# Technical Framework Development

## 1800 MHz Spectrum Licence Band

**TLG-Discussion Paper No. 2**

**Design Requirements for the Technical Framework**

**Determination of Unacceptable Interference / System Models / Propagation Models / Levels of Protection / Device Boundary Criterion**

Document Release Information

|  |  |  |
| --- | --- | --- |
| Version | Date Released | Remarks |
| 1 | 2/09/2011 | Initial Release |
| 2 | 20/11/2011 | Revised GSM-R vehicle parameters, increasing radiated level of registration exempt devices and removal of Scaling Parameter from DBC |
| 3 | 23/01/2012 | Proposal to remove Clause 7(9) from the Section 145 Determination of the updated technical framework |

## 1 Background

This discussion paper deals with the parts of the technical framework that appear in the Section 145 Determination of Unacceptable Interference. Section 145 of the *Radiocommunications Act 1992*, is located in Part 3.5 of *the Act.* This Part of *the Act* deals with the registration of radiocommunications licences, and the details that must be recorded in the register of radiocommunications licenses for the authorisation of the use of a radiocommunications transmitter.

Section 145 of *the Act* authorises the Australian Communications and Media Authority (ACMA) to refuse registration of a transmitter for operation under a spectrum licence if the ACMA is satisfied that the operation of the transmitter could cause unacceptable interference to the licensed operation of other radiocommunications devices. Subsection (4) of Section 145 provides that the ACMA may determine, by written instrument, what are unacceptable levels of interference for the purposes of refusing to register transmitters under a spectrum licence. The *Radiocommunications (Unacceptable Levels of Interference – 1800 MHz Band) Determination*, made under Section 145, is that written instrument for the 1800 MHz band.

The Section 145 Determination is used by the ACMA to set out device registration requirements. These typically include a requirement that the device boundary of a registered transmitter - calculated using a device boundary criterion - must lie within the geographic boundary of the licence.

The Section 145 Determination can also be used to reinforce arrangements that support the operation of low power mobile devices such as hand held devices or low power indoor fixed devices without registration[[1]](#footnote-1) by declaring them not to cause unacceptable interference. The Section 145 Determination is also used to set out arrangements for group registration of similar transmitters and receivers to reduce costs and records management requirements.

## 2 Introduction

This discussion paper looks in detail at the following items that are used to develop the Section 145 Determination;

* system models;
* propagation modelling;
* level of protection;
* device boundary criteria; and
* other device registration arrangements.

An outline of the reasoning leading to selection of the proposed models and requirements has been provided for information. Note that this paper deals primarily with co-channel or co-frequency issues.

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

Table 1 – overview of the proposed changes in this discussion paper

|  |  |
| --- | --- |
| **Item** | **Proposed change** |
| Propagation model used in the Device Boundary Criterion (DBC) | Proposed to change to the modified Hata – Urban model from ERC Report 68. |
| Level of Protection (LOP) | Proposed to reduce the LOP from -122 dBm/30kHz to -115 dBm/30kHz at the licence boundary. |
| DBC methodology | It is proposed to modify the DBC methodology with the aim of increasing accuracy and reliability, and the ease of implementation. The proposed changes include:   * Increase the number of radials from 144 to 360 * Reduce the increment step size along radials from 5 minutes of arc to 500m * Simplify the process of calculating the average terrain height at each increment step along radials |
| EIRP limit in the top 2.5 MHz segment of the band | Increase the EIRP limit from 24.5 dBm/30kHz to 50 dBm/30kHz to allow better use of this spectrum while still allowing for coexistence with of DECT services. |
| DBC exemption for transmitters with an effective height less than 20m | Proposal to remove Clause 7(9) from the Section 145 Determination of the updated technical framework. |
| Areas of high mobile use | Proposed to include Darwin and Hobart areas. Proposed Darwin area is the same as in Marketing Plan, while the Hobart area is a subset of the Tasmania area and includes the Hobart greater metro area. |
| Group registration provisions | It is proposed to remove the provision that allows transmitters within the limit of a town on the Towns Mobile list to be registered as a group. |
| Device registration exemptions | It is proposed that any:   * fixed transmitter with an EIRP of less than 33 dBm; or * mobile transmitter with an EIRP of less than 39 dBm;   within the occupied bandwidth of the transmitter is not required to be registered. |

## 3 System Models

System models are used to simplify the analysis of the technical framework with regard to the reference technologies. The system models are developed through consideration of the five reference technologies identified in the *1800 TLG Discussion Paper No.1*, these are shown below in Table 2 The development of the system models does not exclude the use of other technologies under the licence. The system models for the deployment are simply a tool for the development of the framework.

Table 2 – reference technologies

|  |  |
| --- | --- |
| **Reference Technology** | **Applicable standards and reports** |
| UMTS  (UTRA, WCDMA, HSPA, HSPA+) | ITU-R Report M.2039-2, 3GPP TS 25.101, 3GPP TS 25.104, 3GPP TS 24.942, ECC Report 82, ECC Report 96 |
| LTE  (E-UTRA, LTE-Advanced) | ITU-R Report M.2039-2, 3GPP TS 36.101, 3GPP TS 36.104, 3GPP TS 36.942, CEPT Report 40, CEPT Report 41 |
| GSM  (GPRS, EDGE, GSM-R) | 3GPP TS 45.005, 3GPP TS 51.021, 3GPP TR 03.30, EIRENE System Requirements Specification Version 15.1 |
| WiMAX  (IEEE 802.16) | ITU-R Report M.2039-2, CEPT Report 40, CEPT Report 41, WMF-T23-005-R015v04 |
| Multi-carrier CDMA  (CDMA2000, EV-DV, EV-DO, HRPD) | ITU-R Report M.2039-2, ITU-R Rec. M.1580, ITU-R Rec. M.1581, TIA-97-C |

The aim of the system model is to allow testing of the compatibility of the technical framework and the reference technologies in the band and to simplify testing of compatibility with other services outside the band.

Members of the Technical Liaison Group are asked to confirm that the proposed modelling values are suitable as many of the values presented are based on proposed values and there could have been developments in performance over time.

### 3.1 Current System Model

The current system model is based on a cellular GSM system in Frequency Division Duplex (FDD) mode. This consisted of a 30m omni directional base transmitter / receiver site communicating with a mobile omni antenna device at 1.5m. The deployment constraints of the framework are designed to support base transmit in the upper band (1805-1880 MHz) and base receive in the lower band (1710-1785 MHz).

