Technical Framework Development

2.5 GHz Spectrum Licence Band

TLG-Discussion Paper No. 3
Design Requirements for the Technical Framework
Radiocommunications Advisory Guidelines

Document Release Information

Version	Date Released	Remarks
1	26/10/11	Initial Release
2	5/12/11	Updated Section 5.2 Aeronautical Radionavigation Service and an update to Section 6 Spectrum Licensed ENG/TDD Receivers in the Band 2570-2620 MHz.
3	21/12/11	Final

1. Background

This discussion paper deals with the parts of the technical framework that provide planning guidance in respect to coordination with other services.

Typically spectrum licensees are provided planning guidance in respect to other services under Part 5.3 of the *Radiocommunications Act 1992, the Act*. 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 will consider suggested alternative interference management arrangements.

The use of these guideline arrangements provides flexibility for licensees to make arrangements to manage the risk of interference between services. Should however, licensees be unable to resolve interference issues they can expect that the ACMA to have regard to the guidelines in dealing with any such dispute.

Due to the unique protection requirements of radio astronomy facilities, the ACMA plans in addition to the guidelines to also include a condition in the licence to protect the Mid West Radio Quiet Zone.

2. Spectrum Licence Arrangements

As previously indicated planning guidelines for spectrum licences are normally issued under section 262 of *the Act*. Currently there are no section 262 guidelines written specifically for the 2.5 GHz spectrum licensed band. There is however, one set of section 262 guidelines that applies to all spectrum licences including the 2.5 GHz band and they are the:

- Radiocommunications Advisory Guidelines (Registration of Devices under Spectrum Licences without an Interference Impact Certificate) 1998.

A copy of this set of guidelines is available from the ComLaw website at:
http://www.comlaw.gov.au/ComLaw/Legislation/LegislativeInstrument1.nsf/all/search/34AFEAD4087AE188CA256F96007FCA83

It is proposed however to replace this set of guidelines as the review of existing spectrum licence arrangements has identified that alternative methods for registering devices no longer result in registrations without an Interference Impact Certificate. See the Technical Liaison Group SharePoint web page for further details.

3. Proposed New Section 262 Guidelines

The new section 262 guidelines to be developed for the 2.5 GHz band follow along the lines of those developed for other spectrum licensed bands. Typically a spectrum licence framework will contain two sets of section 262 guidelines specific to the band of operation.

The first is a set of guidelines dealing with management of interference to receivers operated under apparatus, other spectrum or class licences. Typically these receivers are operating in bands adjacent to the spectrum licence. The second deals with the management of interference caused by transmitters operated under apparatus, other spectrum or class licences to registered spectrum licence receivers in the band. The guidelines will therefore outline the inter-band coordination requirements relevant to the 2.5 spectrum licence band.

