urban excise areas

### Background

As part of the process to [optimise arrangements in the 3400–3575 MHz band](https://www.acma.gov.au/consultations/2019-08/optimising-3400-3575-mhz-band-consultation-122019) the ACMA announced plans to excise and resume 75 MHz of unused spectrum in urban areas of NBN Co’s existing 3.5 GHz spectrum licence holdings (referred to as ‘urban excise’). Implementation of this is pending conversion of NBN Co’s apparatus licences in the 3.4 GHz band to spectrum licences and subsequent defragging of nbn’s spectrum holdings. Refer to the [outcome paper](https://www.acma.gov.au/consultations/2019-08/optimising-3400-3575-mhz-band-consultation-122019)for more details.

Another announcement in the outcomes paper was that the ACMA would work with stakeholders to develop arrangements to manage interference to and from urban excise areas. Once developed, we will use these criteria to determine the utility of the spectrum. If it can be reasonably used, an appropriate licensing approach to make that spectrum available for use by other wireless broadband operators will then be investigated.

A definition of urban excise areas is provided in [Appendix A](#_Appendix_A:_Urban).

To facilitate discussion in the TLG, it was assumed that once the current process to defragment licence holdings in the 3.4 GHz band is completed, the frequency range occupied by urban excise areas will be from 3400–3475 MHz.

Table 5 details the proposed timelines for the defrag process. Under current timelines urban excise areas are expected to be surrendered by nbn in the third quarter of 2021. Pending the outcomes of this TLG and an assessment of the utility of urban excise areas, we would then commence work to make the spectrum available.

Indicative timetable for implementation of planning arrangements in 3400–3575 MHz

|  |  |  |
| --- | --- | --- |
| Step | Step detail | Completion date |
| Restack | Restack of apparatus licences in 3400–3575 MHz. | Completed  30 November 2020 |
| Designation/conversion | Pending decision from the Minister decides to designate parts of the 3400–3575 MHz band for spectrum licensing under s.36 of the Radiocommunications Act, the ACMA would commence work to convert nbn apparatus licences to spectrum licences. | Completed  June 2021 |
| Licence consolidation | s.72 of the Act, variations of spectrum licences to consolidate holdings. | July/August 2021 |
| Licence surrender | nbn surrenders their urban excise licences. | September 2021 |
| Allocation | Pending the outcomes of the  3.4 GHz TLG and an assessment of the utility of urban excise areas, the ACMA would then commence work to make urban excise areas available. | Q1 2023 (if allocated as spectrum licenses. This aligns with proposed the 3700–3800 MHz allocation) |

### Summary of options identified

When developing measures to manage interference to and from urban excise areas, the desired outcomes were to:

Provide sufficient protection to existing nbn services and ensure they are not unreasonably constrained in their ability to deploy new and more spectrally efficient technologies in the future.

Maximise the utility of urban excise areas for new wireless broadband services.

Minimise the impact any new measures have on existing 3.4 GHz spectrum licensees.

Advice provided by the TLG on the development of interference management criteria is summarised in this section. The TLG considered 2 possible deployment scenarios for urban excise areas:

A macro-cell[[1]](#footnote-2) scenario.

A restricted cell[[2]](#footnote-3) scenario. Under this scenario there would be restrictions on base station transmitters such as: limits on outdoor antenna heights, lower EIRP levels, etc.

ACMA staff performed studies to assess the viability of the 2 deployment scenarios using an aggregate C/(N+I) criteria for the protection of nbn service areas. These studies are provided in Appendix D. After reviewing the studies, the TLG concluded that a restricted cell scenario would be feasible while a macro-cell scenario, with a reasonable sized network deployed, was not feasible under current equipment capabilities. Some TLG members believed this may change in the next few years (for example if/when greater control in the elevation plane for AAS beam steering becomes available). Consequently, the TLG identified 3 high-level options for making urban excise areas available; these are detailed in Table 6.

Existing 3.4 GHz spectrum licensees indicated a preference for Option 2 – the Hybrid model for the following reasons:

Option 2 would make spectrum available for use sooner than Option 1 while preserving options for future macro-cell deployments.

Under Option 3, it may be difficult to manage interference between multiple operators with services in close proximity to each other.

In response to the second point above, ACMA staff noted that under Option 3, interference management is dependent on a number of factors. This includes the operating parameters, deployment scenarios, (e.g., deployments covering large areas vs deployments covering individual premises), any restrictions that apply (e.g., EIRP, antenna height, etc) and whether operators can synchronise services.

Furthermore, representatives of other prospective wireless broadband operators (e.g., Wireless Internet Service Providers and Industry verticals) were not present in the TLG to provide their views. ACMA notes that these stakeholders will be able to provide feedback on the options identified during the formal consultation process to follow the TLG, which will assist us with deciding on which way to proceed.

Options for use of urban excise areas

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Option | Licence type | Possible conditions | Description |
| 1 | Macro-cell model | Spectrum  licence  or area-wide licence (AWL) | Refer to section [Macro-cell interference management criteria](#_Macro-cell_interference_management) | Development of interference management criteria and any allocation process would be paused. In a few years’ time the ACMA would re-assess the viability of a macro cell scenario. This model would result in a single operator holding a licence in each urban excise area for a given frequency range (i.e., each urban excise area is subdivided by frequency but not by area). Multiple operators in an area could be supported by subdividing the 3400–3475 MHz band. |
| 2 | Hybrid model | Spectrum  licence  or area-wide licence (AWL) | Refer to section [Macro-cell interference management criteria](#_Macro-cell_interference_management)  Criteria for the restricted cell model could also be considered | Similar to Option 1, a single operator would take out a licence in each urban excise area for a given frequency range (i.e., each urban excise area is subdivided by frequency but not by area). To manage interference between different licensees, relevant co-channel and adjacent channel coordination conditions would be implemented. This may limit service deployments to small cells initially. Macro-cell deployments may be possible in the future when new equipment capabilities are available.  Under this option, spectrum could be made available sooner than in Option 1. |
| 3 | Restricted cell model | AWL or  class licence | Refer to section  [Restricted cell interference management criteria](#_Restricted_cell_interference) | Multiple operators could share access to the same frequency in an urban excise area (i.e., an urban excise area could be subdivided in both frequency and area). To manage interference between different licensees, deployments would be limited to a low EIRP and low outdoor antenna heights (i.e., effectively small cell operation).  Under this option spectrum could be made available sooner than in Option 1. |

### Macro-cell interference management criteria

A summary of the TLG’s discussion on the development of interference management criteria for the macro-cell scenario is provided at [Appendix B](#_Appendix_B:_Summary). The criteria identified in discussions are summarised in Table 7. In addition, as a general rule, it is intended that licensees are free to negotiate the implementation of alternative arrangements on a case-by-case basis.

It is noted that there was no agreement within the TLG on what interference management criteria should be applied to manage some interference scenarios. Where this is the case, possible options were identified. One of the key issues where there was no agreement, was whether to include measures to protect nbn services from interference caused by ducting. Refer to [Appendix B](#_Appendix_B:_Summary) for further details on how and why different options were developed.

The term ‘nbn service areas’ is used in the criteria in Table 7. This term, including kmls viewable in Google Earth, is defined in Appendix D (found in key documents section of this consultation).