FDD cellular systems of IMT/IMT-Advanced follow these same characteristics. The dominant interference mode for FDD systems is high site to low site because of the uplink and downlink frequency separation arrangements. The current system model is depicted in Figure 1 below.

Figure 1: Current System Model

**Licence boundary**

4.8 km

1.5 km

1.5 km

4.8 km

**GSM Base station**, horizontal EIRP = 58 dBm/250kHz

Height = 30m

**GSM mobile station**, Benchmark level of protection =

-113dBm/250kHz

Height = 1.5m

The current framework also allows high sited transmitters in the lower band outside areas of high mobile use.[[2]](#footnote-2) In effect this allows fixed point-to-point services or Time Division Duplexing (TDD) in these areas. Although this provides additional flexibility to the framework it also has the potential to cause high site to high site interference to FDD receivers across geographical boundaries. Additional provisions defined in a specific Advisory Guideline are provided in the framework to manage this interference, which will be discussed further in the third discussion paper.

### 3.2 Proposed system models

It is proposed to maintain the priority for FDD services in high mobile use areas, and to preserve the deployment flexibility in the framework by continuing to allow both FDD and TDD in regional areas. These issues are managed using deployment constraints and are discussed further in Section 7.

The system model parameters used to develop the new technical framework are described in Tables 3 – 6, and are based on the relevant standards and CEPT/ECC/ITU reports previously mentioned for each of the reference technologies.

Table 3 – base station transmitter parameters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Transmitter – Base Station** | **GSM** | **UMTS** | **LTE** | **WiMAX (FDD)** | **MC-CDMA** |
| Height above ground level | 30m | 30m | 30m | 30m | 30m |
| Transmitter power | 43 dBm /200kHz | 43 dBm /3.84MHz | 43 dBm /5MHz | 43 dBm /5MHz | 43 dBm /3.75MHz |
| Antenna Gain | 17 dBi | 17 dBi | 17 dBi | 17 dBi | 17 dBi |
| Losses | 2 dB | 2 dB | 2 dB | 2 dB | 2 dB |
| Antenna gain (includes loss) | 15 dBi | 15 dBi | 15 dBi | 15 dBi | 15 dBi |
| Max EIRP/channel BW | 58 dBm /200kHz | 58 dBm /3.84MHz | 58 dBm /5MHz | 58 dBm /5MHz | 58 dBm /3.75MHz |
| Hor. Rad. True Mean Power | 49.7 dBm / 30kHz | 37 dBm / 30kHz | 35.8 dBm / 30kHz | 35.8 dBm / 30kHz | 35 dBm / 30kHz |
| ACLR@ 5MHz | - | 45 dB | 45 dB | 45 dB | 49.3 dB |
| 10 MHz | - | 50 dB | 45 dB | 50 dB | 62.2 dB |

Table 4 – base station receiver parameters

| **Receiver – Base Station** | **GSM** | **UMTS** | **LTE** | **WiMAX (FDD)** | **MC-CDMA** |
| --- | --- | --- | --- | --- | --- |
| Antenna gain (includes loss) | 15 dBi | 15 dBi | 15 dBi | 15 dBi | 15 dBi |
| NF | 5 dB | 5 dB | 5 dB | 5 dB | 5 dB |
| Receiver noise floor | Rec. Sens.= -104 dBm / 200kHz | -103dBm / 3.84MHz | -102dBm / 4.5MHz | -102 dBm / 4.5MHz | -103dBm / 3.75MHz |
| Required I/N | C/I = 9 dB | -6 dB | -6 dB | -6 dB | -6 dB |
| Max Interferer. At the receiver | -113 dBm / 200kHz | -109 dBm / 3.84MHz | -108 dBm / 4.5MHz | -108dBm / 4.5MHz | -109dBm / 3.75MHz |
| Max Interferer. At the receiver | -121 dBm / 30kHz | -130 dBm / 30kHz | -130 dBm / 30kHz | -130 dBm / 30kHz | -130 dBm / 30kHz |
| Blocking in-band (/Rx BW) | -35 dBm (CW) | -40 dBm /3.84 MHz | -43 dBm /4.5 MHz | -40 dBm /4.5 MHz | - |
| Blocking out-of-band (CW) | 0 dBm | -15 dBm | -15 dBm | -15 dBm | - |
| ACS @ 5 MHz | - | 46 dB | 43.5 dB[[3]](#footnote-3) | 46 dB |  |
| 10 MHz | - | - | - | 56 dB |  |
| Maximum tolerable intermodulation interference level (dBm/30kHz)[[4]](#footnote-4) | -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 |

Table 5 – user terminal transmitter parameters

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Transmitter – User Terminal** | **GSM mobile / GSM-R vehicle** | **UMTS** | **LTE** | **WiMAX**  **(FDD)** | **MC-CDMA** |
| Height above ground level | 1.5m / 4m | 1.5m | 1.5m | 1.5m | 1.5m |
| Tx Power | 30 / 36 dBm/200kHz | 21 dBm /3.84MHz | 23 dBm /4.5MHz | 23dBm /4.5MHz | 24 dBm /3.75MHz |
| Antenna Gain | 0 / 6 dBi | 0 dBi | 0 dBi | 0 dBi | 0 dBi |
| Feeder loss | 0 / 3 dB | 0 dB | 0 dB | 0 dB | 0 dB |
| Max EIRP | 21.8 / 30.8 dBm/30kHz | 0 dBm /30kHz | 1.2 dBm /30kHz | 1.2dBm /30kHz | 3 dBm /30kHz |
| ACLR@ 5MHz | - | 33 dB | 30 dB | 30 dB | 33 dB |
| 10 MHz | - | 43 dB | 44 dB | 44 dB | 43 dB |