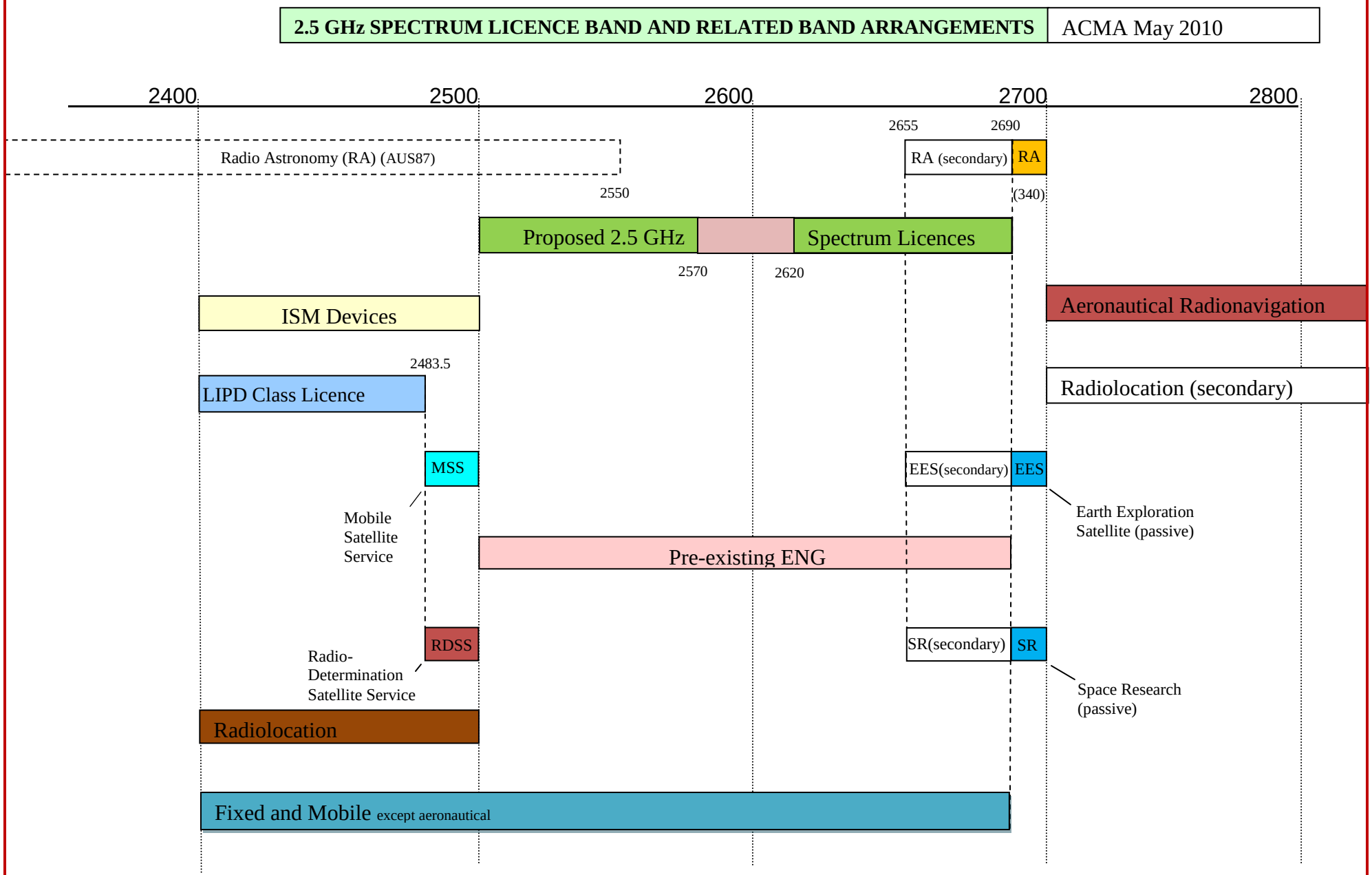
In the case where the Minister has not designated the whole of Australia for spectrum licensing or where class licence arrangements for ENG in regional and remote areas has been provided for, this set of section 262 guidelines will also include arrangements for co-frequency interference protection requirements between spectrum licensed stations and stations operating under apparatus or class licenses in adjacent areas.

4. Other Services in and around the 2.5GHz Spectrum Licence Band

The Australian Radiofrequency Spectrum Plan divides the Australian radiofrequency spectrum into a number of bands and specifies the allocation of services for which the bands may be used, a copy of which is available via the ACMA website at:
http://www.acma.gov.au/WEB/STANDARD/pc=PC_2713

Figure 1 on the following page provides an overview of spectrum usage in the vicinity of the 2.5 GHz spectrum licensed band. Apparatus and other spectrum licensed services have station details recorded in the Register of Radiocommunications Licences (RRL). 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