Summary of macro-cell interference management criteria

|  |  |
| --- | --- |
| **Item** | **Interference management criteria** |
| Synchronisation requirement  (Refer to BS-BS section in [Appendix B](#_Appendix_B:_Summary) for development  of options) | Option 1  Apply the same synchronisation requirement as detailed in clause 11 of Licence Schedule 4 on all 3.4 GHz spectrum licences.  In addition to this, where interference is transient or temporary, for devices operating in the 3400–3475 MHz band, if:  interference is experienced between a device operating in an urban excise area and a device operating in an adjacent area  there is no agreement on how to manage the interference  the interference is not adequately resolved by adopting the synchronisation requirement  then a temporary adoption of special subframe configuration 5 must be implemented within [TBD timeframe] of the notification of the interference for the duration of the interference event. Normal operation can be restored as agreed between the licensees. |
| Option 2  Apply the same synchronisation requirement as detailed in clause 11 of Licence Schedule 4 on all 3.4 GHz spectrum licences.  Beyond this, as is currently the case, licensees can implement technical measures, where possible and as required, to manage interference due to ducting. This could include negotiating with adjacent area licensees. |
| Application of the current  3.4 GHz device boundary criteria (DBC) | For devices deployed within urban excise areas in the  3400–3475 MHz band, the current DBC does not apply. Alternative measures are defined below for new devices (both registered and unregistered).  For devices deployed in the 3400–3475 MHz band outside urban excise areas, the current DBC does not apply within urban excise areas. Alternative measures are defined below for new devices (both registered and unregistered).  The current DBC continues to apply as usual for all other cases. |
| Registering new devices *inside* urban excise areas within the 3400­–3475 MHz band  (Refer to BS-CPE section in Appendix B for development  of options) | Option 1  For registered devices, the following measures apply:  Ensuring the power flux density (or alternatively field strength or received power level into a notional Rx) from a proposed BS inside an urban excise area does not exceed -99.9 dBW/m2/MHz for non-AAS and -91.9 dBW/m2/MHz at a height of 5 metres above ground level within nbn service areas for  [TBD[[3]](#footnote-4)] % of locations. This criterion is to be met in nbn service areas that are within a 64 km radius of a proposed BS. |
| Option 2  For registered devices, the following measures apply:  Ensuring a proposed BS inside an urban excise area satisfies a minimum aggregate C/(N+I) of 13 dB into a notional CPE within nbn service areas for [TBD1] % of locations. This criterion is to be met in nbn service areas that within a 64 km radius of a proposed BS. |
| Registering new devices *outside* urban excise areas within the  3400–3475 MHz band  (Refer to BS-MS section in Appendix B for development  of options) | Option 1  For registered devices, the following measures apply:  Ensuring a proposed BS outside an urban excise area does not exceed -73.9 dBW/m2/MHz for non-AAS and -65.9 dBW/m2/MHz at a height of 1.5 metres above ground level within urban excise service areas for [TBD1] % of locations. This criterion is to be met inside urban excise areas that are within a 64 km radius of a proposed BS.  Existing measures in the 3.4 GHz spectrum licence technical framework apply in all other cases. |
| Option 2  For registered devices, the following measures apply:  Applying similar rules as within urban excise areas. But for C/(N+I) criteria of [TBD1] dBm into a notional MS.  Existing measures in the 3.4 GHz spectrum licence technical framework apply in all other cases. |
| Unregistered devices *inside* urban excise areas within the 3400–3475 MHz band  (Refer to MS/CPE-BS section in Appendix B for development of options) | Option 1  No change to existing requirements. These are:  Operation is only authorised within a licensee’s spectrum space when a third party is authorised to do so by that licensee.  Devices exempt from registration operate on a ‘no interference and no protection’ basis. |
| Option 2  Existing requirements on spectrum licences apply to mobile devices. For fixed UEs (or a subset of defined fixed UEs) existing requirements on spectrum licences apply with the exception that:  Fixed UEs in the 3400–3475 MHz band and inside urban excise areas, are deemed not to cause interference to adjacent area licences. |
| Unregistered devices *outside*urban excise areas within the 3400–3475 MHz band  (Refer to MS/CPE-BS section in Appendix B for development of this approach) | Option 1  No change to existing requirements. These are:  Operation is only authorised within a licensee’s spectrum space when a third party is authorised to do so by that licensee.  Devices exempt from registration operate on a ‘no interference and no protection’ basis. |
| Option 2  Existing requirements apply with the exception that:  Fixed UEs associated with the provision of the NBN in the  3400–3475 MHz band, are deemed not to cause interference into urban excise areas. |
| Devices (both registered and unregistered) in the  3475–3700 MHz band | No change to existing requirements. |
| Measures to enable nbn to deploy new more spectrally efficient technologies in the future (e.g., 5G, AAS) | Option 1  Put a condition on all urban excise area licences in the  3400–3475 MHz band which states that licensees cannot claim protection from interference caused by base stations associated with the delivery of the nbn. |
| Option 2  Before urban excise areas are made available, nbn would coordinate and register devices at all new planned or likely new base station sites.  In addition, a condition would be added to the relevant licences or the s.145(4) Determination, that allows nbn to deploy higher gain antennas (to a defined point) and larger bandwidths at existing nbn BS sites without needing to re-coordinate with services inside urban excise areas. This condition would only apply to nbn BS in the 3400–3475 MHz band and only when managing interference into urban excise areas. Prospective urban excise licensees would need to be made aware of this before any licences are issued. This will ensure they can consider it when planning service deployments.  Any new base stations deployed after this condition is put in place would be subject to general coordination rules (e.g., the PFD or C(I+N) coordination described above). |
| Managing interference between 4G and 5G systems  (Refer to ‘Adjacent channel 4G and 5G systems’ section in [Appendix B](#_Appendix_B:_Summary) for development of options) | Option 1  No change to existing requirements. |
| Option 2  For devices operating in the 3400–3475 MHz band inside urban excise areas, a 15 MHz guard band will apply when a 4G optimised frame structure is used. No guard band is required if the licensee can adopt the same frame structure as the spectrum licensees directly above 3475 MHz. Alternatively, the guard band can be relaxed if there is agreement with frequency adjacent spectrum licensees to do so. |

### 

### Restricted cell interference management criteria

Preliminary draft criteria proposed by ACMA staff is summarised in Table 8. Details on how the PFD limit and size of the guard band were determined are provided at [Appendix B](#_Appendix_B:_Summary).

While this proposal was provided to the TLG for discussion, there was only a brief peer review and comment period. Further development and consultation may be appropriate if this option is chosen for making urban excise areas available for use by other wireless broadband operators. For example, TLG members queried how practical it would be to synchronise the operation of a large number of small cells, especially if they are operated by multiple different operators.

This resulted in the TLG identifying 2 high-level options under the restricted cell approach. One option is where a single operator would have access to each urban excise area for a given frequency, and multiple operators could be supported by subdividing the frequency in an area. The second option is where multiple operators would share access to the same frequency in an urban excise area (i.e., an urban excise area could be subdivided in both frequency and area). These are identified as Options 2 and 3 respectively in Table 6.

Option 2 would be best catered for under a spectrum or apparatus (e.g., AWL) licence type. In this case only HCIS levels 1 and higher would be used.

Option 3 would be best catered for under an apparatus (e.g., AWL) or class licence type. In the case that AWLs are used, HCIS 0 or HCIS 00 could be considered for use to allow smaller licence areas to be defined.

Summary of restricted cell interference management criteria

|  |  |
| --- | --- |
| **Item** | **Interference management criteria** |
| Licence type | Spectrum, apparatus (e.g., AWL) or class licence |
| Definitions | ‘Controlled premises’means premises that are owned by or under the control of a person who is providing a radiocommunications service under a class licence*.*  Note: If a spectrum licence or AWL approach is adopted, the term ‘controlled premises would be defined as the geographical boundary of the licence. |
| General rules for  all transmitters | 1. Operation of transmitters is limited to urban excise areas and within the 3400-3470 MHz band (i.e.**,** 5 MHz guard band). 2. The maximum transmitter EIRP must not exceed 30 dBm. 3. The power spectral density of a transmitter must not exceed 17 dBm EIRP per MHz. 4. Base station transmitters must comply with the unwanted and spurious emission limits described in 3GPP TS 38.104. 5. User equipment transmitters must comply with the unwanted and spurious emission limits described in 3GPP TS 38.101-2. 6. Operation is on a no interference and no protection basis. 7. The operation of transmitters must be synchronised with the operation of services operating under adjacent area 3.4 GHz spectrum licences that are directly adjacent to urban excise areas. In this case**,** synchronisation means operating in accordance with subsections 11(e) and (f) of licence  **S**chedule 4 of the relevant spectrum licence. |
| Additional rules for indoor operation | 1. Indoor operation is limited to an area enclosed by permanent walls on all sides and having a permanent roof. 2. The aggregate power flux-density from transmitters on controlled premises must not exceed –64.9 dBm/MHz/m2 at the external boundary of the controlled premises at a height of 5 metres above ground level. 3. The aggregate power flux-density from transmitters on controlled premises must not exceed –99.9 dBm/MHz/m2 at the boundary of urban excise areas at heights between 5 and 100 metres above ground level. |
| Additional rules for outdoor operation | 1. The aggregate power flux-density from transmitters on controlled premises must not exceed -99.9 dBm/MHz/m2 at the external boundary of the controlled premises at a height of 5 metres above ground level. 2. The aggregate power flux-density from transmitters on controlled premises must not exceed -64.9 dBm/MHz/m2 at the boundary of urban excise areas at heights between 5 and 100 metres above ground level. |

## Review of the s.145(4) Determination

Within the TLG, all 3.4 GHz spectrum licensees supported the changes to the   
s.145(4) Determination detailed in Table 9. Changes discussed within the TLG generally align with those identified in the review of the [2.3 GHz technical framework](https://www.acma.gov.au/consultations/2020-12/review-23-ghz-spectrum-licencing-technical-framework-consultation-372020), the only difference being to the level of protection (LOP). In this case the current LOP was maintained for non-AAS. An 8 dB factor (to account for the dynamic interference environment associated with AAS) was applied to this to derive the LOP for AAS.