Table 6 – user terminal receiver parameters

| **Receiver – User Terminal** | **GSM**  **mobile / GSM-R vehicle** | **UMTS** | **LTE** | **WiMAX (FDD)** | **MC-CDMA** |
| --- | --- | --- | --- | --- | --- |
| Antenna gain (including losses) | 0 / 3 dBi | 0 dBi | 0 dBi | 0 dBi | 0 dBi |
| Receiver sensitivity | -108 / -110 dBm/30kHz | -135 dBm /30kHz | -119 dBm /30kHz | -120 dBm /30kHz | -140 dBm /30kHz[[5]](#footnote-5) |
| Interference degradation margin | 3 dB | 3 dB | 3 dB | 3 dB | 3 dB |
| Fade margin (75% of locations) | 6 dB | 6 dB | 6 dB | 6 dB | 6 dB |
| Body loss | 3 / 0 dB | 0 dB[[6]](#footnote-6) | 0 dB6 | 0 dB6 | 0 dB6 |
| Min. wanted level at receiver | -96 / -101 dBm/30kHz | -126 dBm/30kHz | -110 dBm/30kHz | -111 dBm/30kHz | -131 dBm/30kHz |
| Receiver noise floor (kTB + 9 dB noise figure) | -112 dBm/200kHz | -99 dBm/3.84 MHz | -98 dBm/4.5 MHz | -98 dBm/4.5 MHz | -99 dBm/3.75 MHz |
| Required I/N | C/I = 9 dB | -6 dB | -6 dB | -6 dB | -6 dB |
| Interference threshold at receive antenna | -105 / -113 dBm/30kHz | -126 dBm/30kHz | -126 dBm/30kHz | -126 dBm/30kHz | -126 dBm/30kHz |

## 4. Propagation Modelling

The propagation model chosen for the technical framework appears in the Section 145 Determination as part of the device boundary criterion. The propagation model selected for the technical framework needs to be:

* suitable for FDD systems (e.g. antenna height range);
* a generic model that does not require detailed information on terrain or land usage;
* not too complex and can be easily repeated with certainty; and
* suitable for use in the 1800 MHz band.

The propagation model does not need to be suitable for the detailed planning of services, and licensees are free to use any model for their own planning needs. The selected propagation model will be the basis of the device boundary criterion on which the ACMA may decide to reject the registration of a transmitter to be operated under the spectrum licence.

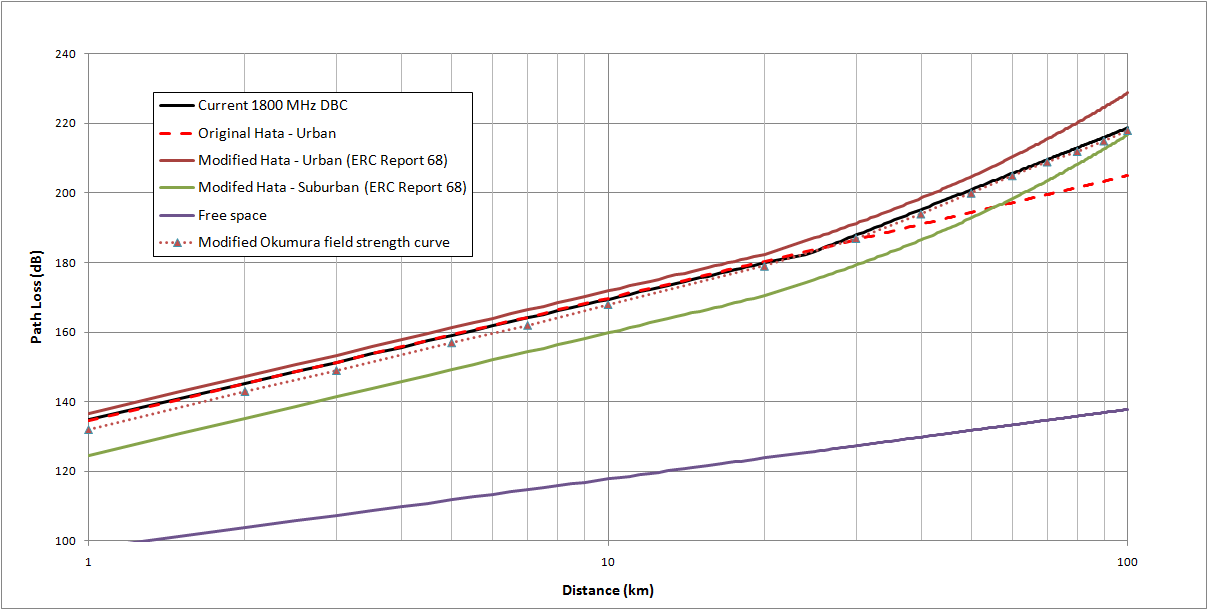
### 4.1 Propagation Modelling used in the Current DBC

Figure 2 provides a comparison of the current DBC propagation model with other recognised propagation models. The models all assume a frequency of 1840 MHz and antenna heights of 30m for base stations and 1.5 for mobile stations.

To make the comparison with the other propagation models the current 1800 MHz DBC has been converted to a path loss by subtracting the current Level of Protection (LOP) of -122 dBm/30kHz from the DBC formula. The Scaling Parameter has also been set to zero to model the interference level at the boundary.

For comparison purposes, Figure 2 also includes a modified Okumura field strength curve for an effective antenna height of 30 metres. This curve was taken from Figure 41(d) (for frequency of 1500 MHz) of the Okumura paper[[7]](#footnote-7) and converted to a received power level using the conversion formula in ITU-R Recommendation P.525. The path loss was determined assuming a transmitter ERP of 60 dBm (1 kW). The path loss was also modified for a frequency of 1840 MHz by adding 2.3 dB.[[8]](#footnote-8)

Figure 2 – Propagation Model Comparison



As shown in Figure 2, the current 1800 MHz band DBC matches the original Hata[[9]](#footnote-9) urban model for distances less than 20km. As the original Hata model is not applicable for greater distances, for distances greater than 20km, the formula used matches the original Okumura field strength curves.

### 4.2 Proposed Propagation Model

The proposed propagation model for the updated framework is based on the modified Hata - Urban model as detailed in ERC Report 68 (Feb 2000).[[10]](#footnote-10) This model is widely used by the International Telecommunication Union Radiocommunications sector (ITU-R) for high site-to-low site propagation modelling in various VHF and UHF sharing studies.

The Hata model is an empirical model (based on measurements) and provides a good measure of the effects of building clutter and antenna height effects in urban/suburban areas. While typically associated with mobile applications it is also applicable for fixed paths. The model is recommended for antenna height of 200 metres, and provides acceptable results for antenna heights of 500 metres.

## 5. Level of Protection (LOP)

The Level of Protection (LOP) is the benchmark protection level given to receivers from co-channel emissions from transmitters operating in adjacent geographic licence areas. This benchmark level is also necessary for the calculation of the device boundary criterion which is used to determine if a transmitter is likely to cause unacceptable interference prior to the ACMA registering a transmitter and therefore limits emissions over the geographic boundaries of the licence.