The Radiocommunications (Low Interference Potential Devices) Class Licence 2000, the LIPD Class Licence permits the operation of a number of different classes of transmitter in the band 2400-2483.5 MHz. This class licence covers a range of devices with ubiquitous distribution throughout the community but of typically limited interference potential. Because of the diversity and mobility of devices operated under the class licence, station details are not recorded in the RRL. More information regarding the characteristics of devices operated under the licence and a copy of the class licence is available at:
http://www.acma.gov.au/WEB/STANDARD/pc=PC_1612


2.5 GHz SPECTRUM LICENCE BAND AND RELATED BAND ARRANGEMENTS
ACMA May 2010
2400
2500
2600
2700
2800
2655
2690
Radio Astronomy (RA) (AUS87)
RA (secondary)
RA
2550
(340)
Proposed 2.5 GHz
Spectrum Licences
2570
2620
ISM Devices
Aeronautical Radionavigation
2483.5
LIPD Class Licence
Radiolocation (secondary)
MSS
EES(secondary)
EES
Mobile Satellite Service
Earth Exploration Satellite (passive)
Pre-existing ENG
RDSS
SR(secondary)
SR
Radio-Determination Satellite Service
Space Research (passive)
Radiolocation
Fixed and Mobile except aeronautical

The band 2400-2500 MHz is designated for use by Industrial Scientific and Medical (ISM) applications. This band has been identified internationally for use of non communications use of radiofrequency energy. The most prevalent ISM device operated in this band is the domestic microwave oven. Emission limits for ISM devices are regulated through the ACMA Electromagnetic Compatibility (EMC) regime. Further information regarding the EMC regime can be found at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_310704

4.1 Radio Astronomy secondary service allocations and footnote AUS 87

Highly sensitive radio astronomy receivers are operated at a number of rural sites in Australia in spectrum identified for use by the Radio Astronomy Service (RAS). Footnote AUS 87 to the Australian Radiofrequency Spectrum Plan 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.

While the use of the spectrum allocated to the RAS as a secondary service and the spectrum covered by footnote AUS 87 is to be used by radio astronomers on an opportunistic basis only, arrangements are in place in the band 2500-2550 MHz requiring notification of proposals to operate apparatus licensed transmitters that could impact on receivers at those sites, 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. Spectrum licensees proposing to operate fixed registered transmitters in that band (TDD) will be requested to provide similar notification.

4.2 Radio Astronomy primary and passive Space Services allocations

The band 2690 to 2700 MHz is covered by the international footnote 340 in the Australian Radiofrequency Spectrum Plan which prohibits all emissions in the band. This arrangement is in place to protect sensitive passive services such as radio astronomy, earth exploration satellite and space research that make use of this band using highly sensitive receivers. ACMA requires protection of licensed radio astronomy sites operating in this band to the requirements of the International Telecommunications Union (ITU) recommendations.

The CSIRO holds licenses for this band for the Paul Wild Observatory near Narrabri and for the Parkes Observatory near Parkes in central New South Wales.

There is currently no known use or proposed use of this band by Earth Exploration Satellite (EES) or Space Research (SR) Services. For reference EEC Report 45 examines sharing and adjacent band compatibility between UMTS/IMT-2000 Wireless Access Services (WAS) in the band 2500-2690 MHz and adjacent services, including radio astronomy.

4.3 Mid Western Radio Quiet Zone

The Mid Western Radio Quiet Zone is located in remote central Western Australia occupying an area of a 70 km radius centred on a site latitude 26^{o} 42’ 15” S longitude 116^{o} 39’ 32” E (AGD66). The site has been identified for future radio astronomy facilities and is potentially important for international studies. An approximation of this area from within the spectrum map grid will not be spectrum licensed and so will not be part of a licence. However coordination with the site at the centre of the zone will be necessary for licensees of adjacent areas. Details necessary for the coordination with the site can be found in RALI MS 32

Coordination of apparatus licensed services within the mid west Radio Quiet Zone; a copy is available at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_2708.