In addition to these general changes, ACMA staff also proposed to exempt nbn services operating in the 3400–3475 MHz band from having to meet the DBC at urban excise area boundaries. The intention is that ultimately such interference will be managed by the measures developed for use of urban excise areas. This change is being applied now as a temporary measure before these arrangements are finalised and implemented. It is proposed to include it now so nbn are not prevented from registering devices near urban excise areas in the interim period.

A draft update to the s.145(4) Determination is provided at Appendix C (found in the key documents section of this consultation).

Amendments considered to the s.145(4) Determination

|  |  |
| --- | --- |
| Item | Detail of amendment |
| 3.4 GHz definition | Change to 3400-3700 MHz |
| Level of protection (LOP) | Non-AAS: -98 dBm/MHz (this is the current LOP)  AAS: -90 dBm/MHz |
| Digital Elevation Model (DEM) | Adopt 3-sec DEM |
| Calculation resolution | 100m (current 250m) |
| Value of m | 1080 – this equates to 108 km  (currently 432 for 250 m resolution, which equates to 108 km) |
| Propagation modelling | Specify that ITU-R P.525 (free-space path loss) is to be used in calculations along with ITU-R P.526 (diffraction)  Inclusion of clutter loss for stations that are at height 6m or lower based on Recommendation ITU-R P.2108-0. If the loss calculated is less than 0 dB, the calculated loss value is replaced with 0 dB. If the loss calculated is greater than 8 dB, the calculated loss value is replaced with 8 dB. |
| Grandfathering clause for existing device registrations | While changes identified are unlikely to affect existing registration, to ensure this an addition clause could be added. This will state  that devices are required to meet the requirements of the  s.145(4) Determination that applies at the time of registration. |
| Exemption for nbn services meeting DBC at urban excise boundary | Transmitters operating under nbn 3.4 GHz spectrum licences, with an occupied bandwidth wholly within the 3400–3475 MHz band, will not be required to meet the DBC into urban excise areas. |

## Review of the Rx spurious emission limits

The current unwanted emission limits for registered receivers (i.e., base stations) are reproduced in Table 10. It was identified within the TLG that these are the limits that are defined in 3GPP standards for non-AAS Rx and apply to individual receivers. Different limits are also defined for AAS Rx.

Receiver unwanted emission limits outside the   
3360–3840 MHz frequency band

|  |  |  |
| --- | --- | --- |
| **Frequency  range (f)** | **Total radiated power**  **(dBm)** | **Measurement bandwidth** |
| 30 MHz ≤ f ≤ 1 GHz | -57 | 100 kHz |
| 1 GHz ≤ f ≤ 12.75 GHz | -47 | 1 MHz |

3GPP TS 38.104 defines non-AAS Rx spurious emission limits in terms of conducted power for each individual receiver. Having the limits in Table 10 defined as a TRP mean they apply to all receivers associated with a device (or equivalently operating within an individual cell/sector) rather than individual receivers.

To align with 3GPP TS 38.104, non-ASS Rx spurious emission limits should be defined in terms of mean power (equivalent to conducted power) per receiver. While this would result in high levels of unwanted emissions, the levels would still be lower than those defined for non-AAS transmitters. Consequently, adopting these limits is expected to have a negligible change in interference environment to adjacent band services.

3GPP defined receiver spurious emission limits for AAS are defined in Table 11. As the limit is defined as a TRP, it places a cap on emissions from all Rx associated with a device (or equivalently operating within an individual cell/sector). There is a noticeable difference between 3GPP TS 38.104 and current limits. The 3GPP TS 38.104 limits mirror the spurious emission limits currently in place for AAS transmitters in the 3.4 GHz band. Consequently, adopting these limits is expected to have a negligible change in interference environment to adjacent band services.

Importantly for time division duplex (TDD) systems, the AAS limits only apply during periods in which the associated transmitter is not operating. As the limit is defined as a TRP, it places a cap on emissions from all Rx associated with the device.

3GPP AAS receiver spurious emission limits outside the   
3360–3840 MHz frequency band[[4]](#footnote-5)

|  |  |  |
| --- | --- | --- |
| **Frequency  range (f)** | **Total radiated power (dBm) per cell/sector** | **Measurement bandwidth** |
| 30 MHz ≤ f ≤ 1 GHz | -27 | 100 kHz |
| 1 GHz ≤ f ≤ 12.75 GHz | -21 | 1 MHz |

In summary, the outcomes of TLG discussions were to:

Redefine the receiver spurious emission limits for non-AAS Rx in Table 10 in terms of mean power (rather than total radiated power) and clarify that the limits apply to individual receivers.

Adopt the receiver spurious emission limits for AAS set out in Table 11.

Include a note to clarify that, for TDD devices, the receiver spurious emission limits only apply during periods the associated transmitter is not operating.

## Review of the RAG Rx

The scope of the TLG included a possible review of text in the RAG Rx relating to interference management with defence radar systems. The aim was to provide greater guidance on the issue where appropriate. After further consideration, the Department of Defence decided changes were not required at this time. Consequently, there was no further discussion on this issue within the TLG.

# Appendix A: Urban excise areas

The geographical areas covered by urban excise areas are:

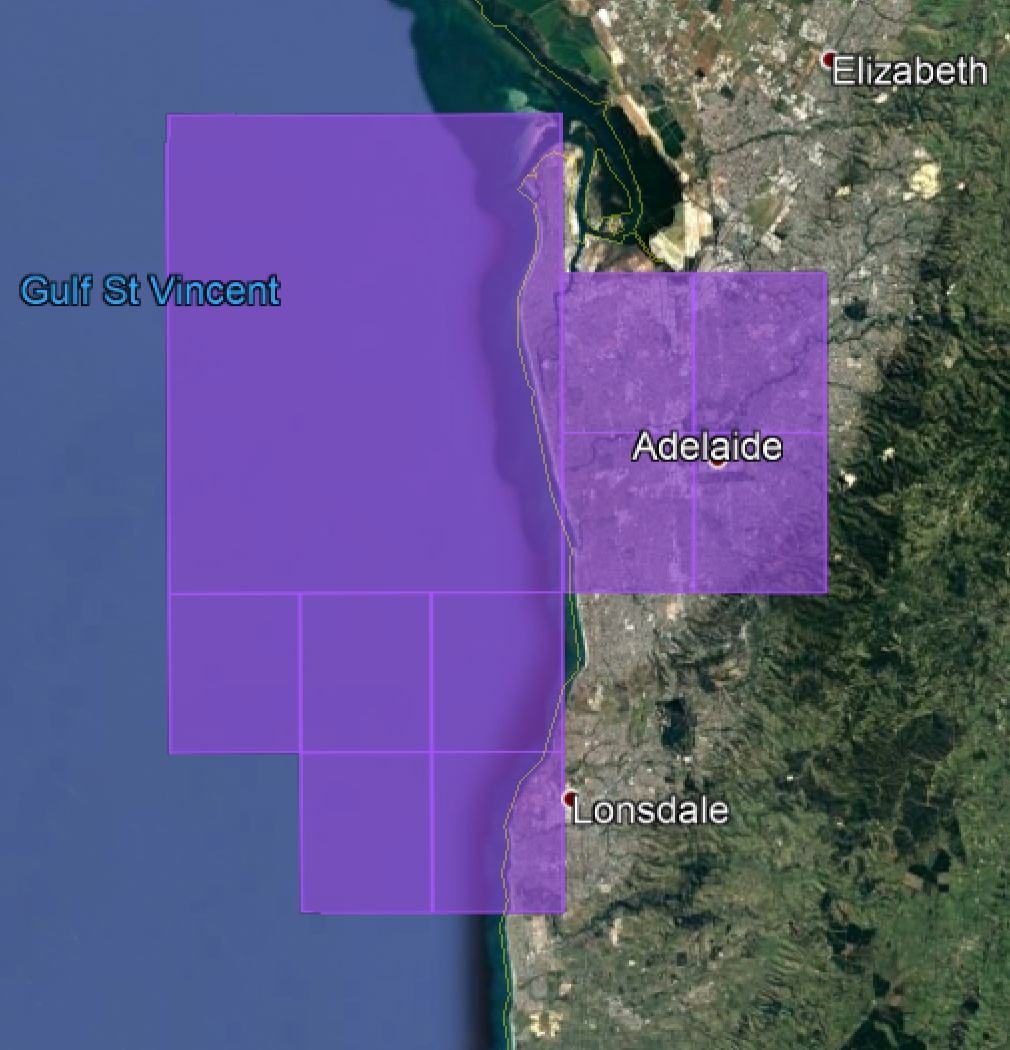
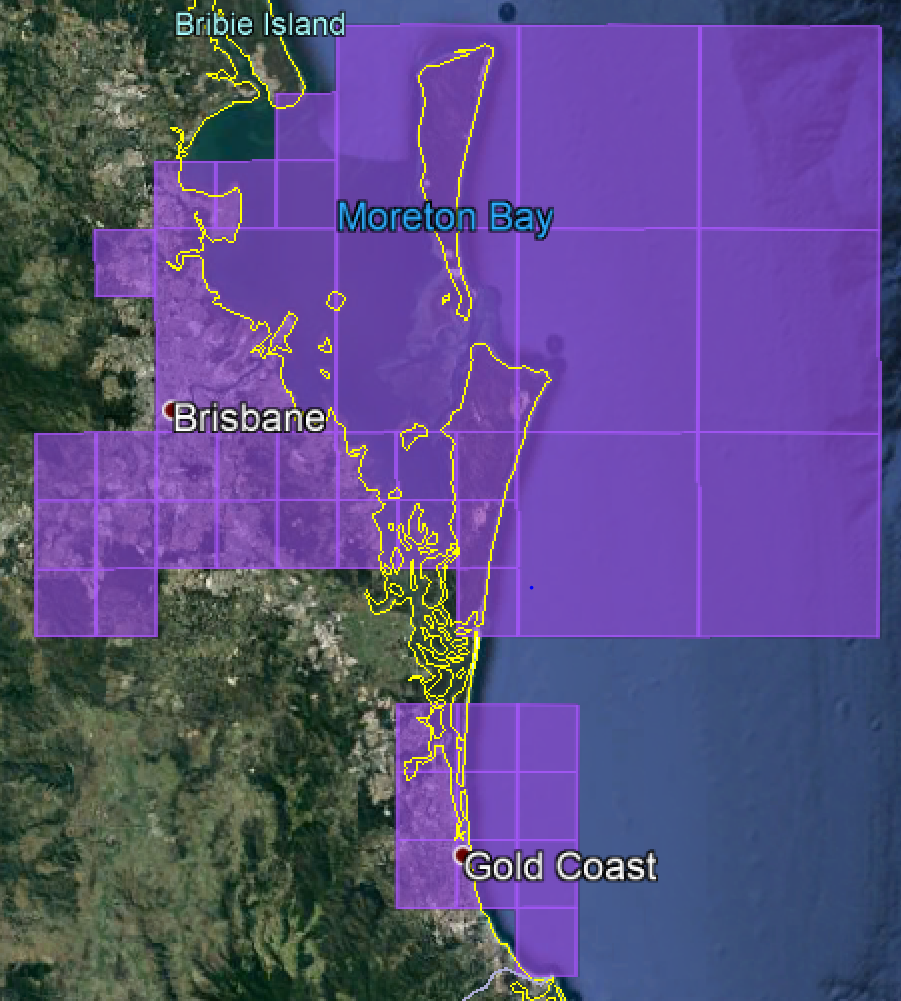
* described in Table 12
* illustrated in Figure 1.

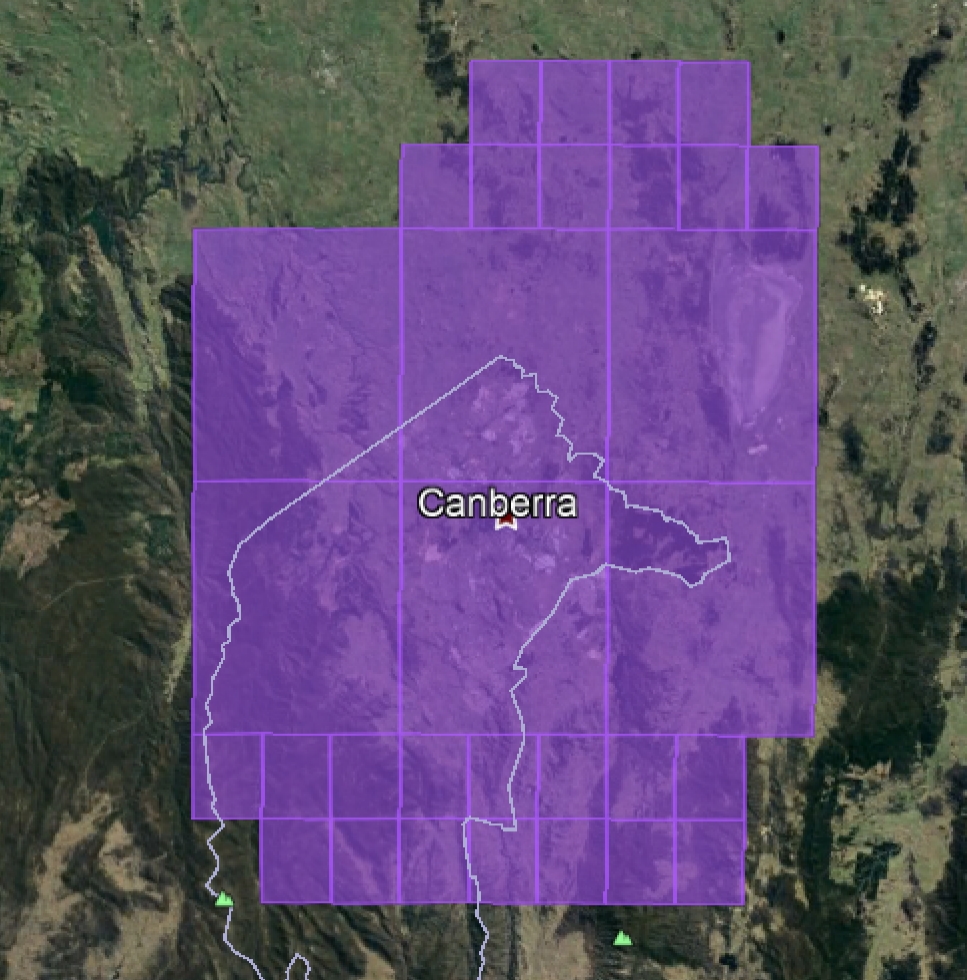
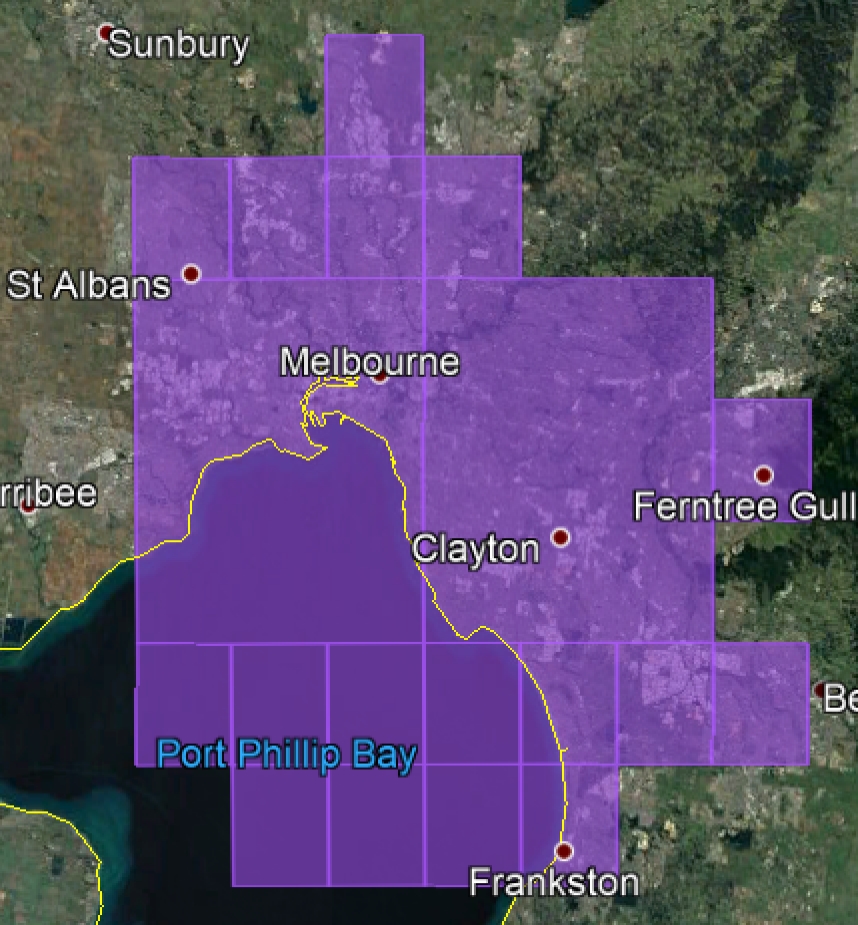
HCIS description of urban excise areas