The LOP in the spectrum licence technical framework is typically based on factors including the receiver sensitivity, the system noise floors, protection ratios, margins and allowances. FDD system arrangements make the interference path a high site to low site or a low site to high site propagation path. This type of propagation path has higher losses compared to near free space high site to high site paths. This reduces the necessary separation distance from the interference source.

**The Protection This Level of Protection Does Not Provide**

It should be noted that this Level of Protection does not apply to emissions from devices operating in frequency adjacent spectrum licences in the same geographic area. Guidance and protection requirements to manage out-of-band interference are contained in the Section 262 Advisory Guidelines, and will be discussed further in discussion paper 3. It is also noted that spectrum licensees are also required to manage out-of-band interference that arises from devices being located within 200 metres of each other.

### 5.1 Current Level of Protection

The current LOP is based on the required protection for the technology or technologies expected to be used in the band. In the 1800 MHz band the current LOP is based on a mobile GSM receiver and is set at -122.2 dBm/30kHz (converted from -113 dBm/250 kHz). The current LOP is calculated as follows:

Table 7 – calculation of the current LOP value

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** |  |
| Receiver sensitivity (in a slow fade environment) | -98 dBm/250kHz | A |
| Interference degradation margin | 4 dB | B |
| Reliability Margin (75% of locations) | 8 dB | C |
| Antenna/body loss | 3 dB | D |
| Mobile station wanted level | -83 dBm/250kHz | E = A+B+C+D |
| Protection ratio (C/I) | 13 dB | F |
| Correction factor on the interference path (for 95% of the time) | 17 dB | G |
| LOP | -113 dBm/250kHz  (-122.2 dBm/30kHz) | E-F-G |

### 5.2 Proposed Level of Protection

The intention of the proposed LOP is to reduce transmitter deployment restrictions by allowing transmitters to be located closer to the licence boundary. This is achieved through identifying a compromise between the level of emissions over the boundary and the anticipated protection requirements of receivers.

The proposed LOP is specified at the licence boundary and is developed considering the interference requirements of the reference technologies, as well as the necessary separation distances to meet these requirements. It is intended that the proposed LOP at the boundary is sufficient to ensure that there is adequate separation between base stations and the boundary to manage co-existence of adjacent area services after considering all potential interference paths.

For FDD system the interference paths at the area boundary are between base stations and mobile stations. The necessary separation distance between area adjacent services can be determined after analysing each interference path and calculating the required minimum path loss. As this band is expected to be used by existing and future GSM technologies as well as IMT technologies, it is necessary to consider how these different technologies will co-exist across the geographical boundary.

Table 8 below details the required path loss and separation distance (using the modified Hata – Urban propagation model) for all interference paths across the licence boundary, and includes the notional EIRP and protection requirements for GSM and IMT technologies as detailed in Section 3.2.

Table 8 – Minimum coupling losses required for co-existence across the licence boundary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **GSM BS to IMT MS** | **IMT BS to GSM MS** | **GSM MS to IMT BS** | **IMT MS to GSM BS** |
| **EIRP dBm/30kHz** | 50 | 36 | 22 | 3 |
| **Max Int. (at Rx antenna ) dBm/30kHz** | -126 | -105 | -145 | -136 |
| **Required path loss (dB)** | 176 | 141 | 167 | 139 |
| **Separation distance (km)** | 13.5 | 1.3 | 7.5 | 1.2 |
|  | **GSM BS to GSM MS** | **GSM MS to GSM BS** | **IMT BS to IMT MS** | **IMT MS to IMT BS** |
| **EIRP dBm/30kHz** | 50 | 22 | 36 | 3 |
| **Max Int. (Rx antenna) dBm/30kHz** | -105 | -136 | -126 | -145 |
| **Required path loss (dB)** | 155 | 158 | 162 | 148 |
| **Separation distance (km)** | 3.5 | 4 | 5.5 | 2 |

As evident in Table 8, the scenario that requires the highest level of path loss isolation is for interference from a GSM base station to an IMT mobile station.

The interference threshold level assumed for IMT mobile stations in Table 8 is based on the receiver noise floor plus an Interference to Noise ratio (I/N) of -6 dB. [[11]](#footnote-11) This equates to approximately -126 dBm/30kHz.

A LOP based on the interference threshold of -126 dBm/30kHz will place additional constrains on licensees when coordinating with the DBC. That is, it will require transmitters to be located further from the licence boundary. Although not ideal for optimal performance, it is expected that IMT technologies will be able to tolerate an interference level greater than -126 dBm/30kHz and still maintain a service through the use of more robust modulation and coding schemes as well as reduced data-rates (or smaller cells) for affected mobile receivers at the cell edge. Therefore, to allow base stations to be located closer to the licence boundary, the proposed LOP is not based on this scenario (i.e. the interference path from GSM base station to IMT mobile station).

The scenario with the next highest path loss requirement in Table 8 is interference from a GSM mobile station to an IMT base station. This represents a critical scenario as base stations are a higher risk of interference because of their relative antenna height and fixed location. Therefore the LOP chosen at the boundary should be adequate to maintain a satisfactory separation between GSM mobile stations and LTE base stations, i.e. 7.5 km.

A deployment model for IMT and GSM technologies can be described as shown below in Figure 3 using the proposed propagation model and the GSM mobile station to IMT base station isolation requirement of 7.5km from Table 8. Figure 3 also includes an assumed 2 km cell radius for both technologies.[[12]](#footnote-12) To get the necessary base station separation from the boundary to satisfy the 7.5 km separation (GSM mobile to IMT base) as shown in Figure 3, the LOP of -115 dBm/30kHz at the licence boundary is required. That is, the proposed LOP of -115dBm/30kHz will require the IMT base station to be located 3 km from the boundary, and the GSM base station to be located 6.5 km from the boundary.

Figure 3 – system model for co-existence across the licence boundary

**Licence boundary**

**IMT mobile station**, EIRP = 3 dBm/30kHz

Height = 1.5m

4.5 km

2 km

2 km

1 km

**IMT Base station**, horizontal EIRP = 36 dBm/30kHz

Height = 30m

**GSM Base station**, horizontal EIRP = 50 dBm/30kHz

Height = 30m

**GSM mobile station**, EIRP = 22 dBm/30kHz

Height = 1.5m

7.5 km

Given the proposed level of protection of -115 dBm/30kHz at the boundary and the subsequent base station separation from the boundary as shown in Figure 3, Table 9 below shows the calculated interference level for each scenario presented in Table 8.

