# Technical Framework Development

# 1800 MHz Spectrum Licence Band

**TLG-Discussion Paper No. 3**

**Design Requirements for the Technical Framework**

**Radiocommunications Advisory Guidelines**

Document Release Information

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| Version | Date Released | Remarks |
| 1 | 7/10/2011 | Initial Release |
| 2 | 23/01/2012 | * Increased notional antenna gain; * Addition of information to assist with coordination with Met-Sat stations; * Amended antenna heights for which receivers are to be afforded protection; * Included additional advice regarding coordination to and from GSM-R services. |

## 1. Background

This discussion paper outlines changes to the Radiocommunications Advisory Guidelines (RAGs) that provide planning guidance to spectrum licensees with respect to coordination with other apparatus and class licensed services. These RAGs are made under Part 5.3 of the Radiocommunications Act 1992(the Act). Specifically, sub-section (1) of section 262 authorises the ACMA to make written advisory guidelines about any aspect of radiocommunication or radio emissions. These guidelines are not mandatory requirements and the ACMA may consider alternative interference management arrangements.

The use of the RAGs provides flexibility for licensees to make arrangements to manage the risk of interference between services. In the case that licensees are unable to resolve interference issues they can expect the ACMA to have regard to the guidelines in dealing with any such dispute.

It should be noted that spectrum licensees are required to manage interference between devices operated under their own licences. This includes devices operated under third party authorisations.

## 2. Spectrum Licence Arrangements

There are three section 262 guidelines written specifically for the 1800 MHz spectrum licensed band. These are:

* *Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed and Class-licensed Receivers – 1800 MHz Band) 1999* – which details the protection requirements for adjacent band and area apparatus and class licensed services from spectrum licensed transmitters. Because the whole of Australia has not been designated for spectrum licensing in the 1800 MHz band this advisory guideline includes both in-band and out-of-band protection requirements;[[1]](#footnote-1)
* *Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed and Class-licensed Transmitters – 1800 MHz Band) 1999* – which deals with the protection of registered 1800 MHz band spectrum licensed receivers from in band and adjacent band apparatus and class licensed transmitters;[[2]](#footnote-2)
* *Radiocommunications Advisory Guidelines (Protection of Mobile Base Receivers – 1800 MHz Lower Band) 1999* – details the protection requirements for high sited spectrum licensed receivers operating in the lower band in areas of high mobile use.[[3]](#footnote-3)

There is also one section 262 guideline that applies to all spectrum licensed bands known as the *Radiocommunications Advisory Guidelines (Registration of Devices under Spectrum Licences without an Interference Impact Certificate) 1998*.[[4]](#footnote-4) It should be noted that the ACMA intended to revoke this RAG and replace it with a new RAG which aligns with current registration processes and requirements. For more information see the *Reference paper – Guard Space or Agreement,* available on the TLG SharePoint site.

Changes to services and associated protection requirements in and adjacent to the 1800 MHz band have given rise to the necessity to make amendments to the RAGs for the band. The new guidelines will be based on the existing advisory guidelines and will incorporate the proposed changes as detailed in this discussion paper.

In this discussion paper the views and suggestions of the members of the Technical Liaison Group (TLG) are sought on the suitability of the proposed requirements. Table 1 provides a high level overview of the proposed changes in this paper.

Table 1 – Overview of the Proposed Changes in this Discussion Paper

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| **Technical framework component** | **Item** | **Proposed change** |
| Protection of adjacent apparatus and class licensed services | Point-to-point fixed services | Updated coexistence requirements due to implementation date of the updated framework. |
| Meteorological-satellite service (space-to-Earth) | Update references to ITU-R Recommendations to the current versions. |
| Class licensed Cordless Communications Devices | Update to reflect proposed EIRP increase in the 1877.5-1880 MHz segment as described in the second discussion paper. |
| Radio astronomy service | Introduction of notification procedures as detailed in RALI MS-31. |
| Public Telecommunication Services (PTS) | Introduction of coexistence arrangements for future proposed apparatus licensed PTS operating in regional and remote areas as well as on board aircraft. |
| Managing out-of-band interference to registered spectrum licensed receivers | Protection of registered spectrum licensed receivers | * Specify that both apparatus and registered spectrum licensed fixed transmitters must afford out-of-band protection to registered spectrum licensed receivers on a first-in-time basis. * Out-of-band protection is to be extended to high sited lower band spectrum licensed receivers operating outside areas of high mobile use. |
| Compatibility requirement | Maintain the current maximum unwanted level at the receiver of never more than -123.5 dBm/30kHz for more than 1% of the time in any one hour period. |
| Notional receiver structure | * Clarify that the ACS, receiver intermodulation rejection, receiver blocking and spurious response immunity is specified at the input to the receiver. * The RF selectivity formula is unchanged; however, its location in the notional receiver structure has been clarified. * The antenna gain and feeder loss recorded in the RRL is to be used for coordination. If either of these is unavailable then the default values of 18 dBi gain and 2 dB losses are to be used. |
| ACS | Modify requirement to suit new technologies. |
| Receiver intermodulation rejection | Modify requirement to suit new technologies. |
| Receiver blocking | Modify requirement to suit new technologies. |
| Spurious response immunity | Unchanged. |
| Protection of high sited receivers in the lower band | Additional DBC methodology | * Increasing the number of radials to 360. * Specifying the maximum radial length of 200 km. * Requiring the additional DBC to be satisfied at the licence boundary. * The Level of Protection to be met at the licence boundary is -136.5 dBm/30kHz, which is based on the compatibility requirement of -139.5 dBm/30kHz for a notional receiver located 3 km from the licence boundary. |
| Application of the additional DBC | The additional DBC is required to be satisfied at:   * the geographical boundary of the spectrum licence under which the high sited lower band transmitter operates, including boundaries between spectrum and apparatus licence areas; * at the geographical boundary of any 1800 MHz band spectrum licence by any apparatus licensed transmitter. |

## 3. Services in and adjacent to the 1800 MHz Spectrum Licence Band

Figure 1 provides an overview of spectrum usage in the vicinity of the 1800 MHz spectrum licensed band. Apparatus and other spectrum licensed services have station details recorded in the Register of Radiocommunications Licences (RRL).[[5]](#footnote-5)

Apparatus and class licensed services within and adjacent to the 1800 MHz spectrum licence band include:

* Apparatus licensed point-to-point Fixed Services in the band 1700-1920MHz
* Apparatus licensed Meteorological-satellite service (space-to-Earth) receivers in the band 1670-1710 MHz
* Class licensed Cordless Communications Devices[[6]](#footnote-6) (CCD) in the band 1880-1900 MHz
* Radio astronomy services[[7]](#footnote-7) in the band 1250-1780 MHz
* Apparatus licensed Public Telecommunication Services (PTS) at specific frequencies in the band 1710-1785 / 1805-1880 MHz.