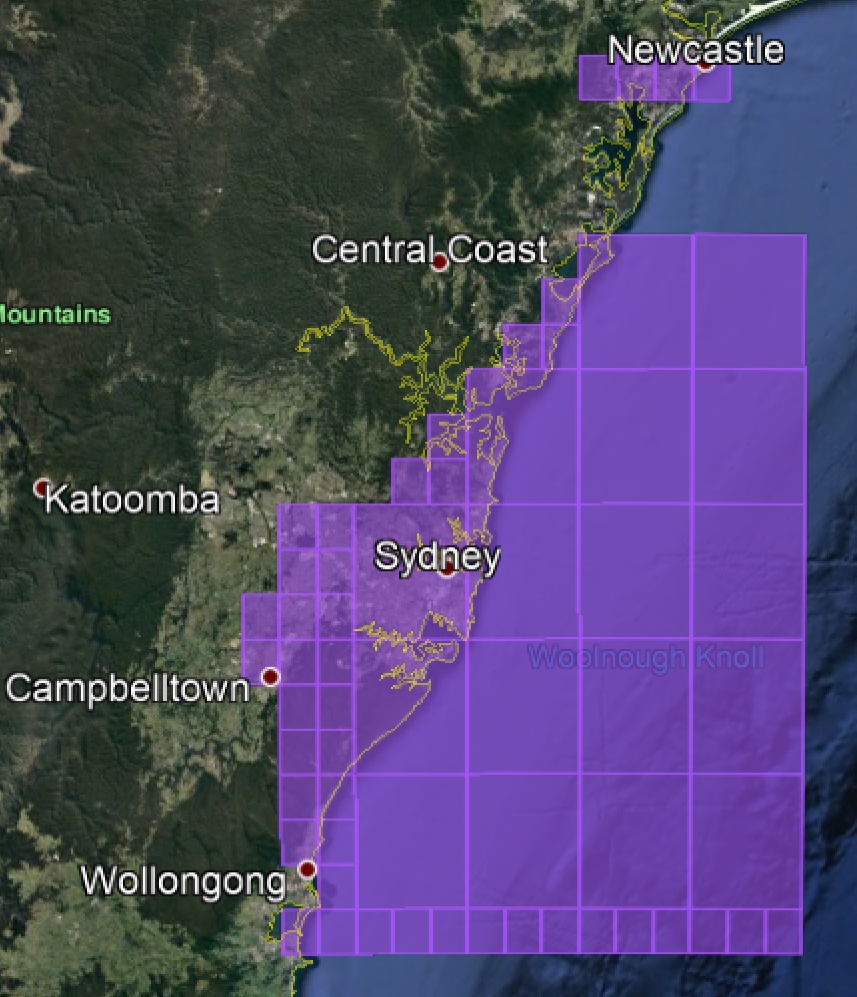
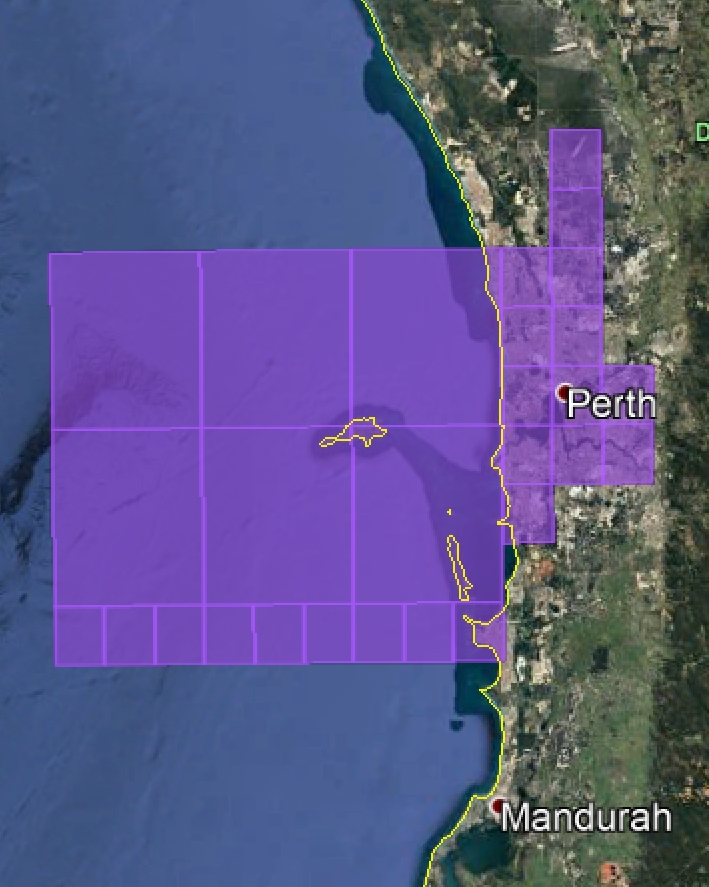
| Sub-area name | HCIS |
| --- | --- |
| Adelaide | IW3N, IW3O4, IW3O5, IW3O7, IW3O8, IW6B1, IW6B2, IW6B3, IW6B5, IW6B6 |
| Brisbane | NT9B, NT9C, NT9D, NT9E, NT9F, NT9G, NT9H, NT9K, NT9L, NT8H3, NT8L2, NT8L3, NT8L5, NT8L6, NT8L8, NT8L9, NT9A6, NT9A7, NT9A8, NT9A9, NT9I1, NT9I2, NT9I3, NT9I4, NT9I5, NT9I6, NT9J1, NT9J2, NT9J3, NT9J4, NT9J5, NT9J6, NT9J9, NT9N5, NT9N6, NT9N8, NT9N9, NT9O4, NT9O7, NU3B2, NU3B3, NU3C1, NU3C4 |
| Canberra | MW4D, MW4H, MW5A, MW5B, MW5E, MW5F, MW2M5, MW2M6, MW2M7, MW2M8, MW2M9, MW2N4, MW2N5, MW2N7, MW2N8, MW2N9, MW4L1, MW4L2, MW4L3, MW4L5, MW4L6, MW5I1, MW5I2, MW5I3, MW5I4, MW5I5, MW5I6, MW5J1, MW5J2, MW5J4, MW5J5 |
| Melbourne | KX3P, KX3L6, KX3L7, KX3L8, KX3L9, KX6D1, KX6D2, KX6D3, KX6D5, KX6D6, LX1M, LX1I7, LX1N4, LX4A1, LX4A2, LX4A3, LX4A4, LX4A5, LX4B1 |
| Perth | BV1M, BV1N, BV1O, BV4A, BV4B, BV4C, BV1L5, BV1L8, BV1P1, BV1P2, BV1P4, BV1P5, BV1P7, BV1P8, BV4D1, BV4D2, BV4E1, BV4E2, BV4E3, BV4F1, BV4F2, BV4F3, BV4G1, BV4G2, BV1P9, BV4D3, BV4D4, BV4G3 |
| Sydney | NV7G, NV7H, NV7J, NV7K, NV7L, NV7M, NV7N, NV7O, NV7P, NW1A, NW1B, NW1C, NW1D, NW1E, NW1F, NW1G, NW1H, MV9P2, MV9P3, MV9P5, MV9P6, MV9P7, MV9P8, MV9P9, MW3D1, MW3D2, MW3D3, MW3D5, MW3D6, MW3D8, MW3D9, MW3H2, MW3H3, MW3H5, MW3H6, MW3H9, MW3L2, MW3L3, NV4O7, NV4O8, NV4O9, NV4P7, NV7F6, NV7F8, NV7F9, NV7I6, NV7I8, NV7I9, NW1I1, NW1I2, NW1I3, NW1J1, NW1J2, NW1J3, NW1K1, NW1K2, NW1K3, NW1L1, NW1L2, NW1L3 |

Note: The HCIS coordinates can be converted into a Placemark file (viewable in Google Earth) through a facility on the [ACMA website](https://acma.gov.au/convert-hcis-area-description-placemark-0).