Table 9: maximum received interference level across the licence boundary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **GSM BS to IMT MS** | **IMT BS to GSM MS** | **GSM MS to IMT BS** | **IMT MS to GSM BS** |
| **EIRP dBm/30kHz** | 50 | 36 | 22 | 3 |
| **Separation distance (km)** | 7.5 | 7.5 | 7.5 | 7.5 |
| **Path loss (dB)** | 167.4 | 167.4 | 167.4 | 167.4 |
| **Interference level at Rx antenna dBm/30kHz** | -117.4 | -131.4 | -145.4 | -164.4 |
| **Max Int. (Rx antenna) dBm/30kHz** | -126 | -105 | -145 | -136 |
|  | **GSM BS to GSM MS** | **GSM MS to GSM BS** | **IMT BS to IMT MS** | **IMT MS to IMT BS** |
| **EIRP dBm/30kHz** | 50 | 22 | 36 | 3 |
| **Separation distance (km)** | 11 | 11 | 4 | 4 |
| **Path loss (dB)** | 173.2 | 173.2 | 157.7 | 157.7 |
| **Interference level at Rx antenna dBm/30kHz** | -123.2 | -151.2 | -121.7 | -154.7 |
| **Max Int. (Rx antenna) dBm/30kHz** | -105 | -136 | -126 | -145 |

### As evident in Table 9, all stations will receive an interference level less than the maximum tolerable level as described in Section 3.2 for the reference technologies, with the exception of IMT mobile stations.

In the worst case the IMT mobile station will receive an interference level of -117.4 dBm/30kHz from an adjacent GSM base station. Although this is greater than the interference threshold of -126 dBm/30kHz, it still equates to a carrier-to-interference ratio (C/I) of 7.4 dB, assuming the minimum wanted level of -110 dBm/30kHz for LTE.

The LOP of -115 dBm/30kHz at the boundary is intended to provide adequate base station separation from the boundary to enable co-existence between adjacent area services while not placing overly restrictive constraints on transmitter deployment. Protecting to the full interference threshold of -126 dBm/30kHz will result in greater transmitter separation from the boundary and more constraints on deployment. However, if greater protection is required for particular circumstances, licensees can decide to place services further from the boundary to gain the required extra protection.

The proposed Level of Protection (LOP) at the licence geographic boundary is -115 dBm/30kHz. Advice is sort from the TLG as the whether the proposed LOP provides a sufficient balance between deployment flexibility and receiver protection, considering the likely receiver locations and deployment configurations.

## 6. Device Boundary Criterion (DBC)

The device boundary of a transmitter, calculated using the Device Boundary Criterion (DBC), must lie within the geographic area of the licence otherwise the transmitter may be declared under the Section 145 Determination to cause unacceptable interference. The device boundary aims to minimise co-channel interference across the geographic boundary of the licence.

It does this by regulating the maximum radiated power level of transmitters located near the boundary of the licence. Alternatively it can be seen as a tool for calculating the necessary separation of transmitters from the boundary of the licence to prevent interference to receivers in the adjacent licence geographic area. The device boundary is drawn up by applying the device boundary criterion to the radio propagation paths along radials about the proposed transmitter site.

The device boundary criterion value is calculated at set distances outward along each radial. The position of the device boundary is located where the value of the device boundary criterion diminishes to zero or first becomes a negative value.

The device boundary criterion is the difference between the horizontally radiated power of the transmitter including the level of measurement uncertainty and the modelled propagation loss of the path combined with the level of protection given to receivers in the geographically adjacent licence area.

### 6.1 Current Boundary Criterion

The current DBC is based on the original Hata urban propagation model and Okumura field strength curves, as well as the Level of Protection (LOP) of -122 dBm/30kHz. The current DBC also has the Scaling Parameter set to 4.8, which means that the LOP is met at the point 4.8 km beyond the boundary and not at the boundary. This is because the current system model in Figure 1 assumes the GSM mobile station being located at least 4.8 km from the boundary.

As with all previous spectrum licence bands, the 1800 MHz band DBC requires calculation along radials from the transmitter location. In the 1800 MHz band there are 144 radial with 2.5º spacing with the first radial starting at 1.25º referenced from true north.

The area between each radial (sectors) is divided into 30 segments that are at 5 minute increments along the radial. An illustration of sectors and segments arrangements is shown below in Figure 4.

Figure 4 – Sectors and segments

segment

*(not to scale)* sector

sector/segment intersection area

for calculating hagm(φn)

The DBC calculation is made at 5 minute steps along each radial, up to a maximum of 30 steps. The DBC calculation also uses the average terrain height in each segment (hagm), which is calculated by averaging the terrain height of the RadDEM[[13]](#footnote-13) cells that have half or more of their area within the segment.

The current DBC also limits the effective antenna heights used in the calculation, where heights greater than 1600m and less than 1.5m are set at 1600m and 1.5m respectively.

### 6.2 Proposed Device Boundary Criterion Methodology

The proposed methodology aims to improve the accuracy, reliability and ease of implementing the device boundary. It also aims to provide a consistent methodology across all new spectrum licence bands and those that are due to expire.

The proposed new DBC methodology increases the number of radials to 360 (1º spacing), and decreases the step size along each radial, where the DBC calculation is made, to 500 metres. It is intended that this increase in resolution will increase the accuracy of the DBC by taking better account terrain elevations as well as facilitating deployment of devices closer to the boundary. The method in which the average terrain height at each increment is calculated is also proposed to change, with the aim of simplifying the process and removing ambiguity. Further detail of the proposed methodology can be found in the paper *Proposed Device Boundary Criterion Methodology.*

In order to simplify the DBC process it is proposed to reduce the maximum effective antenna height used in the calculation to 500 metres. In this way just one propagation model can be used in the DBC calculation. A review of existing registered devices in the 1800 MHz band indicates that 99.9% of existing sites have an effective antenna height of less than 500m on at least one radial at the point where the device boundary is satisfied.[[14]](#footnote-14)

Given the maximum effective antenna height of 500m, the propagation model as described in Section 4, and the proposed LOP as described in Section 5, the maximum radial length is approximately 40 km (rounded up from 39 km). Devices located greater than 40 km from the boundary will always pass the proposed DBC. Therefore services located greater than 40 km from a geographical boundary are deemed to comply with the DBC, and are taken not to cause unacceptable interference.