**1800 MHz Spectrum Licence BAND AND RELATED BAND ARRANGEMENTS**

October 2011

1700 1750 1800 1850 1900

1710

1805

Radio Astronomy (AUS87)

1780

Point-to-point Fixed Service

(remote only)

(regional and remote)

(remote only)

PTS

PTS

PTS

PTS

(regional and remote)

1820

Regional areas

1880

(space-to-Earth)

Meteorological-satellite service

1785

Cordless Communications Devices (CCD)

CCD

1800 MHz spectrum licence band

1725

Regional areas

Capital city areas

Capital city areas

## 4. Managing Interference caused to Receivers Operated under Apparatus and Class Licences

Information for spectrum licensees on managing interference to receivers operated under apparatus and class licences is contained in the section 262 RAG titled *Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed and Class-licensed Receivers – 1800 MHz band) 1999* (RAG SL-Tx).[[8]](#footnote-8)

The power level of transmitters that can be operated under the 1800 MHz spectrum licence technical framework may be sufficient to cause interference to apparatus and class licensed receivers operating in adjacent spectrum. The principle interference mechanisms are:

Blocking – The in-band emission level of the transmitter at the victim receiver exceeds the blocking ability of the victim receiver;

Out-of-band – Emissions of the transmitter outside the band of the licence are sufficiently high to cause co-channel interference to victim receiver; and

Intermodulation – Mixing of high level in-band emissions gives rise to an out-of-band product within the victim receiver bandwidth.

The impact of these interference mechanisms is typically caused by the proximity of the spectrum licence transmitter to an apparatus or class licensed receiver and the distance to its wanted signal transmitter.

As the 1800 MHz band has not been designated for spectrum licensing Australia wide there is also the potential for in-band interference to adjacent area services from 1800 MHz band spectrum licensed transmitters.

During planning for new transmitters, spectrum licensees must pay attention to the interference risks associated with these mechanisms both to their own systems and to receivers operated under all licence types.

### 4.1 Point-to-point Fixed Services

Apparatus licensed point-to-point services have allocations within the 1800 MHz band (typically in the range 1700-1920MHz) in accordance to the channel arrangements in Appendix 1 of RALI FX-3.[[9]](#footnote-9) The current framework details the sharing arrangements between spectrum licensed transmitters and apparatus licensed point-to-point receivers which can be located in regional and remote areas. This means that there are both in-band and out-of-band interference scenarios to consider.

The current RAG SL-Tx grouped point-to-point services into three categories each with different coordination requirements, depending on when their licence was first issued. Given the proposed changes to the technical framework and the resulting variation to interference potential, point-to-point services are divided into new categories.

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| The proposed categories for apparatus licensed point-to-point fixed services are:   * Category 1 – receivers whose apparatus licence was issued before the date that the updated technical framework is in place. * Category 2 – receivers whose apparatus licence was issued after the date that the updated technical framework is in place. |

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| The proposed protection requirements for point-to-point fixed services are detailed below. Application of the below requirement is on a first in time basis.  Category 1 receivers are to be provided with continuing out-of-band and in-band protection from interference according to RALI FX-3 of the full period of the spectrum licence.  Category 2 receivers -   * are to be provided with out-of-band protection from interference according to RALI FX-3 when they are registered first-in-time; * are required to accept levels of in-band emissions from spectrum licensed transmitters that are operated in accordance with the core conditions and the section 145 Determination of the updated technical framework. |

### 4.2 Meteorological-satellite service (space-to-Earth)

Meteorological-satellite service (Met-Sat) systems operate in the band 1670-1710 MHz, and are frequency adjacent to the 1800 MHz spectrum licence band. Met-Sat Earth stations use this band for the reception of data to assist in meteorological forecasting and other scientific purposes. The service uses both geostationary (GSO) and non geostationary (NGSO) satellite transmitters. The band 1698-1710 MHz is typically utilised for NGSO purposes, with GSO operating below 1698 MHz.[[10]](#footnote-10)

Out-of-band emissions from both fixed and mobile transmitters operated under an 1800 MHz band spectrum licence have the potential to cause interference to Met-Sat receivers. The potential for interference is also likely to be increased for technologies that utilise wide band emissions. Spectrum licensees should be mindful that the protection requirements set out below apply to interference from all transmitters operated under their licence, including mobile transmitters.

Apparatus licensed Met-Sat Earth stations require continuing protection from spectrum licensed services in the 1800 MHz band. In addition to complying with the spectrum licence core conditions, spectrum licensees are to ensure protection of Met-Sat Earth stations to the levels specified in the ITU-R Recommendations:

* ITU-R Recommendation SA.1026-4: Aggregate interference criteria for space-to-Earth data transmission systems operating in the Earth exploration-satellite and meteorological-satellite services using satellites in low-Earth orbit; and
* ITU-R Recommendation SA.1160-2: Interference criteria for data dissemination and direct data readout systems in the earth exploration-satellite and meteorological-satellite services using satellites in the geostationary orbit.

The following references and points provide additional information regarding the calculation of appropriate coordination distances, propagation models, threshold coordination levels and Earth station receiver and antenna characteristics:

* ITU-R Recommendation SA.1027-4: Sharing criteria for space-to-Earth data transmission systems in the Earth exploration-satellite and meteorological-satellite services using satellites in low-Earth orbit;
* ITR-R Recommendation SA.1161-1: Sharing and coordination criteria for data dissemination and direct readout systems in the Earth exploration-satellite and meteorological-satellite services using satellites in geostationary orbit;
* ITU-R Recommendation SA.1158-3: Feasibility of frequency sharing in the 1670-1710 MHz band between the meteorological-satellite service (space-to-Earth) and the mobile-satellite service (Earth-to-space);
* The main source of interference will be from a mobile transmitter in the lower band caused by either in-band or out-of-band emissions. The probability of interference depends on not only physical proximity to an Earth station, but also network configuration and operation, such as the mobile station EIRP level which will depend on cell size and location of the mobile relative to the base station;
* Liaison is encouraged between the spectrum licensee and the Met-Sat station operator to determine additional details about specific sites which may assist in coordination. These details include:
  + Type of Met-Sat service (e.g. recoded data playback or direct data readout) and type of satellite orbit, GSO or NGSO;
  + Antenna azimuth and elevation, or minimum elevation angle;
  + Receiver RF and IF bandwidth and response (including additional filtering that may be installed);
  + Antenna height and gain (if not available in the RRL)
* In the event that a Met-Sat antenna radiation pattern is unavailable, ITU-R Recommendation S.465-6[[11]](#footnote-11) may be used for coordination. Although Met-Sat Earth stations are outside the frequency range of this recommendation the derived antenna patterns are still suitable.
* Coordination is on a first-in-time basis, therefore the operator of any new or relocated Met-Sat station will need to assess the interference potential from existing spectrum licensed services (both fixed and mobile);
* Local terrain and clutter can also be taken into account.