1. Illustration of urban excise areas (purple areas)

# Appendix B: Summary of discussion on urban excise interference management criteria

This appendix summarises TLG discussion on the development of interference management criteria to and from urban excise areas.

## Interference mechanisms

To manage interference to/from urban excise areas, the following interference mechanisms were identified for consideration:

Base station (BS) to Base station (BS-BS): Interference between BS operating in adjacent area and frequency licences.

BS to user terminals: Interference from a BS to a user terminal operating in operating in adjacent area or frequency licences. Two cases are defined:

BS to customer premise equipment (BS-CPE)[[5]](#footnote-6): Interference from a BS operating inside an urban excise area to a CPE operating under an nbn licence.

BS to mobile station (BS-MS): Interference from a BS to an MS operating in an adjacent area or frequency licence.[[6]](#footnote-7)

User terminals to BS: Interference from a user terminal to a BS operating in adjacent area and frequency licences. Two cases are defined:

CPE- BS3: Interference from a CPE operating under an nbn licence to a BS operating in an urban excise area.

MS-BS: Interference from an MS to a BS operating in an adjacent area or frequency licence.4

User terminal to user terminal inference (MS/CPE-MS).

In addition to the mechanisms above, the TLG identified a preference to manage interference between adjacent channel 4G and 5G systems when they are using different frame structures.

Two possible deployment scenarios were considered for urban excise areas:

A macro-cell scenario.

A restricted cell scenario. Under this scenario restrictions would apply such as limits on outdoor antenna heights, lower EIRP levels, etc.

## Macro-cell scenario discussion

### BS-BS

It is expected that both co-channel and adjacent BS-BS interference can largely be managed by the application of the following existing measures in the 3.4 GHz technical framework:

* The co-sited devices requirement detailed in [clause 3 of Licence Schedule 4 on all 3.4 GHz spectrum licences](https://web.acma.gov.au/rrl/licence_image.extract_pdf?pLICENCE_NO=10917464).
* The synchronisation requirement (SyncRec) as detailed in [clause 11 of Licence Schedule 4 on all 3.4 GHz spectrum licences](https://web.acma.gov.au/rrl/licence_image.extract_pdf?pLICENCE_NO=10917464).

The TLG noted that based on the SyncRec, the guard period (GP) that applies provides adequate co-channel BS-BS protection out to about 64 km. however, there are cases in the 3.4 GHz (and 2.3 GHz) band, where cochannel interference can occur at separation distances beyond this due to anomalous propagation (e.g., ducting). Such interference can be experienced at distance much greater than 64 km from a transmitter for macro-cell deployments. It can be experienced in specific areas (e.g., up and down the coast of WA) at certain times of the year. It is currently experienced periodically by all licensees in bands TDD technologies are deployed, this includes the 2.3 GHz and 3.4 GHz bands. Interference due to ducting can be caused from a licensees’ own services or from other licensees’ services.

Existing technical frameworks do not define measures to cater for interference caused by ducting when it is into wireless broadband receivers (it can consider it for services such as Radio Astronomy). Doing so would greatly reduce utility of the spectrum due to the large distances this type of interference can occur over.

nbn indicated that urban excise represents a significant shift form the interference scenario they currently experience and would introduce a new source of interference. Specifically, they would be moving from a situation where they have no co-channel neighbours in metro areas to one where they do. To manage this, the measure supported by nbn is the inclusion of a secondary fallback scheme to the synchronisation condition. The intention is this would only apply during periods ducting is a problem (for example during certain times of the year and certain areas).

The secondary fallback measure would adopt *special subframe configuration 5* which has a larger guard period than *special subframe configuration 6*.[[7]](#footnote-8) This guard period would assist in managing co-channel interference between base stations up to a distance of 193 km. Due to the larger guard period, this fallback scheme is slightly less efficient than the existing.

Mobile network operators (MNOs) argued that ducting is an existing issue that all licensees experience and need to actively manage. They did not support regulatory measures being defined to manage it. Adoption of the secondary fallback scheme would reduce system capacity. If it is an issue, MNO’s believed licensees can implement different technical measures and/or negotiate with adjacent area licensees to manage it.

nbn have stated that they are already implementing possible measures to manage ducting between their own systems. These measures may not be sufficient to protect against additional ducting interference from urban excise areas. nbn indicated that the effect of interference could be seen as a reduction in uplink performance in a base station sector or, in the worst case, an outage. Such interference can occur for periods of an minutes/hours or even days at a time, but events usually occur during specific times of the year.

#### TLG outcome

The TLG supported maintaining the existing measures in the 3.4 GHz technical framework to manage BS-BS interference. Regarding interference due to ducting, 3 possible solutions were considered:

No addition measures to manage interference caused by ducting. Licensees can implement technical measures, where possible and as required, to manage interference due to ducting. This could include negotiating with adjacent area licensees.

* Require new BS in the 3400–3475 MHz band to be coordinated with existing co-channel BS located 64 km away. While this option was briefly discussed, it was identified it would severely reduce utility of urban excise areas due to the large coordination distance involved.
* Include a secondary fallback synchronisation scheme for licences in urban excise aeras and adjacent nbn licences. This would mean that, for devices operating in the 3400-3475 MHz band, where interference is transient or temporary, if:

interference is experienced between a device operating in an urban excise area and a device operating in an adjacent area

there is no agreement on how to manage the interference

the interference is not adequately resolved by adopting the standard synchronisation requirement

then a temporary adoption of special subframe configuration 5 must be implemented within [TBD timeframe] of the notification of the interreference for the duration of the interference event. Normal operation can be restored as agreed between the licensees.

### BS-CPE

For the purposes of the TLG, CPEs were only considered to operate under nbn licences. This means only co-channel interference from urban excise areas needed to be consider for the BS-CPE case. Usually, a spectrum licence technical framework does not provide specific protection for BS-CPE interference. However, an inherent level of protection is afforded provided by the Device Boundary Criteria (DBC) specified in the [Radiocommunications (Unacceptable Levels of Interference   
— 3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Details/F2018C00557).

The DBC provides a method for limiting the levels of emissions that leave a licence area. The intention is to provide a level of certainty to adjacent area licensees regarding the future usability of their spectrum, irrespective of who deploys services first-in-time. The level of protection (LOP) afforded by the DBC can be set as high or low as desired and is usually a compromise between managing interference and maximising the utility of a spectrum licence. For example, the more stringent the LOP is set, the greater protection licensees have from interference. However, this also results in larger ‘dead-zones’ near licence boundaries where utility is reduced and licensees either cannot deploy or are required to implement various types of mitigation strategies to minimise emissions leaving their licence area.

For the following reasons, the use of the existing DBC to manage BS-CPE interference was not considered appropriate:

When urban excise areas were developed, it was not considered whether existing nbn BS would meet the DBC with the newly created area. The intention was to identify HCIS in urban (and surrounding suburban) areas that were not part of the nbn terrestrial wireless service area. Therefore, many existing nbn BS would not meet the DBC at the urban excise area boundary. Having to adhere to the DBC would also limit the ability of nbn to increase sectorisation on existing sites and migrate to AAS (with higher gain antennas) in the future.

Changing the DBC to accommodate nbn BS would require a reduction in the LOP. This would increase the risk of interference into nbn service areas.

The 3.5 GHz band may be the only frequency available for the delivery of nbn services in a number of areas, a method to manage BS-CPE interference is required.

* Urban excise areas are smaller than existing metro areas in the 3.4 GHz and other bands. The area boundary also passes through areas of significant population. This means the dead zones created by using the existing DBC would greatly restrict the locations new services could be deployed in urban excise areas, thereby reducing their utility.

It was noted that nbn are close to finalising the rollout of their terrestrial wireless network (not accounting for possible densification in the future) and the areas they are required to provide terrestrial wireless broadband service are well defined (noting this may evolve over time with population growth). Taking this into account, it is considered that a first-in-time coordination approach may be applied to manage BS-CPE interference in this case without significantly impacting nbn services.