As previously indicated, the current DBC includes a Scaling Parameter of 4.8, which means that the LOP is met 4.8 km beyond the licence boundary, which is the closest GSM mobile receivers were assumed to be to the boundary. Given that the updated deployment model in Section 5.2 (Figure 3) assumes both GSM and IMT technologies which has mobile receivers located at different minimum distances from the licence boundary, setting the LOP to a fixed location beyond the boundary is not feasible. The proposed LOP of -115 dBm/30kHz is specified at the boundary and is intended to ensure that the appropriate protection of services either side of the licence boundary is met.

As the Scaling Parameter will by default be zero, it is proposed to remove it from the proposed DBC. Although a Scaling Parameter of zero could be included, it is considered that it is not a necessary component of the DBC and removing it does not affect how licensees can make agreements when required.

The proposed propagation loss component of the proposed DBC is shown below. The remaining components of the proposed DBC are included in the *TLG reference paper -* *Proposed Device Boundary Criterion Methodology.*

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| **Proposed device boundary criterion calculation (Schedule 2 Part 3)**  **Part 3 Calculation of Propagation Loss**   1. In calculating *PL(lr, Lr):*  |  |  |  | | --- | --- | --- | | *f* | : | assigned frequency of transmitter (megahertz) | | *hgr* | : | is the nominal receive antenna height above ground level being 1.5 metres | |  | : | is the transmit effective antenna height (metres) as defined in Schedule 3 | | *d(lmn, Lmn)* | : | is the distance in kilometres between the location of the transmitter, *(lt, Lt)*, and the mth increment on the nth radial *(lmn, Lmn).* |   if  < 1.5 metres, then  = 1.5 metres; or  if  > 500 metres then  = 500 metres.   1. The propagation loss for the mth increment on the nth radial is established as follows:   Step 1: Calculate the constants required      Step 2: Calculate the propagation loss for the mth increment on the nth radial |

### 6.3 Proposed New Digital Elevation Model (DEM)

As indicated in the first 1800 MHz band discussion paper, the ACMA is intends to transition from the Australian Geodetic Datum 1966 (AGD66) to the Geocentric Datum of Australia 1994 (GDA94).

This change in datum will also require the Digital Elevation Model (DEM) used in spectrum licensing to also be in GDA94. Currently effective antenna heights calculations are made using RadDEM, which is a 9 second DEM and is in the AGD66 format. It is intended to use a DEM already in GDA94 rather than convert RadDEM to GDA 94. The likely DEM to be used is published by Geoscience Australia and is called *GEODATA 9 Second Digital Elevation Model Version 3.* For more information refer to the *TLG reference paper – Adoption of GDA94 for spectrum licensing.*

### 6.4 Comparison of the Proposed and Current DBC

A comparison between the current and proposed DBC methodologies was undertaken to assess the impact of the proposed changes to the DBC methodology, including the proposed changes to the propagation model and the LOP.

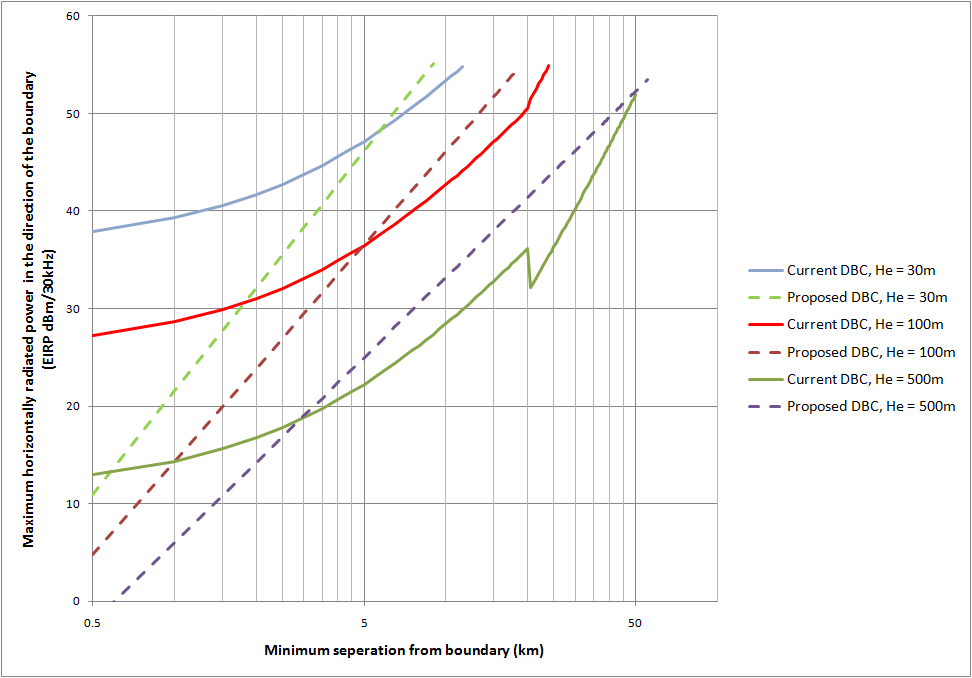
The plot in Figure 5 shows the EIRP from a transmitter versus the required separation distance from the licence boundary for different effective antenna heights for both the current and proposed DBC. This comparison shows that for low antenna heights the current DBC tends to be less restrictive, where as for larger heights, the proposed DBC tends to become more restrictive.

For low EIRP levels the current DBC will allow transmitters to be deployed closer to the licence boundary than the proposed DBC. This is particularly evident for low effective antenna heights such as 30m, where a 36dBm/30kHz LTE transmitter could be deployed at the boundary if it were not limited by the current 5 minute increment size. This is due to the Scaling Parameter being set to the default value of 4.8. This shows that a decrease in increment step size to 500m could not be feasibly implemented with the current DBC and a Scaling Parameter of 4.8.

A preliminary evaluation of the proposed DBC has been run against all existing device registrations in the band to evaluate the affect the proposed DBC will have on existing registrations. This evaluation found that the vast majority of registrations that had passed the current DBC will also pass the proposed DBC. It also found that for some registrations that failed the current DBC and thus were registered using guard space or agreement, will now pass using the proposed DBC.

TLG members are encouraged to evaluate the proposed DBC methodology to determine what affect it will have on existing and future devices.