Additional information can also be found in Appendix 7 of the ITU-R Radio Regulations for the determination of the coordination area around an Earth station in the frequency bands between 100 MHz and 105 GHz.

Protection requirements are proposed to remain the same other than updating references to the ITU-R Recommendations to reflect updated versions and withdrawn recommendations. It is also proposed to include the additional information detailed about which may further assist in coordination.

### 4.3 Cordless Communications Devices (CCD)

Cordless Communications Devices (CCD) are authorised to operate in the band 1880-1900 MHz under the *Radiocommunications (Cordless Communications Devices) Class Licence 2001.[[12]](#footnote-12)* Technologies authorised to operate in the band 1880-1900 MHz under this class license are Digital Enhanced Cordless Telephone (DECT) and the Japanese Personal Handyphone Service (PHS).

As discussed in discussion paper 2, the current framework specifies a maximum EIRP limit of 24.5 dBm/30kHz in the 1877.5-1800 MHz segment of the band to provide protection to adjacent band DECT services. This is considered to be overly conservative and restricts the efficient use of spectrum. Increasing the maximum EIRP to 50 dBm/30kHz will maintain a balance between the coexistence with DECT services, utility of the 1800 MHz spectrum licensed band and utility of the 1900-1920 MHz segment of the 2 GHz spectrum licensed band. This maximum EIRP limit is proposed to be included in the update to the section 145 Determination as described in discussion paper 2.

Based on European and ACMA studies, this increase in the EIRP cap is expected to have a minimal impact to DECT services.[[13]](#footnote-13) This is because of the ability of DECT to relocate to another channel within its channel plan to avoid interference.

Class licensed CCD services will be required to accept in-band and out-of-band interference from spectrum licensed devices that comply with the licence core conditions and the section 145 Determination.

### 4.4 Radio Astronomy Service Receivers

Highly sensitive radio astronomy receivers are operated at a number of sites in Australia in spectrum identified for use by the Radio Astronomy Service (RAS) in the band 1250-1780 MHz. Footnote AUS 87 to the Australian Radiofrequency Spectrum Plan[[14]](#footnote-14) identifies the significant sites used for radio astronomy in Australia and spectrum that is used by the RAS at those sites on an opportunistic basis.

Due to the highly sensitive nature of Radio Astronomy recievers, licensees are requested to pay regard to radio-astronomy station receivers operating on frequencies in and adjacent to the 1800 MHz spectrum licensed band. The radio-astronomy facilities identified under Footnote AUS87 are shown in Table 2.

Table 2 – Locations of Recognised RAS Receiver Stations

|  |  |  |  |
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| **Observatory** | **Location** | **Latitude** | **Longitude** |
| Parkes Observatory | Parkes | 32° 59' 59.9" S | 148° 15' 44.4" E |
| Paul Wild Observatory Narrabri | Narrabri | 30° 18' 52.0" S | 149° 32' 56.3" E |
| Mopra Observatory Coonabarabran | Mopra | 31° 16' 4.5" S | 149° 5' 58.7" E |
| Mount Pleasant Observatory Hobart | Hobart | 42° 48' 12.9" S | 147° 26' 25.9" E |
| Ceduna Observatory | Ceduna | 31° 52' 08.8" S | 133° 48' 35.4" E |
| Canberra Deep Space Communication Complex Tidbinbilla | Tidbinbilla | 35° 23' 54.0" S | 148° 58' 40.0" E |

*Note: Coordinates in the above table are referenced in ADG66 Datum, however may be converted to GDA94 in the update to the Advisory Guideline.*

While these facilities operate on a fortuitous reception basis, the ACMA would encourage spectrum licensees to directly liaise with radio-astronomy station operators particularly during the system planning phases of new systems, to minimise the potential interference impact on these stations. RALI MS-31[[15]](#footnote-15) provides guidance on proposed procedures for notification to these facilities when deploying services and relevant contact details.

The frequency bands and radii listed in Table 3 are the recommended notification zones for each of the recognised observatory locations from Table 2.

Table 3 – Recommended Notification Zones Applicable to the 1800 MHz Band

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Band (MHz)** | **Notification Zones (km radius)** | | | | | |
| **Parkes** | **Narrabri** | **Mopra** | **Hobart** | **Ceduna** | **Tidbinbilla** |
| 1 250-1 780 | 200 | 250 | 150 | 100 | n/a | 120 |

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| It is proposed to include the above notification procedure for RAS receiver stations into the updated 1800 MHz band spectrum licence technical framework. |

### 4.5 Public Telecommunications Services (PTS)

The Public Telecommunications Services (PTS) is a service that consists of one or more stations that are operated for the provision of a Public Mobile Telecommunications Service (PMTS). Mobile stations that communicate with PTS land stations are authorised by the Radiocommunications (Cellular Mobile Telecommunications Devices) Class Licence 2002.

Two types of PTS licences are available in the 1800 MHz band:

* PMTS Class B – which authorises the use of terrestrial systems;
* PMTS Class C – which authorises the use of systems onboard aircraft.

A limited number of PMTS Class B systems have been authorised to operate in regional and remote areas. The ACMA is developing a new RALI (RALI MS-34) to facilitate further licensing of these systems. This RALI will be largely similar to the existing RALI MS-33 and provide details about channel plans and guidance on interference criteria and frequency coordination procedures.

For managing interference caused by transmitters operating under a spectrum licence, PTMS Class B receivers operating in the 1800 MHz band are divided into two types:

* ***PTS land station receivers –*** PTS land stations receivers operate in the 1710-1785 MHz band outside those areas designated for 1800 MHz spectrum licences.
* ***PTS mobile station receivers***- PTS mobile station receivers operate in the 1805-1880 MHz band outside those areas designated for 1800 MHz spectrum licences.

PMTS Class B land station receivers are required to accept levels of in-band interference from spectrum licensed transmitters that are operated in accordance with the section 145 Determination and the licence core conditions. In addition, PTS land station receivers are to be provided out-of-band protection in accordance with RALI MS-34 from new fixed spectrum licensed transmitters operating in the 1710-1785 MHz band with an effective height of greater than 10 metres (high sited transmitters).