5. Protection of Apparatus Licensed and Class Licensed Receivers

A section 262 guideline will be developed to provide information to spectrum licensees on managing interference to receivers operated in systems under apparatus, class and spectrum licences in other bands. The power level of transmitters that can be operated under the 2.5 GHz spectrum license are sufficient that receivers tuned to signals in adjacent spectrum can suffer interference from transmitters operated under the 2.5 GHz spectrum licence. The principle causes of this interference are:

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

These interference mechanisms are typically transmitter site issues for equipment operating at frequencies in the UHF and the microwave bands.
Spectrum licensees must pay attention during planning to the interference risks associated with these mechanisms, both to their own systems and to receivers operated under other licence types due to the flexibility provided within the technical framework.

5.1 Fixed and Mobile Services

There are a small number of apparatus licensed fixed link assignments that overlap the 2.5 GHz band prior to spectrum licensing in remote areas. There are no channel plans for these services as these are one-off special purpose links. Details of these links can be found in the RRL. These overlapping links will be reassigned to other frequencies by the end of the reallocation period unless spectrum licensees wish to make other arrangements with the current operators.

The closest formal apparatus licensed fixed link band is the 2.2 GHz band (2025-2285 MHz). A channel plan and arrangements under which they operate can be found in RALLI FX03 a copy of which is available at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_2599

There are currently no apparatus licensed mobile systems operating in or adjacent to the 2.5 GHz band. The closest apparatus licensed mobile systems operate in the Public Telecommunications Services (PTS) band 2110-2170 MHz. Frequency coordination arrangements for systems operating in these bands can be found in RALI MS 33 a copy of which is available at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_312470

Coordination with apparatus licensed services is carried out using specific data from the RRL using methods described in RALIs and where specific RALI information or methods are not available using information and methods described in relevant ITU-R Recommendations. Coordination with apparatus licensed services is based on a first in time basis and should new

apparatus licensed fixed or mobile services wish to be licensed in adjacent spectrum they will be required to coordinate with registered existing spectrum licensed systems.

5.2 Aeronautical Radionavigation Service

Stations operating in the aeronautical radionavigation service in the band 2700-2900 MHz consist of radar systems. These systems are used for air traffic control and interference has a potential impact on air safety. Many of these stations are located at major airports and are licensed to Airservices Australia however there are also some stations licensed to the Department of Defence.

Due to the sensitivity of the receivers used in these airport radar systems there is a need to coordinate with these stations when planning the location of outdoor base stations typically within 10 km of these stations. Details of these stations can be found in the RRL and can be identified as assignments in the band with the Station Class field containing the code AL – Aeronautical Radionavigation Land.

Studies overseas and within Australia indicate that through the coordinated use of appropriate power levels, antenna heights and antenna patterns at a proposed IMT base station it should be possible to operate at a distance of less than a kilometre from an aeronautical radionavigation service radar site. Currently there is no RALI describing coordination requirements with the Aeronautical Radionavigation Service in the band 2700-2900 MHz but such a RALI might be developed in the future and a note will be added to this effect.

For coordination 2.5 GHz spectrum licensees are referred to the RRL for site and other technical information regarding the aeronautical radionavigation radar station sites and to ITU-R REC M.1464-1 "Characteristics of radiolocation radars and characteristics and protection criteria for sharing studies for the aeronautical radionavigation and meteorological radars in the radiodetermination service operating in the 2700-2900 MHz band".

Information on procedures for coordination can be found in ITU-R REC M.1461 "Procedures for determining the potential for interference between radars operating in the radiodetermination service and systems in other services ". Further information can be found in the 2.5 GHz TLG Master Document SPP 07/2011 Radar and IMT Adjacent Band Sharing at 2700 MHz. In the absence of sufficient site specific information for coordination, the following maximum vertical PFD limit at the radar site for out-of- band emissions from a station operated under a 2.5 GHz spectrum licence can be use: -125 dBm/MHz/m^2 at the radar site.