Two alternative approaches to the DBC were considered to manage BS-CPE interference:

* Define a PFD criteria: Ensure the PFD from a proposed new BS does not exceed a defined limit at a specified height within nbn service areas6. While this approach would likely provide sufficient protection, MNOs consider it would be overly conservative in cases where nbn have services deployed close to urban excise areas. This is because it does not take into account CPE antenna directionality or scenarios where high levels of interference can be tolerated (i.e., where C/(N+I) margins are high).
* Define a C/(N+I) criteria: Ensure the C/(N+I) into a notional CPE is not exceed. This involves:

Defining a notional CPE, including an antenna pattern.

Obtaining details of nbn’s service area within 64 km of urban excise area boundaries that are accurate as of the time of registering a device. To avoid any privacy issues, this would need to be a generic service area that encompasses locations nbn needs to be able to provide services. Individual CPE sites are not defined.[[8]](#footnote-9)

Placing registered nbn BS within the service area provided by nbn.

A proposed new BS inside urban excise areas would need to assess the C/(N+I) into a notional CPE at specified locations within the service area. The notional CPE would be pointed to the closest nbn BS. This would take into account CPE antenna directionality and scenarios where higher levels of interference can be tolerated.

nbn indicated that CPEs pointed at the best available BS at the time they were deployed. As the network has been densified over time, and CPE pointing not necessarily changed, not all CPEs will be pointing at the closest BS. Consequently, nbn had concern that a C/(N+I) approach may not accurately reflect the level of interference received in all cases.

Both of the above approaches would provide a defined level of protection from BS operating in urban excise into existing service areas. They would not place restrictions on emissions outside of nbn service areas.

ACMA staff performed studies to assess the viability of the 2 deployment scenarios using an aggregate C/(N+I) criteria for the protection of nbn service areas. These studies are provided in Appendix D (found in the key documents section of this consultation). After reviewing the studies, the TLG concluded that a restricted cell scenario would be feasible while a macro-cell deployment scenario, with reasonable sized network deployed, was not feasible under current equipment capabilities. Some TLG members believed this may change in the next few years (for example greater control in the elevation plane for AAS beam steering becomes available).

#### TLG outcome

The TLG was unable to reach agreement on the best approach to use when managing BS-CPE interference. Consequently, both approaches, the PFD criteria and C/(N+I) criteria, are identified as alternative options. This criterion is only intended to apply to manage co-channel interference to and from urban excise areas in the   
3400–3475 MHz band. The current DBC should continue to apply for all other cases.

### BS-MS

For the purposes of the TLG, the BS-MS scenario only applies to MS operating within the 3400–3475 MHz band and inside urban excise areas. In this case, both adjacent and co-channel interference cases need to be considered.

Usually, a spectrum licence technical framework does not provide specific protection for BS-MS interference. However, an inherent level of protection afforded is provided in the 3.4 GHz technical framework by:

For the adjacent channel scenario – unwanted emission limits defined in [licence   
Schedule 2 on all 3.4 GHz spectrum licences](https://web.acma.gov.au/rrl/licence_image.extract_pdf?pLICENCE_NO=10917464).

For the co-channel scenario – the device boundary criteria (DBC) specified in the [Radiocommunications (Unacceptable Levels of Interference — 3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Details/F2018C00557).

For the adjacent channel BS-MS scenario, the TLG discussed adopting the existing measures in the 3.4 GHz spectrum licence technical framework. These measures, along with some simple network design principles (e.g., to manage ‘near-far’ effects), were considered suitable to manage BS-MS interference.[[9]](#footnote-10)

For the co-channel case, the same options as identified for the BS-CPE scenario were considered by the TLG. It is noted that different parameters are used for the notional MS to account for the typically lower antenna gain and height of MS compared to CPE’s. The use of clutter in propagation modelling is also proposed for both the PFD and C/(N+I) criteria.

#### TLG outcome

The TLG was unable to reach agreement on the best approach to use when managing BS-MS interference. Consequently, both options, the PFD criteria and C/(N+I) criteria, are presented as possible options. It is noted that this criterion is only intended to apply for the management of co-channel BS-MS interference into urban excise areas in the 3400–3475 MHz band. The current DBC should continue to apply for all other cases.

### MS/CPE-BS

Usually, a spectrum licence technical framework does not provide specific protection for MS/CPE interference. An inherent level of protection afforded is provided in the   
3.4 GHz technical framework by:

For the adjacent channel scenario – unwanted emission limits defined in [licence Schedule 2 on all 3.4 GHz spectrum licences](https://web.acma.gov.au/rrl/licence_image.extract_pdf?pLICENCE_NO=10917464).

For the co-channel scenario – the DBC specified in the [Radiocommunications (Unacceptable Levels of Interference — 3.4 GHz Band) Determination 2015](https://www.legislation.gov.au/Details/F2018C00557) (this limits how close a base station, and by association UEs, deploy to a licence boundary).

Operation of an MS/CPE is only authorised within a licensee’s spectrum space unless a third party is authorised to do so by another licensee.

In the event none of the above mechanisms is adequate, [clause 9 of licence Schedule 4 on all 3.4 GHz spectrum licences](https://web.acma.gov.au/rrl/licence_image.extract_pdf?pLICENCE_NO=10917464) states that devices exempt from registration (e.g., MS/CPE) must not cause harmful interference.

For the adjacent channel scenario, the TLG discussed maintaining the existing measures in the 3.4 GHz spectrum licence technical framework. This along with some simple network design principles are considered suitable to manage MS/CPE-BS interference.7

For the co-channel scenario, noting the limitations identified for the current DBC, it is considered that the alternative mechanisms for the management of BS-CPE and BS-MS interference would assist in managing MS/CPE-BS interference for new service deployments. Clause 9 of licence Schedule 4 would then apply in the event there is interference. However, given existing nbn services are located much closer to the urban excise boundary then would normally be the case for a 3.4 GHz spectrum license (this is a result of how urban excise areas were developed – refer to BS-CPE discussion), there is an increased risk that CPEs could cause co-channel interference into urban excise areas. It is considered that application of clause 9 of licence Schedule 4 could unintentionally result in some CPEs having to modify or cease operation. To avoid this situation, clause 9 of licence Schedule 4 should not apply to CPEs associated with delivery of the nbn.

To provide symmetry with urban excise areas, MNOs proposed a similar condition apply to fixed UEs inside urban excise areas. ACMA staff noted that such a condition would likely increase the risk of harmful interference to nbn services.

#### TLG outcome

The TLG was unable to reach agreement on the best approach to use when managing MS/CPE-BS interference. Consequently, the following options were identified:

For devices outside urban excise areas operating in the 3400–3475 MHz band:

Option 1: Adopt existing requirements. This means devices exempt from registration operate on a ‘no interference and no protection’ basis. Also, operation is only authorised within a licensee’s spectrum space when a third party is authorised to do so by that licensee.

Option 2: Existing requirements apply with the exception that CPEs associated with the provision of the NBN in the 3400–3475 MHz band, are deemed not to cause interference into urban excise areas.

For devices inside urban excise areas operating in the 3400–3475 MHz band:

Option 1: Adopt existing requirements. This means devices exempt from registration operate on a ‘no interference and no protection’ basis. Also, operation is only authorised within a licensee’s spectrum space when a third party is authorised to do so by that licensee.

Option 2: Existing requirements apply with the exception that fixed UEs (or a subset of defined fixed UEs are deemed not to cause interference to adjacent area licences.

### MS/CPE-MS

A spectrum licence technical framework does not usually provide specific protection for MS/CPE-MS interference. An inherent level of protection is provided by:

Both co-channel and adjacent channel scenarios: The generally lower levels of emissions (including the effects of power control) and statistical nature of any interference.

For both adjacent and co-channel scenarios: the synchronisation requirement (SyncRec) as detailed in [clause 11 of Licence Schedule 4 on all 3.4 GHz   
spectrum licences](https://web.acma.gov.au/rrl/licence_image.extract_pdf?pLICENCE_NO=10917464).

Operation of an MS/CPE is only authorised within a licensee’s spectrum space when it is a third party authorised to do so by another licensee.

For the 3.4 GHz band the main mechanism managing MS/CPE-MS interference is the SyncRec.7 This would result in adjacent frequency and area MS/CPE transmitting and receiving at the same time, thereby removing the possibility of interference. It is also considered that other mechanisms identified for the management of BS-BS, BS-CPE and BS-MS would further assist in managing any co-channel interference in the event services are not synchronised. For this reason, the TLG did not identify any additional specific measures to manage MS/CPE-MS interference scenario.