PMTS Class B mobile station receivers are required to accept levels of in-band and out-of-band interference from spectrum licensed transmitters that are operated in accordance with the section 145 Determination and the licence core conditions.

PMTS Class C systems are authorised to operate under the following conditions:

* The licensee is not authorised to operate a station: (a) in the geographic areas; and (b) on the frequencies, where a spectrum licence is in force. In order to operate inside a spectrum licence space the operator must obtain third part authorisation from the licensee.
* The licensee must not operate a station below a height of 5000 metres above ground level, except in accordance with section 10 of the Radiocommunications Licence Conditions (PTS Licence) Determination 1997.
* Emissions from the Cellphone Radiofrequency Management Unit (CRFMU) shall not exceed the following power levels, measured in a 30kHz bandwidth, at any point outside of the aircraft:
  + -20.6 dBm within the frequency range 870 - 890 MHz,
  + -25 dBm within the frequency range 935 - 960 MHz,
  + -20 dBm within the frequency range 1805 - 1880 MHz,
  + -20 dBm within the frequency range 2110 - 2170 MHz.
* Emissions from the BTS shall not exceed a power level of -12 dBm, measured within a 30kHz bandwidth, at any point outside of the aircraft. Mobile stations connected to the BTS shall be controlled to operate at a power control level of 15 (nominal output power 0dBm), as specified for DCS1800 in part 4.1.1 of 3GPP TS 45.005.
* Out of band emission power levels of the CRFMU in a frequency band shall be attenuated, relative to the maximum power level of the CRFMU in the frequency band, by the corresponding minimum values:
  + 870 - 890 MHz operating range - A minimum attenuation of 6dB, 25dB and 45dB at offsets greater than 1.6 MHz, 5MHz and 40MHz respectively from the operating range;
  + 935 - 960 MHz operating range - A minimum attenuation of 6dB, 25dB and 45dB at offsets greater than 2 MHz, 6.25MHz and 50 MHz respectively from the operating range;
  + 1805 - 1880 MHz operating range - A minimum attenuation of 6dB, 25dB and 45dB at offsets greater than 6 MHz, 18.75MHz and 50MHz respectively from the operating range;
  + 2110 - 2170 MHz operating range - A minimum attenuation of 6dB, 25dB and 45dB at offsets greater than 4.8 MHz, 15MHz and 120 MHz respectively from the operating range.
* Only radiating cable type antennas shall be used with the BTS and CRFMU to transmit and receive signals to and from the onboard mobile devices. At a range of 2 meters, this antenna must have a coupling loss of at least 69dB within the frequency range 1805-1880 MHz, and at least 66dB within the frequency ranges 870-960 MHz and 2110-2170 MHz.
* Conditions specified in the *Radiocommunications Licence Conditions (PTS Licence) Determination 1997*

PMTS Class C licences will be offered the same protection from transmitters operating under a spectrum licence as they are afforded from other apparatus licensed services, as a result they will be required to accept levels of in-band and out-of-band interference from spectrum licensed transmitters that are operated in accordance with the section 145 Determination and the licence core conditions.

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| It is proposed to include the above protection requirements for PTS services in the updated 1800 MHz band spectrum licence technical framework. |

### 4.6 Interference from spectrum licensed transmitters operated on aircraft

As indicated in Section 4.5, the PMTS Class C licence authorises the operation of public telecommunications services onboard aircraft when outside spectrum licensed areas. When the aircraft enters a spectrum licence area the PMTS Class C licence is no longer valid and the devices must be either authorised directly under a spectrum licence, or through a third party authorisation with the spectrum licensee.

Conditions of any third party authorisations are developed between the concerned parties. If a spectrum licensee decides to issue a third party authorisation for the use of public telecommunication service devices onboard aircraft, it is advised that the authorisation, where possible, adopts the same technical conditions as the PMTS Class C licence.

It should be noted that this advice is intended to help make deployment of public telecommunications services on aircraft simpler through having consistent licence conditions and to effectively manage interference to other systems onboard the aircraft as well as ground based services. This advice by no means obligates a spectrum licensee to issue a third party authorisation. Similarly, if a spectrum licensee requires different technical conditions to be attached to a third party authorisation, the spectrum licensee is free to do so.

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| It is proposed to include the above advice in the updated 1800 MHz band spectrum licence technical framework. |

## 5. Managing Interference from Spectrum, Apparatus and Class Licensed Transmitters

Information for managing interference to registered spectrum licensed receivers from frequency adjacent spectrum, apparatus and class licensed services is contained in the section 262 RAG titled *Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed and Class-licensed Transmitters – 1800 MHz band) 1999* (RAG SL-Rx).[[16]](#footnote-16)

Only registered receivers operating under the spectrum licence are afforded protection. Protection from out-of-band interference is provided on a first in time basis for allocated primary services. That is, existing assigned or registered (primary service) transmitters will not be considered as causing interference to new receivers where the existing transmitters meet their licence requirements. Receivers are offered protection from in-band interference by the device boundary criteria and the out-of-band emissions core condition. If additional protection is required, it is the responsibility of licensees to design their network appropriately or negotiate agreements with relevant licensees.

To assist in the planning of new services and to avoid out-of-band interference to receivers registered under an 1800 MHz spectrum licence, the ACMA specifies a minimum notional receiver performance level and a compatibility requirement for spectrum licensed receivers. These criteria provide the basis upon which spectrum and apparatus licensed spectrum users will be able to manage interference between services, using good engineering practice.

Individual receivers operated under the spectrum licence that are mobile, portable, or unregistered will not be provided protection via these guidelines. This is because the lack of necessary registration details for such devices does not support the use of a practical coordination procedure for interference management. Spectrum licensees operating these receivers will need to employ other techniques to guard against interference caused by those emissions.

The ACMA does not intend to enforce minimum receiver performance levels. While receiver performance will not be a mandatory requirement, the technical framework provides a minimum notional receiver performance level. Other spectrum and apparatus licensees can coordinate against the notional receiver to determine if they will cause interference, on a first in time basis. The ACMA will also pay regard to the notional receiver in an interference dispute such that poor performing receiver will not be protected.

### 5.1 Protection of Registered Spectrum Licensed Receivers

The current framework requires only fixed apparatus licensed transmitters to provide protection to existing spectrum licensed receivers to the levels detailed in the RAG SL-Rx on a first in time basis. This means there is no protection requirement from out-of-band interference caused by a spectrum licensed transmitter. In order to make the framework more robust and account for the potential for high sited transmitters in the lower band, it is proposed that fixed spectrum licensed transmitters are also required to provide protection to spectrum licensed receivers on a first-in-time basis.