5.3 Radiolocation Service

The band 2300 to 2500 MHz is allocated to the radiolocation service on a primary basis but there are currently no apparatus licensees in Australia. The band 2700-2900 MHz is allocated to the radiolocation service on a secondary basis[1]. Details of these stations can be found in the RRL and can be identified as assignments in the band with the Station Class field containing the code LR – Radio Location. Stations of this class are operated by the Bureau of Meteorology (BoM) and the Department of Defence at sites around Australia.

[1] However footnote 423 gives ground based radiolocation radars used for meteorology equality to stations in the aeronautical radionavigation service.

The stations operated by the BoM are typically located at high sites in or adjacent metropolitan areas. The stations operated by Defence are typically located in regional and remote areas. Due to the sensitivity of the receivers used in these radar systems there will be a need to coordinate with these stations when planning the location of outdoor base stations typically within 20 km of these sites. There are approximately 20 of these sites around Australia.

Studies by the ACMA indicate that through the coordinated use of appropriate power levels, antenna heights and antenna patterns at a proposed IMT base station it should be possible to operate at a distance of less than a kilometre from a radiolocation service radar site. Currently there is no RALI describing coordination for the Radiolocation Service operating in the band 2700-2900 MHz but such a RALI might be developed in the future and a note will be added to that effect.

For coordination 2.5 GHz spectrum licensees are referred to the RRL for site and other technical information regarding the radiolocation radar stations site and other technical data and to ITU-R REC M.1464-1 "Characteristics of radiolocation radars and characteristics and protection criteria for sharing studies for the aeronautical radionavigation and meteorological radars in the radiodetermination service operating in the 2700-2900 MHz band". Further information can be found in the 2.5 GHz TLG Master Document SPP 07/2011 Radar and IMT Adjacent Band Sharing at 2700 MHz.

5.4 Mobile Satellite and Radio Determination Satellite Services

The Mobile Satellite Service (MSS) the Radiodetermination Satellite service RDSS have allocations in the band 2483.5-2500 MHz in the Space to Earth direction from satellites to earth stations. ECC Report 45 includes a number of studies covering the protection of these services based on likely IMT services in the 2.5 GHz band. There are no current Australian apparatus licences in this band at this time.

The ACMA encourages direct liaison between spectrum licensees and the earth station operators during the system planning phases of new systems. The protection requirements for space services receivers are set out in the following recommendation:

- ITU-R Recommendation SA.363-5: Space operation system frequencies, bandwidths and protection criteria available from the ITU website at: http://www.itu.int/pub/R-REC .

Additional information regarding the calculation of appropriate coordination distances, propagation models, threshold coordination levels and earth station receiver and antenna characteristics can be found in Appendix 7 if the ITU-R Radio Regulations.

5.5 Radio Astronomy

5.5.1 Radio astronomy in non-primary allocation bands

Spectrum licensees, as previously discussed will be requested to pay regard to radio astronomy stations that might receive on frequencies in the 2.5 GHz spectrum licensed band. A number of radio astronomy facilities operate in bands of the Australian Radiofrequency Spectrum Plan carrying Australian footnote AUS87. This footnote indicates that there are facilities operated by the CSIRO at (the coordinates are referenced to AGD66):

		Latitude		Longitude	
The Paul Wild Observatory	Narrabri	30° 59' 52.084"	S	149° 32' 56.327"	E;
The Parkes Observatory	Parkes	32° 59' 59.8657"	S	148° 15' 44.3591"	E;
The Mopra Observatory	Coonabarabran	31° 16' 4.451"	S	149° 5' 58.732"	E;

by the University of Tasmania located at:

Mount Pleasant Observatory	Hobart	42° 48' 12.9207"	S	147° 26' 25.854"	E;
Ceduna Observatory	Ceduna	31° 52' 8.8269"	S	133° 48' 35.3748"	E;

and at the

Deep Space Communications Complex	Canberra	35° 23' 54"	S	148° 58' 40"	E

The ACMA would encourage the direct liaison of spectrum licensees with the radio astronomy facilities operators particularly during the system planning phases of new systems to minimise the potential interference impact on these facilities. Note that this requirement applies only fixed registered transmitters operating in the band 2500-2550 MHz part of the FDD mobile uplink band. Notification requirements for apparatus licensed system (triggers) for all RAS stations can be found in RALI MS31 available from the ACMA website at: http://www.acma.gov.au/WEB/STANDARD/pc=PC_2708

5.5.2 Radio astronomy in the primary allocation band

Coordination requirements with the apparatus licensed stations in the 2690-2700 MHz band can be found by reference to relevant RALIs and ITU-R Recommendations. RALLI MS 31 and ITU-R REC RA.769-9 provide details of requirements and site details to allow coordination of base stations with The Paul Wild Observatory and the Parkes Observatory in central western NSW. Prospective spectrum licensees should familiarise themselves with the methods and coordination limits in these documents.

It is proposed that the guidelines will contain a requirement that when planning stations to be operated under 2.5 GHz spectrum licence, emissions in the band 2690 to 2700 MHz should be restricted such that the total expected power of such emissions within the band arriving at the specified point above the ground at the following facilities would be no greater than -177 dBm/10 MHz:

(a) The Parkes Observatory located at latitude 32° 59' 59.9" S, longitude 148° 15' 44.4" E (AGD66) at a point 30 m above the ground; and
(b) The Paul Wild Observatory Narrabri located at latitude 30° 18' 52.0" S, longitude 149° 32' 56.3" E (AGD66) at a point 18 m above the ground.

Studies carried out by the ACMA indicate that coordination is typically required for outdoor base stations located within 100 km of these sites but that it should be possible to establish base stations taking into account appropriate antenna heights, antenna direction, terrain and power levels to distances within 20 km of these sites. See the 2.5 GHz TLG Master Document SPP 09/2011 IMT and Radio Astronomy Sharing Studies; for further information.

5.6 Receivers associated with Transmitters Operated under Class Licences

Currently the LIPD class licence allows the operation of low interference potential devices such as radiolocation, WiFi and frequency hopping devices with maximum EIRPs of up to 4 W in the band 2400-2483.5 MHz.

Previously mentioned the ACMA is considering the introduction of new class licence arrangements in the 2.5 GHz band to support ENG and WAS services. The ENG class licence arrangements are intended to allow ENG systems to operate in rural and remote areas where there are no registered devices under a 2.5 GHz spectrum licence. The WAS class licence arrangements are intended to facilitate the early rollout of WAS services in regional and remote areas with the permission of the Apparatus Licence Licensee.

The ACMA is also considering the introduction of a multi-band class licence to cover the operation of low power mobile services onboard aircraft that would come into effect after the reallocation period. While devices operated under a class licence are licensed to operate on a no-interference, no-protection basis, this does not mean that the ACMA does not consider the potential interference affects from other services.

The proposed 2.5 GHz spectrum licence out-of-band and out of area emission limits are however considered sufficient by the ACMA to minimise the potential for interference to receivers of devices operated under a class licence in the adjacent band. Provided the provisions of the 2.5 GHz spectrum licence are met, a station under the 2.5 GHz spectrum licence will be considered not to cause interference to a receiver operated under the class licence.

TLG members are asked for their views regarding the class licenses being considered by the ACMA to facilitate ENG operation in regional and remote areas, trials and early rollouts of WAS in regional and remote areas, and low power mobile services onboard aircraft.

6 Spectrum Licensed ENG/TDD Receivers in the Band 2570-2620 MHz

Registered spectrum licensed transmitters in the 2.5 GHz band will be required to coordinate with registered receivers operating in the band 2570-2620 MHz. It is intended that ENG collection stations operating in that band will be registered as part of the conversion process from apparatus licensing to spectrum licensing in the band 2570-2620 MHz. This process will provide first in time status for these collection stations. TDD services may also operate in this band in the future.