Figure 5: Comparison of required separation distances between the current and proposed DBC



## 7. Other Device Registration Arrangements

The Section 145 Determination also includes other device registration arrangements that:

* provide for coexistence with adjacent band DECT services;
* declare the use of low power transmitters within the licence area as not causing unacceptable interference;
* provide the definition of a group of transmitters or receivers for the group registration;
* simplify the registration requirements for devices located well away from the geographic boundary (greater than 40 km as proposed in Section 6); and
* set out deployment constraints to encourage high site / low site frequency selection in areas of defined high mobile use.

### 7.1 Protection of adjacent band DECT services

Digital Enhanced Cordless Telephone (DECT) services operate in the band 1880-1900 MHz which is adjacent to the 1800 MHz spectrum licensed band. DECT services are class licensed and authorised under the Radiocommunications (Cordless Communications Devices) Class Licence 2001.[[15]](#footnote-15)

The current framework specifies an EIRP limit of 24.5 dBm/30kHz in the top 2.5 MHz[[16]](#footnote-16) segment of the band to provide for coexistence with adjacent band DECT services. This specification is contained in the current Section 145 Determination.

European studies ECC Reports 96[[17]](#footnote-17) and 146[[18]](#footnote-18) and CEPT Report 41[[19]](#footnote-19) conclude that no guard band is required between GSM, UMTS, LTE or WiMAX services at the boundary 1880 MHz to allow coexistence with DECT services. This is because of the ability of DECT to relocate to other frequencies away from the 1800 MHz boundary to avoid interference.

It is considered that the current EIRP limit of 24.5 dBm/30kHz in the top 2.5 MHz segment is overly conservative and restricts the efficient use of this spectrum. From the specifications of the reference technologies in Section 3, the maximum base station EIRP is 50 dBm/30kHz, based on a GSM station.

In addition to the above mentioned European studies, the ACMA has undertaken a study to assess the relationship between the EIRP in the top 2.5 MHz segment and the resulting effect on DECT services.[[20]](#footnote-20) Based on this study it is expected that an emission level of 50 dBm/30kHz in the top 2.5 MHz segment will have a minimal effect on DECT services. Therefore, increasing the EIRP cap to 50 dBm/30kHz will maintain an equitable balance between enabling efficient use of this segment by spectrum licensees while providing for coexistence with adjacent band DECT services.

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| It is proposed to increase the EIRP cap in the top 2.5 MHz segment (1877.5-1880 MHz) of the 1800 MHz band to 50 dBm/30kHz. |

### 7.2 Proposed registration exemption requirements

The current framework includes a provision that exempts mobile transmitters or fixed indoor transmitters with an EIRP of less than 24.5 dBm/30 kHz from registration. The current definition of an indoor fixed transmitter includes a requirement that it is located greater than 5 metres from an external surface.

It is proposed to change the framework so that types of devices such as femtocells[[21]](#footnote-21) and leaky-feeder systems are not required to be registered. This will be implemented through specifying that any device that has an EIRP level below a specified limit is exempt from registration. This exemption will include mobile transmitters, and low powered indoor and outdoor fixed transmitters which have a low interference risk.

There are two EIRP limits proposed considering the range of technologies and network types expected to be used in the band; one for fixed transmitters and another for mobile transmitters.

The proposed EIRP limit for fixed transmitters is 33 dBm within the occupied bandwidth of the transmitter. This limit is based on the current mobile and fixed indoor transmitter exemption limit of 24.5 dBm/30kHz converted to a 200 kHz bandwidth (i.e. 33 dBm/200kHz).

The proposed EIRP limit for mobile transmitters is 39 dBm within the occupied bandwidth of the transmitter. This level is based on a GSM-R vehicle mobile station which may have an EIRP of up to 39 dBm/200 kHz, based on a 36 dBm/200 kHz transmit power and a 3 dBi antenna gain (including feeder loss).

Any mobile transmitter with an EIRP exceeding 39 dBm/occupied bandwidth will be deemed to cause unacceptable interference under the updated Section 145 Determination. Any fixed transmitter with an EIRP exceeding 33 dBm/occupied bandwidth will be required to be registered in accordance with the provisions in the Section 145 Determination.

It should be noted that although low powered transmitters such as mobiles phones and femtocells are exempt from the device registration requirements, it is the licensee’s responsibility to ensure that all devices operated under their spectrum licence comply with the conditions of the licence.

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| It is proposed that any:   1. fixed transmitter with an EIRP of less than 33 dBm; or 2. mobile transmitter with an EIRP of less than 39 dBm;   within the occupied bandwidth of the transmitter is deemed not to cause unacceptable interference and is exempt from registration.  Advice is sort from the TLG as to whether the proposed EIRP limit will include all mobile transmitter types and technologies expected to be used in the band. |

### 7.3 Definition of groups of transmitters and receivers

Allowing group registrations from transmitters and receivers reduces the administrative burden for licensees with devices with similar characteristics. In providing the definition of groups of devices, consideration is necessary to ensure that any reduction in registration requirements does not significantly increase the risk of interference or future coordination difficulties.

After reviewing the band, it is proposed to remove the provisions for group registration of transmitters and receivers that are located within the limits of a town specified in the Towns Mobile List. It is considered that this current arrangement reduces the accuracy of the Register of Radiocommunication Licences (RRL) through not detailing the locations of individual devices that may be separated by kilometres. This may lead to coordination difficulties with adjacent services that rely on the RRL for coordination.

Arrangements for groups of transmitters located within 10 metres of the same central point will remain unchanged.

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| It is proposed to remove the provisions for group registration of transmitters and receivers that are located within the limits of a town specified in the Towns Mobile List. |

### 7.4 Proposed deployment constraints

To give priority to FDD systems in areas of high mobile use the current framework does not allow transmitters in the lower band at effective antenna heights above 10 metres. Outside these areas high sited transmitters are allowed in the lower band.

As indicated in the system model, it is proposed to maintain the current deployment constraints which provide a balance between protection of FDD in major population areas and deployment flexibility in regional areas.

Areas of high mobile use are designated in the Section 145 Determination and include all of the major capital city areas as well as a subset of the Canberra area (limited to cover the Canberra and Queanbeyan greater metropolitan areas).

It is proposed to maintain the existing areas as well as introducing additional areas to include Darwin and Hobart. This is intended to give priority to FDD in these areas to support the growth of mobile networks.