The current framework provides protection for specific registered spectrum licence receivers operating in areas of high mobile spectrum use (metropolitan areas), however, it does not provide protection to registered lower band spectrum licence receivers operating at high sites outside areas of high mobile spectrum use (in regional areas).

It is proposed to offer the same level of protection to registered spectrum licence receivers in all areas regardless of antenna height. This will ensure that all registered spectrum licence receivers operating in the lower band (1710-1785 MHz) (i.e. base receive) will be afforded protection on a first in time basis.

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| It is proposed that a registered fixed transmitter operating under an apparatus or spectrum licence must provide protection to the specified minimum notional receiver performance level and meet the compatibility requirement, to a fixed spectrum licensed receiver:  (a) which meets the minimum notional level of performance; and  (b) which is registered before  (i) the registration date for a spectrum licensed transmitter; or  (ii) the licence issue date for an apparatus licensed transmitter; and  (c) operating under a spectrum licence in the lower band, or  (d) operating under a spectrum licence in the upper band with an effective antenna height (for any increment 1, he1(φn)) less than 10 metres. |

### 5.2 Compatibility Requirement

The compatibility requirement has been specified in different spectrum licence technical frameworks as either the maximum acceptable unwanted signal or as the minimum wanted signal level at the registered receiver and a protection ratio. Given the range of technologies that could be used under the 1800 MHz framework and the potential range of wanted levels and associated protection ratios, it is proposed to specify a maximum unwanted signal level at the receiver as the compatibility requirement.

The current compatibility requirement is a minimum wanted level of -114.5 dBm/30kHz and a 9 dB wanted to unwanted ratio. This equates to a maximum unwanted level of -123.5 dBm/30kHz.

To simplify the framework and to account for IMT technologies that have different wanted levels and protection ratios, it is proposed to specify the compatibility requirement as only a maximum unwanted level at the receiver. It is also proposed to maintain the current maximum unwanted level of -123.5 dBm/30kHz.

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| The proposed compatibility requirement is a maximum unwanted signal level at the receiver of never more than -123.5 dBm/30kHz for more than 1% of the time in any one hour period. |

### 5.3 Notional Receiver Model

All receiver performance requirements are specified at the input to the receiver. Therefore when coordinating with a spectrum licensed receiver the adjacent licensee must also take into account the associated receiver infrastructure that may increase or decrease the interference signal. These items are shown in Figure 2 and include:

* Antenna gain
* Feeder loss
* Combiner loss
* External RF selectivity devices (such as filters or duplexers)

Figure 2 – Notional Receiver Model

External RF selectivity

Receiver

Feeder and combiner losses

Antenna gain

Adjacent channel selectivity, blocking, receiver intermodulation rejection and spurious response immunity requirements are measured at the input to the receiver

Including a requirement for external RF selectivity will allow higher interference levels entering the receive antenna that still meet the maximum interference levels at the input of the receiver. Consequently, this will provide more efficient use of spectrum by increasing the overall interference immunity performance of the spectrum licensed receiver.

The current technical framework specifies a notional RF selectivity curve between the antenna and the antenna connector of the equipment. It is proposed that this same selectivity curve will remain in the new framework; however, will be defined as the combination of any form of filtering that occurs between the receiver antenna and the input of the receiver. This will continue to allow efficient coordination with adjacent band services.

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| The proposed external RF selectivity between the antenna and the antenna connector of the receivers, offset from the licence frequency boundary is:   * 2 + 60 \* log10(1 + (2 \* Frequency offset / 10)1.8) dB for offsets less that 20.5 MHz; and * 70 dB for offsets greater than 20.5 MHz. |

As described in Figure 2 above, all receiver requirements are measured at the input of the receiver. Therefore the interference signal will be increased and decreased by the antenna gain and feeder losses respectively.

The current framework specifies a fixed notional receive antenna of 19 dBi in all directions and a fixed feeder loss of 4 dB. This fixed specification does not allow for efficient coordination when actual parameters vary from these fixed values.

It is proposed that the gain of the receive antenna and the feeder loss recorded in the RRL shall be used for coordination. If an antenna gain or feeder loss is not available in the RRL then the following notional values shall be used:

(a) antenna gain of 18 dBi;

(b) feeder loss of 2 dB.

### 5.4 Receiver Adjacent Channel Selectivity (ACS)

Receiver Adjacent Channel Selectivity (ACS) is a measure of the ability of a receiver to receive a wanted signal without exceeding a specified degradation in output quality due to the presence of an unwanted adjacent channel signal.

The current technical framework specifies ACS limits at offsets less than 1 MHz and blocking limits at offsets greater than 1 MHz from the licence band edge. As future technologies utilise wide band emissions, the frequency offsets applicable to ACS and blocking are greater than those in the current framework, which was developed for narrow band GSM services. Subsequently, the proposed ACS values are developed considering both GSM ACS and blocking requirements as well as the ACS specifications of the IMT technologies.

Table 4 shows the ACS specifications for the reference technologies sourced from:

* 3GPP TS 45.005;
* ITU-R Report M.2039;
* 3GPP TS 36.104; and
* CEPT Report 40.

Table 4 – ACS levels for the reference technologies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ACS** | **GSM** | **UMTS** | **LTE** | **WiMAX (FDD)** |
| 1st adjacent 5 MHz | - | 46 dB | 43.5 dB | 46 dB |
| 1st 200kHz channel | 18 dB | - | - | - |
| 2nd 200kHz channel | 50 dB | - | - | - |
| 3rd 200kHz channel | 58 dB | - | - | - |

Note: The minimum ACS value in TS 36.104 for LTE base station receivers is specified in the form of an unwanted signal level at a given offset from the wanted signal edge. This can be converted to the form of a wanted to unwanted signal ratio by reference to the wanted signal used for the measurement. E.g. the wanted level for a 5 MHz channel is -95.5 dBm and the unwanted level is -52 dBm, therefore the ACS expressed as a ratio of wanted to unwanted is: -52 dBm – -95.5 dBm = 43.5 dB.

From Table 4, LTE has the lowest ACS value over the adjacent 5 MHz. GSM being a narrowband technology has a lower ACS value of 18 dB in the first adjacent 200 kHz channel. This means that GSM has less isolation than IMT in the first 200 kHz and greater isolation at offsets greater than 200 kHz.

Given that ECC Report 82 and CEPT Report 40 recommend a 200 kHz guard band between GSM and IMT services, it is unnecessary to protect to the GSM requirement in the adjacent 200 kHz. Subsequently, it is proposed that the ACS be changed to 43.5 dB at offsets between 0 and 5 MHz based on the LTE specification.