#### TLG outcome

No new measures required in the 3.4 GHz technical framework.

### Adjacent channel 4G and 5G systems

Adjacent channel interference as well as co-channel BS-BS interference is managed via the SyncRec. As nbn currently uses 4G technology, this condition mandates use of a 4G frame structure.

The SyncRec only applies if there is interference and there is no agreement on how to manage it. This means adjacent band MNO’s are currently able to implement a 5G optimised frame structure in metropolitan areas as nbn has no services deployed there. However, if new services are deployed within urban excise, they would be required to synchronise with nbn to manage co-channel BS-BS interference. Unless a suitable guard band is implemented, this would have a flow on effect of requiring all adjacent frequency spectrum licensees to fallback to a less efficient 4G frame structure.

Advice from 3.4 GHz spectrum licensees was that a 15 MHz guard band would be sufficient to manage interference in this instance.

#### TLG outcome

The TLG identified 2 options to manage this issue:

Option 1: No change to existing requirements.

Option 2: For devices operating in the 3400–3475 MHz band inside urban excise areas, a 15 MHz guard band will apply when a 4G frame structure is used. No guard band is required if the licensee can adopt the same frame structure as the spectrum licensees directly above 3475 MHz. Alternatively, the guard band can be relaxed if there is agreement with the directly adjacent spectrum licensees to do so.

## Restricted cell scenario discussion

ACMA staff provided a possible restricted cell model to the TLG. A summary of the TLG consideration and details of this proposal are provided in the *Proposed restricted cell interference management criteria* section of this paper.

Details on how the proposed PFD limits and guard bands were determined are for this model are outlined below.

### PFD limit development

This section provides detail on how ACMA staff developed the notional PFD limits for the restricted cell scenario.

Draft PFD limit at urban excise boundaries

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Parameter** | **Value** | **Reference** |
| **A** | CPE antenna gain | 20 dBi | Antenna gain for nbn B42 CPE |
| **B** | Effective antenna aperture | -14 dB(m2) | Equation 2, for frequency of 3400 MHz |
| **C** | CPE noise figure | 7 dB | Representative noise figure |
| **D** | Thermal noise | -114 dBm/MHz | = kTB, assuming T = 293 K |
| **E** | I/N | -5 dB | Provided by nbn |
| **F** | Max. interference | -112 dBm/MHz | =C+D+E |
| **G** | PFD limit | -99.9 dBm/(m2.MHz) | Equation 1, assumes non-AAS |

Draft PFD limit at controlled premise boundary

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Parameter** | **Value** | **Reference** |
| **A** | MS antenna gain | -4 dBi | Recommendation ITU-R M.2292 |
| **B** | Effective antenna aperture | -36.1 dB(m2) | Equation 2, for frequency of 3400 MHz |
| **C** | Body loss | 4 dB | Recommendation ITU-R M.2292 |
| **D** | MS noise figure | 9 dB | Recommendation ITU-R M.2292 |
| **E** | Thermal noise | -114 dBm/MHz | = kTB, assuming T = 293 K |
| **F** | I/N | 0 dB | Actual level seen would be lower further away from boundary |
| **G** | Max. interference | -101 dBm/MHz | =C+D+E+F |
| **H** | PFD limit | -64.9 dBm/(m2.MHz) | Equation 1, assumes non-AAS |

The equation for power flux density is:

**equation 1**

Where:

: Power flux density (W/m2)

: Received power (W)

: Effective antenna aperture (m2)

The equation for effective antenna aperture is:

**equation 2**

Where:

: Gain of the receiving antenna

: wavelength (m)

### Guard band development

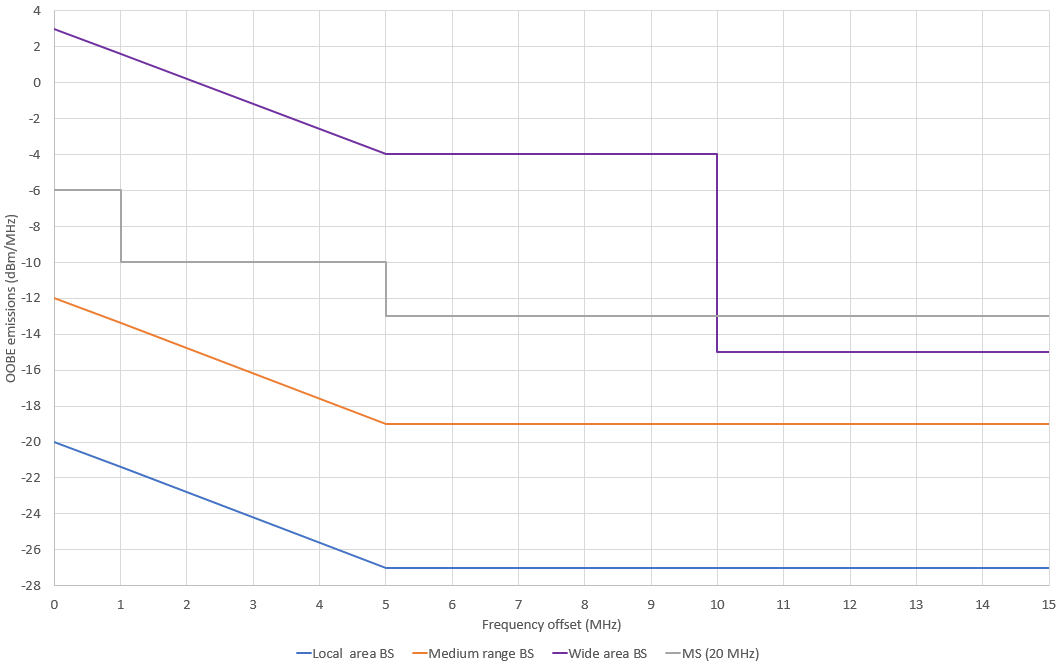
This section provides ACMA staffs initial high-level thinking on a possible guard band between restricted cell use of urban excise areas and services deployed under adjacent band spectrum licences.

A guard band below the 3475 MHz frequency boundary would assist in minimising interference from uncoordinated restricted cell deployments in the 3400–3475 MHz band into adjacent band 5G services operating under 3.4 GHz spectrum licences. Advice from some TLG members is that a guard band of 15 MHz is sufficient to manage interference between unsynchronised 4G and 5G adjacent band wide area (Tx power > 38 dBm) BSs. A smaller guard band may be possible in the case of lower powered local area (Tx power ≤ 24 dBm) and medium range   
(Tx power ≤ 31 dBm) BSs.

Figure 2 compares the unwanted emission limits for the different classes of BS as well as an MS. Local area and medium range BS have lower emissions than wide area BS at less than a few MHz from their operating channel edge. Given 4G and 5G operation is most efficient in BWs that are an integer multiple of 5 MHz, a 5 MHz guard band (along with EIRP restrictions) may be sufficient to manage interference in this case.

This approach has not yet considered ACS performance of adjacent band services.

1. 3GPP OOBE limits



1. A macro-cell is considered to refer to a base station within a mobile network that provides radio coverage to user terminals over a large area. They are typically characterised by transmitters with high-power and high-gain antennas with antennas mounted on ground-based masts, roof tops and other existing structures to support wide-area coverage. [↑](#footnote-ref-2)
2. A restricted cell is considered to be a base station that has some form of restriction on its operation that limits or reduces the size of the radio coverage to user terminals. It encompasses terms such as micro cells, small cells, femtocells, etc. [↑](#footnote-ref-3)
3. The TLG did not define a percentage of locations to apply this limit. [↑](#footnote-ref-4)
4. Section 10.7.2 of [3GPP TS 38.104](https://www.3gpp.org/DynaReport/38104.htm). [↑](#footnote-ref-5)
5. For the purposes of the TLG, CPEs are defined as fixed, high gain user terminals, typically wall or roof mounted on homes or businesses. They are used to deliver services associated with the NBN. [↑](#footnote-ref-6)
6. For the purposes of the TLG, MS are not considered to operate under nbn licences. [↑](#footnote-ref-7)
7. Refer to Table 4.2.2 of [3GPP TS 36.211](https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2425) for a description of special subframes. [↑](#footnote-ref-8)
8. nbn provided the TLG with kmls and shapefiles of the service areas as of December 2020. [↑](#footnote-ref-9)
9. The issue of managing interference between adjacent channel 4G and 5G systems when they are using different frame structures is considered in the *Adjacent channel 4G and 5G systems* section. [↑](#footnote-ref-10)