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| It is proposed to introduce two new areas of designated high mobile use, in which the deployment constraints will be based on FDD use. In these areas a transmitter in the lower band with an effective antenna height of greater than 10 metres in the 1st increment on each radial is taken to cause unacceptable interference. These proposed new areas are:   * Darwin high mobile use area – which is identical to the Darwin spectrum licence area as designated in the Marketing Plan; and * Hobart high mobile use area – which is a subset of the designated Tasmanian spectrum licence area that only includes the Hobart greater metropolitan area. This proposed area is described by connection the coordinates in Table 9 below.     Table 9: coordinates for the proposed Hobart high mobile use area (referenced in AGD66 Datum)   |  |  | | --- | --- | | **º ‘ “ East** | **º ‘ “ South** | | 147 05 00 | 42 40 00 | | 147 40 00 | 42 40 00 | | 147 40 00 | 43 05 00 | | 147 05 00 | 43 05 00 |   Note: The definition for high mobile use areas may be converted to GDA94 or replaced with hierarchal identifiers[[22]](#footnote-22) in the update to the Section 145 Determination. |

Clause 7(9) of the current Section 145 Determination states that the following transmitters are not deemed to cause unacceptable interference even if any part of their device boundary lies outside their licence area:

* Transmitters that have an effective antenna height of less than 20 metres; and
* Operate in the band:
  + 1805 – 1880 MHz in any locations; or
  + 1710 – 1785 MHz outside areas of high mobile use.

In effect, this provision exempts these transmitters from calculating a DBC and will allow low sited transmitters to be deployed in close proximity to a geographical boundary without any EIRP restriction. Although this provides increased deployment flexibility to the framework it also creates unwarranted potential co-frequency interference issues.

With changes to the registration exemption requirements (detailed in Section 7.2), this provision is considered unnecessary in the updated framework.

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| It is proposed to remove Clause 7(9) from the Section 145 Determination of the updated technical framework |

It is expected that the proposed changes to the registration exemption requirements described in Section 7.2 (which includes low EIRP outdoor stations which are typically deployed at low heights), will offset some of the reduced flexibility as a result of removing this provision.

## 8. Comment Period

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

1. The licence contains a statutory condition exempting mobile and fixed indoor devices from device registration requirements, see subsection 69 (2) of *the Act*. However while not mandatory, registration could be desirable in some circumstances and the section 145 Determination arrangements ensure that this is possible. [↑](#footnote-ref-1)
2. Areas of high mobile use are defined in Schedule 4 of the *Radiocommunications (Unacceptable Levels of Interference – 1800 MHz Band) Determination 1999* [↑](#footnote-ref-2)
3. Calculated using the adjacent interference level of -52 dBm and wanted level of -95.5 dBm from 3GPP 36.104, (-52 - -95.5 = 43.5 dB). This value is consistent with the value proposed in the third 1800 MHz band discussion paper. [↑](#footnote-ref-3)
4. Offsets for intermodulation performance refers to the unwanted signal centre frequency from the receiver channel edge [↑](#footnote-ref-4)
5. Assumes single 9600 bit/s traffic channel [↑](#footnote-ref-5)
6. Assumed non-hand held device, e.g. USB modem, which results in a larger cell radius which is used as a worst case in determining the impact of the proposed LOP in Section 5.2. [↑](#footnote-ref-6)
7. Y. Okumura, et al., “Field Strength and Its Variability in VHF and UHF Land-Mobile Radio Service,” *Rev. Elect. Commun. Lab., vol. 16, no. 9-10, Sept, -Oct. 1968.* [↑](#footnote-ref-7)
8. 2.3 dB is the difference between 1500 MHz and 1840 MHz using the frequency component of the original Hata model, i.e. 26.16log(1840) – 26.16log(1500) = 2.3. [↑](#footnote-ref-8)
9. Hata, Masaharu, “Empirical Formula for Propagation Loss in Land Mobile Radio Services,” *IEEE transaction on Vehicular Technology,* Vol, VT-29, No 3, pp. 317-325, August 1980. [↑](#footnote-ref-9)
10. “Monte-Carlo simulation methodology for the use in sharing and compatibility studies between different radio services or systems”, *Naples, February 2000, revised in Regensburg, May 2001 and Baden, June 2002.* [↑](#footnote-ref-10)
11. See ITU-R Report M.2039 – Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analysis. [↑](#footnote-ref-11)
12. The 2 km cell radius is calculated using the mobile minimum wanted levels from Section 3 and the modified Hata - Urban propagation model. For the IMT mobile station, the minimum wanted level for LTE is used as this is the highest of the IMT technologies. [↑](#footnote-ref-12)
13. RadDEM means the digital elevation model developed by the ACMA for radiocommunications purposed that contains modelled terrain height information for Australia in cells of a size of 9 seconds or arc. [↑](#footnote-ref-13)
14. This analysis was made using the proposed DBC and LOP. A site was counted as having an effective antenna height of greater than 500m if the effective height where the DBC was satisfied on at least one radial is greater than 500m. Therefore, it is expected that the total number of radials with an effective height greater than 500m where the DBC is satisfied would be significantly less than 0.1%. [↑](#footnote-ref-14)
15. A copy can be found at: <http://www.comlaw.gov.au/Details/F2008C00546> [↑](#footnote-ref-15)
16. 1877.5-1880 MHz [↑](#footnote-ref-16)
17. See: <http://www.erodocdb.dk/doks/filedownload.aspx?fileid=3324&fileurl=http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP096.PDF> [↑](#footnote-ref-17)
18. See: <http://www.erodocdb.dk/doks/filedownload.aspx?fileid=3658&fileurl=http://www.erodocdb.dk/Docs/doc98/official/pdf/ECCREP146.PDF> [↑](#footnote-ref-18)
19. See: <http://www.erodocdb.dk/doks/filedownload.aspx?fileid=3688&fileurl=http://www.erodocdb.dk/Docs/doc98/official/pdf/CEPTREP041.PDF> [↑](#footnote-ref-19)
20. See the report *‘Interference impact analysis for DECT services from 1800 MHz and 2 GHz band spectrum licensed transmitters’.* [↑](#footnote-ref-20)
21. A femtocell is a fixed low power base station typically connected to the network via the customers broadband internet connection [↑](#footnote-ref-21)
22. Refer to the *TLG Reference Paper – GDA94 Adoption* for a definition of hierarchical identifiers. [↑](#footnote-ref-22)