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| The proposed ACS requirement offset from the upper and lower frequency limits of the spectrum licence is:   1. 43.5 dB with a frequency offset of less than 5 MHz. |

In addition to providing increased protection necessary for future IMT technologies, it is intended that the proposed ACS levels will also provide future GSM services adjacent channel and blocking protection to levels equal to or greater than the current framework.

### 5.5 Receiver Blocking

Receiver blocking is a measure of the ability of a receiver to receive the wanted signal in the presence of a high level unwanted signal on frequencies other than the adjacent channel. High levels of unwanted signal can change the operating point of the RF amplifier or mixer stages reducing receiver sensitivity effectively blocking the reception of low level wanted signals.

Table 5 shows the blocking interference signal levels for the reference technologies. The two blocking requirements are specified for different frequency ranges in line with technology standards:

* Within the band 1690 – 1805 MHz (values converted to a common reference bandwidth of 30kHz), and
* Outside the band 1690 – 1805 MHz.

Table 5 – Blocking Levels for the Reference Technologies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | GSM | UMTS | LTE | WiMAX (FDD) |
| Blocking – in the band 1690-1805 MHz (converted to a 30kHz bandwidth) | -35 dBm (CW) | -60 dBm /30kHz | -65 dBm /30kHz | -62 dBm /30kHz |
| Blocking - outside of the band 1690-1805 MHz (CW) | 0 dBm | -15 dBm | -15 dBm | -15 dBm |

The proposed blocking requirement is based on the specified levels in the applicable standards for the reference technologies. Given the varying protection requirements and channel bandwidths of the reference technologies the worst case values were used. The CW level for frequencies outside the band 1690-1805 MHz represents a total received unwanted signal level independent of the emission bandwidth.

The receiver blocking requirement is specified as an absolute level rather than a ratio so its relationship to equipment standards is clear, and is not reliant on other aspects such as the minimum wanted level or the receiver noise floor which vary across technologies.

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| The proposed minimum unwanted signal level to cause receiver blocking is:  (a) -65 dBm/30kHz at an offset greater than 5 MHz from the upper and lower frequency of the spectrum licence;  (b) a total received signal level of -15 dBm for frequencies outside the band 1690-1805 MHz. |

### 5.6 Receiver Intermodulation Rejection

Receiver intermodulation rejection is a measure of the ability of a receiver to receive the wanted signal without exceeding a specified degradation in output quality caused by the presence of two or more unwanted signals with a specific amplitude and frequency relationship to the wanted signal frequency. Receiver intermodulation rejection is a function of the receiver front end linearity and the radio frequency filter characteristic.

Technology standards state the power levels of the interfering signals and the offsets from the receivers tuned frequency. Frequency offsets are typically based on a multiple of the technology’s channel bandwidth, and therefore specific offsets for different technologies will vary. Table 6 shows the maximum interference signal for the reference technologies.

Table 6 – Maximum Tolerable Interference Levels for Intermodulation Rejection for the Reference Technologies

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | GSM | UMTS | LTE | WiMAX (FDD) | MC-CDMA |
| Maximum tolerable unwanted signal level (dBm/30kHz)[[17]](#footnote-17) | -57 dBm @ 700 & 1500kHz or equivalent offsets | -69 dBm @ 7.5 & 17.5 MHz offsets | -74 dBm starting @ offsets of 2.1 MHz | -70 dBm starting @ offsets of 7.5 & 17.5 MHz | -54 dBm @ 1.25 & 2.5 MHz or equivalent offsets |

The proposed ACS limits and new compatibility requirement will restrict any interference emissions at offsets less than 5 MHz to be less than -80 dBm/30kHz (based on the proposed compatibility requirement of -123.5 dBm/30kHz plus the ACS of 43.5dB). Therefore the proposed intermodulation immunity requirement can apply from offsets greater than 5 MHz and still provide adequate protection to narrow bandwidth channels.

It is proposed to reduce the intermodulation response rejection requirement level to match LTE as it is the least immune of the reference technologies. The minimum frequency offset should also be suitable for technologies which use narrow bandwidth channels that are susceptible to interferers at small offsets.[[18]](#footnote-18)

In order to account for differences in technologies, the intermodulation rejection requirement is defined as a maximum power level from an individual out-of-band signal when in the presence of another signal of equal or greater power level and with a frequency relationship that may result in a third order or higher intermodulation product on the operating frequency of the spectrum licensed receiver.

It is chosen to specify the receiver intermodulation rejection requirement as an absolute level rather than a ratio so its relationship to equipment standards is clear, and it is not reliant on other aspects such as the minimum wanted level or the receiver noise floor which vary across technologies.

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| The proposed receiver intermodulation rejection requirement is a minimum unwanted level of:   1. -74 dBm/30kHz for each unwanted signal at offsets of greater than 5 MHz from the upper and lower frequency limits of the spectrum licence. |

### 5.7 Receiver Spurious Response Immunity

Spurious response immunity is a measure of the ability of the receiver to discriminate between the wanted signal and an unwanted signal at any frequency, outside the frequency band of the licence, to which the receiver responds.

The current technical framework specifies a spurious response immunity of at least 65 dB. An independent spurious response immunity requirement for base station receivers is not included in the equipment standards for the reference technologies.[[19]](#footnote-19) Without a standardised minimum requirement it is difficult to determine an appropriate value given that it is dependent on the receiver architecture that may vary for the different technologies. Therefore, it is proposed that this specification remains unchanged in the updated technical framework.

Whilst an independent spurious response immunity requirement may not be necessary for some technologies (such as IMT), this performance benchmark may still be required by other technologies that could potentially be deployed in the band. Retaining the spurious response immunity requirement in the updated framework will therefore provide a more technology flexible framework.

It is proposed that the receiver spurious response immunity requirement remains at 65 dB in the updated technical framework, and is specified as the ratio of the unwanted level to the level of the compatibility requirement.

### 5.8 Additional coordination to and from GSM-R services

As indicated in the second discussion paper, the update to the 1800 MHz band technical framework considers GSM-R services as well as technologies such as GSM, UMTS, and LTE used to provide Public Mobile Telecommunication Services (PMTS).

Although GSM-R is based on the standard GSM platform, its use and deployment configurations vary to some degree to that of a GSM PMTS network. These variations may include an increase in the minimum quality of service and reliability, as well as the introduction of vehicle mobile stations which may have an increased EIRP (up to 39 dBm/200kHz) and increased notional antenna height (4 metres).