The spectrum licensing technical framework being developed for the 2570-2620 MHz band is predominately the same as that being developed for the 2.5 GHz band as both have been developed with reference to European arrangements. Main differences that the framework for the 2570-2620 MHz band is a proposed lower out-of-area power limit of 43 dBm/30 kHz, a maximum antenna gain of 27 dBi has been used in some modelling (ENG collection stations in capital city CBD areas) and a lower notional ACS value for ENG receivers.

The result is that the 262 guideline will contain a worst case coordination zone of nearly 15 km around ENG collection stations (ie maximum permitted EIRP, maximum antenna gain, extra). A typical coordination zone would however be 1.5 km. TDD stations in the band under the framework however are modelled with a horizontal gain of 14 dBi (17 dBi-3 dB for down tilt) would typically fall within the 200 m site management distance.

The RRL details will provide the necessary station site and antenna details for coordination. The technical framework documents for the 2570-2620 MHz band will contain additional details such as the level of protection at the receiver, and receiver minimum levels of performance of ENG receivers operating in the 2570-2620 MHz band.

While the information in the 262 guideline should be sufficient for coordination purposes, additional ENG station characteristics can be found in ITU-R Rec F.1777 System characteristics of television outside broadcasting, electronic news gathering and electronic field production in the fixed service for use in sharing studies.

7. Managing Interference to 2.5 GHz Spectrum Licensed Receivers

A second set of section 262 guidelines will provide information for spectrum licensees in the 2.5 GHz band on managing interference from non-spectrum licensed services to allow planning and coordination with existing stations. The guideline will also provide information to licensees in adjacent bands to coordinate with 2.5 GHz spectrum licensed receivers.

Only registered receivers operating under the spectrum licence can be protected during the assignment of new apparatus licensed services. Protection is provided on a first in time basis for allocated primary services. That is, existing assigned or registered transmitters will not be considered as causing interference to new spectrum licensed receivers where the existing transmitters meet their licence requirements.

To assist in the planning of new services to avoid causing interference to receivers registered under the 2.5 GHz spectrum licence, the ACMA will assume a minimum notional receiver performance level and a compatibility requirement for receivers operated under the 2.5 GHz spectrum licence framework. These criteria provide a basis upon which spectrum and apparatus licensed spectrum users to coordinate and manage interference between services, using good engineering practice.

Individual low power mobile or nomadic receivers operated under the spectrum licence are not provided protection via these guidelines. It is intended not to require the registration of low power mobile or nomadic devices making coordination problematic at best. The technical framework out-of-band requirements and device boundary arrangements provide protection for mobile or nomadic receivers operating in conjunction with base stations.

8. Minimum Receiver Performance

The ACMA does not intend to enforce minimum receiver performance levels. However while receiver performance will not be a mandatory requirement, a minimum notional receiver performance level will be assumed when considering interference. This minimum level of performance is specified so that receivers with poor performance do not deny large amounts of spectrum space to transmitters in order to protect the receiver from interference.

Typically these requirements aim to limit the area within which there is a risk of interference to that specified in the licence for the site interference management requirement (within 200 m of the of transmitter site). The minimum notional performance level for a receiver will specify requirements for:

- Selectivity;
- Intermodulation immunity; and
- Blocking.

Assessment and/or measurement procedures should be referenced to existing engineering standards and should take into account relevant factors in accordance to good engineering practice. The levels developed for the guideline are referenced to the antenna connector with frequency offsets specified from the licence frequency edge.

It is proposed to base performance requirements on those assumed in the development of the BEM in CEPT Report 19. To meet the assumed values used to develop the BEM in CEPT Report 19 and discussed in ECC Report 119, additional filtering will in many cases be required for equipment meeting typical minimum receiver technical standards.