These differences between GSM-R and PMTS may give rise to additional coexistence considerations when services are in close proximity. European studies detailed in ECC Reports 96, 146, and 162 and CEPT Report 41, detail coexistence between PMTS using GSM, UMTS, LTE and WiMAX with adjacent band GSM-R services. These studies are conducted at 900 MHz however it is expected that the results will similarly apply to 1800 MHz services.

The European studies indicate that in the majority of cases these services will be able to coexist if there is at least a 200 kHz guard band in place between PMTS and GSM-R. These studies also indicate that in some circumstances, typically when a GSM-R vehicle mobile station is operating near its sensitivity level, there have been reports of interference from nearby PMTS base stations. ECC Report 162 indicates that the majority of cases reported involve GSM base stations, while a limited number involve UMTS base stations.

These studies also indicate that high powered GSM-R vehicle mobile stations have the potential to cause desensitisation to IMT PMTS base stations receivers when in close proximity and operated at a high radiated power level. The probability of interference can increase if there is no GSM-R uplink power control implemented.

ECC Report 162 provides a range of potential coordination mechanisms which may be considered for adjacent band coexistence between GSM-R and PMTS services. These mechanisms are extensive and consider various circumstances and potential causes of interference, however they are not exhaustive.

It is recommended that all spectrum licensees, when planning and deploying their networks, are conscious of the coexistence issues that may arise due GSM-R services, typically GSM-R vehicle mobile stations, that may potentially operate in the band. It is also recommended that affected licensees seek to coordinate between themselves to help prevent and resolve interference that may arise to or from GSM-R mobile stations. Licensees should also be aware that:

* Coexistence between GSM-R networks and PMTS networks using GSM, UMTS, LTE and WiMAX technologies has been studied in ECC Reports 96, 146 and 162 and CEPT 41. These reports conclude that in general a 200 kHz guard band (channel edge to channel edge) is sufficient for coexistence. However, in some cases additional coordination may be needed;
* Some GSM-R operators may choose to implement a two GSM channel guard band (400 kHz) at the frequency boundary with another spectrum licensee, due to the non-spurious out-of-band emission core condition level in the first 200 kHz offset exceeding the LTE, UMTS and WiMAX levels in this range;
* Coordination with mobile stations may be difficult due their mobility; however GSM-R services will typically operate in close proximity to railway infrastructure;
* Potential interference paths are in both directions, i.e. to and from GSM-R vehicle mobile stations;
* ECC Report 162 has a range of coordination mechanisms that may be used to address coexistence between GSM-R and PMTS.

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| It is proposed that the above recommendations are placed in the updated 1800 MHz band spectrum licence technical framework. |

## 6. Protection of Base Station Receivers

The deployment constraints under the current and proposed technical framework allow transmitters outside areas of high mobile use (as defined in the section 145 determination) to operate at high sites (an effective antenna height greater than 10 metres) in the lower band. This creates a potential high site to high site interference path to base station receivers in the lower band (FDD receivers) from adjacent area spectrum licensed transmitters as well as apparatus licensed point-to-point Fixed services.

To manage this high site to high site interference path and provide protection to FDD base station receivers in areas of high mobile use, an additional DBC is contained in the section 262 RAG titled *Radiocommunications Advisory Guidelines (Protection of Mobile Base Receivers – 1800 MHz Lower Band) 1999* (RAG SL-DBC).[[20]](#footnote-20)

The additional DBC is applicable to both spectrum and apparatus licensed transmitters operating outside areas of high mobile use.

### 6.1 Current Additional DBC Methodology

The current device boundary is calculated according to the distance that is necessary to satisfy the additional DBC. This distance is measured along 144 radials (2.5º spacing) from the transmitter location to a maximum length of 150 minutes of arc. The additional DBC is required to be satisfied on each radial at the first specified elevation contour immediately after entering the designated area of high mobile use.[[21]](#footnote-21)

The DBC equation is:

HRP – Lb – CR ≤ 0;

Where:

HRP = Horizontal radiated power; and

Lb = Propagation loss, which is recommended to be calculated using the diffraction model in ITU-R Recommendation P.526; and

CR = Compatibility requirement for a notional receiver

The current compatibility requirement is -142.5 dBm/30kHz and is based on a GSM base station with the following parameters:

* receiver sensitivity = -114.5 dBm/30kHz
* antenna gain (including losses) = 15 dBi
* protection ratio = 13 dB
* receive antenna height = 30 metres.

### 6.2 Proposed Additional DBC Methodology

In order to improve the accuracy of the additional DBC, it is proposed to increase the number of radials to 360 (1º spacing). It is proposed to change the maximum radial length to 200 km which is consistent with the current coordination zone around spectrum licensed areas, as detailed in Appendix 7 of RALI FX-3. Specifying the maximum radial in kilometres rather than minutes also means that the actual length of each radial is consistent for varying latitudes.

A DBC based on an elevation contour may not provide adequate protection to FDD base receivers that have the potential to be located at elevations higher than 48 or 650 metres within the designated area. A large portion of some high mobile use areas have an elevation of greater than 48 or 650 metres and therefore FDD receivers in these areas are not protected from in-band interference.

The proposed new additional DBC follows the methodology of the standard DBC by specifying a set level of protection to be met at the geographic boundary of the spectrum licence under which the transmitter operates. The intention of this amendment is to provide greater protection to FDD receivers located over a larger portion of the licensed area.

The compatibility requirement used in the additional DBC should be amended to match that used in the notional receiver compatibility requirement. That is, the maximum interference level at the receiver should be -123.5 dBm/30kHz. Considering the proposed notional antenna gain of 18 dBi and feeder loss of 2 dB, the maximum interference level incident at the receiver antenna is -123.5 dBm – 18 dBi + 2 dB = 139.5 dBm/30 kHz.

The proposed compatibility requirement of the notional FDD base station receiver is a maximum interference level of -139.5 dBm/30kHz at the receive antenna.

As the proximity of a FDD base receiver to the boundary is limited by the DBC requirements for the related base transmitter specified in the section 145 determination, the compatibility requirement does not need to be met at the licence boundary. A Level of Protection (LOP) at the boundary can be determined based on the compatibility requirement and proximity of the notional receiver from the boundary.

Assuming the reference technology specifications and the proposed DBC in discussion paper 2, the closest a base station receiver will be to the licence boundary is 3 km.[[22]](#footnote-22) Therefore the compatibility requirement is only required to be met 3 km beyond the boundary.

Assuming the out-of-area EIRP limit of 54.5 dBm/30kHz and the proposed compatibility requirement of -139.5 dBm/30kHz, the required path loss is 194 dB (54.5 dBm - -139.5 dBm). Using the diffraction over a spherical Earth model from ITU-R Rec P.526, a frequency of 1710 MHz and antenna heights of 30 metres, a separation distance of approximately 85 km is required to satisfy a path loss of 194 dB. Given that the FDD base station receiver is assumed to be at least 3 km from the licence boundary, the high sited transmitter needs to be at least 82 km from the licence boundary to satisfy the 85 km transmitter to receiver separation distance. This is illustrated below in Figure 3.

Figure 3 – Deployment Model of a FDD Base Station Receiver and a High Sited Lower Band Transmitter

**Licence boundary**

82 km

3 km

**FDD Base station receiver**,

Height = 30m

LOP = -139.5 dBm/30kHz

**High sited - lower band transmitter** horizontal EIRP = 54.5 dBm/30kHz

Height = 30m

85 km

Considering the deployment model in Figure 3, and the spherical Earth propagation model, the path loss over 82 km is approximately 191 dB. Therefore the LOP at the licence boundary to be used in the additional DBC is -136.5 dBm/30kHz (54.5 dBm – 191 dB).

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| It is proposed to modify the additional DBC methodology by:   * increasing the number of radials to 360; * specifying the maximum radial length of 200 km; * requiring the additional DBC to be satisfied at the point where a radial intersects the licence boundary; * specifying the Level of Protection to be met at the licence boundary is -136.5 dBm/30kHz, which is based on the compatibility requirement of -139.5 dBm/30kHz for a notional receiver located 3 km from the licence boundary. |

### 6.3 Application of the Additional DBC

Under the current framework, the additional DBC is only used to provide protection to FDD base station receivers located in designated areas of high mobile use. Therefore FDD base stations receivers located in other spectrum licence areas are only provided in-band protection from apparatus licensed transmitters and spectrum licensed transmitters in adjacent regional areas[[23]](#footnote-23) in accordance with the DBC in the section 145 determination. This DBC is designed for high site to low site interference paths, and therefore does not adequately provide protection to high sited receivers. As a result, FDD receivers may be required to leave large buffer zones within their licensed area to ensure adequate in-band protection.

To support the growth of mobile networks in regional areas and to give priority to FDD services in these areas, it is proposed to apply the in-band protection of the additional DBC to all spectrum licensed areas.

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| It is proposed that new lower band apparatus licensed transmitters and high sited spectrum licensed transmitters (effective antenna height greater than 10 metres) in regional areas will be required to provide in-band protection to all 1800 MHz spectrum licensed areas in accordance with the additional DBC. The additional DBC is required to be satisfied at:   * the geographical boundary of the spectrum licence under which the high sited lower band transmitter operates, including boundaries between spectrum and apparatus licence areas; * at the geographical boundary of any 1800 MHz band spectrum licence for apparatus licensed transmitters. |

## 7. Comment Period

The comment period for the second release of the discussion paper closes 3rd of February 2012. Comments should be placed on the 1800 MHz Spectrum Licence TLG SharePoint site.

1. A copy can be found at: <http://www.comlaw.gov.au/Details/F2005C00559> [↑](#footnote-ref-1)
2. A copy can be found at: <http://www.comlaw.gov.au/Details/F2005B00393> [↑](#footnote-ref-2)
3. A copy can be found at: <http://www.comlaw.gov.au/Details/F2005B00394> [↑](#footnote-ref-3)
4. A copy can be found at: <http://www.comlaw.gov.au/Details/F2005B00435> [↑](#footnote-ref-4)
5. The RRL is available from the ACMA as a CD-ROM or can be accessed on-line via the ACMA website at: <http://web.acma.gov.au/pls/radcom/register_search.main_page> [↑](#footnote-ref-5)
6. These devices are also known as the Cordless Telecommunication Service (CTS) under the 1.9 GHz Band Plan, see <http://www.acma.gov.au/WEB/STANDARD/pc=PC_285> [↑](#footnote-ref-6)
7. Refer to footnote AUS87 of the *Australian Radiofrequency Spectrum Plan* [↑](#footnote-ref-7)
8. It should be noted that the title of this RAG may change in the updated technical framework. [↑](#footnote-ref-8)
9. A copy can be found at: <http://www.acma.gov.au/webwr/radcomm/frequency_planning/frequency_assignment/docs/fx3/1-8g.pdf> [↑](#footnote-ref-9)
10. See ITU-R Recommendation SA.1745. Use of the band 1668.4-1710 MHz by the meteorological aids service and meteorological-satellite service (space-to-Earth) [↑](#footnote-ref-10)
11. ITU-R Recommendation S.465-6: Reference radiation pattern for earth station antennas in the fixed-satellite service for the use in coordination and interference assessment in the frequency range 2 to 31 GHz. [↑](#footnote-ref-11)
12. A copy can be found at: <http://www.comlaw.gov.au/Details/F2008C00546> [↑](#footnote-ref-12)
13. See European studies: ECC Reports 96 and 146, CEPT Report 41, and the ACMA report *‘Interference impact analysis for DECT services from 1800 MHz and 2 GHz band spectrum licensed transmitters’.* [↑](#footnote-ref-13)
14. The Australian Radiofrequency Spectrum Plan is available at: <http://www.acma.gov.au/WEB/STANDARD/pc=PC_2713> [↑](#footnote-ref-14)
15. RALI MS31 Notification zones for apparatus licensed service around radio astronomy facilities; a copy is available at: <http://www.acma.gov.au/WEB/STANDARD/pc=PC_2708> [↑](#footnote-ref-15)
16. It should be noted that the title of this RAG may change in the updated technical framework. [↑](#footnote-ref-16)
17. Offsets for intermodulation performance refers to the unwanted signal centre frequency from the receiver channel edge [↑](#footnote-ref-17)
18. Technologies which operate channels with narrow bandwidths include GSM and LTE which can operate channels with bandwidths down to 1.4 MHz. [↑](#footnote-ref-18)
19. In some equipment standards, assessment of a receiver’s spurious response immunity may be incorporated into other receiver performance requirements, such a blocking performance. [↑](#footnote-ref-19)
20. It should be noted that the title of this RAG may change in the updated technical framework. [↑](#footnote-ref-20)
21. 650 metres elevation contour for the Canberra high mobile use area and 48 metres elevation contour for all other high mobile use areas. [↑](#footnote-ref-21)
22. Based on an IMT base station with an EIRP of 36 dBm/30kHz and an antenna height of 30 metres. [↑](#footnote-ref-22)
23. Areas outside the defined areas of high mobile use [↑](#footnote-ref-23)