The European BEM was developed based on a minimum 100 m base station separation. It is however intended where appropriate to increase the minimum separation assumption from 100 m to the 200 m in line with the spectrum licence interference site management requirement. Within this distance detailed site coordination is typically required.

LTE base station specifications will be used to demonstrate the proposed requirements. The LTE base station receiver technical standard requirements are those specified in ETSI TS 136 104 V9.3.0. The LTE standard requirements will be provided as examples as they are the most widely proposed technology for use in the band at this time. The performance of the other proposed technologies examined in this framework typically exceed the LTE receiver performance requirements.

The following figure shows the notional receiver model. Cable losses are incorporated in the effective antenna gain (as in CEPT Report 19). The guideline will explicitly express that the minimum notional receiver performance is the combined performance at the antenna connector made up of the performance of the receiver equipment and any additional external filter.

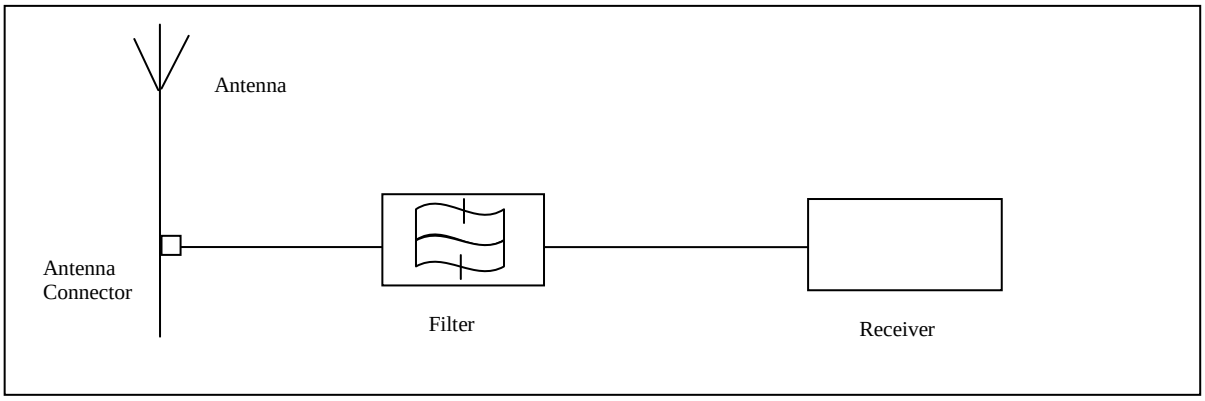


Figure 1: Minimum receiver performance model

8.1 Adjacent Channel Selectivity

Adjacent Channel Selectivity (ACS) means a measure of the ability of a receiver to receive a wanted signal in the presence of an unwanted signal on an adjacent channel at a given frequency offset. ACS reflects the IF filter and modulator performance. Likely sources of interference in the adjacent 5 MHz channel are spectrum licensed mobile transmitters of other licensees or devices operated in the so called restricted block or guard bands.

ECC Report 119 examines the compatibility of FDD and TDD systems in the 2.5 GHz band and determined that even with a 5 MHz guard band it would be necessary to provide an

additional 50 dB or more of filtering in the second adjacent channel (beyond 5 MHz offset to protect the receivers sufficiently to allow base station to base station distances of 100 m.

The minimum ACS value specified in ETSI TS 136 104 V9.3.0 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 as set out in that technical standard that being a level equal to the receiver sensitivity + 6 dB.

For example ETSI TS 136 104 specifies the minimum reference sensitivity for a wide area base station of a 5 MHz or greater channel bandwidth as -101.5 dBm. The wanted signal level for testing purposes is: reference sensitivity +6 dB = -95.5 dBm. The ACS specification in ETSI TS 136 104 is -52 dBm for a wideband (5 MHz E-UTRA) unwanted signal with a centre frequency offset of 2.5075 MHz or more from the wanted signal edge. The ACS expressed as a ratio of the unwanted to wanted signal is: -52 dBm – (-95.5 dBm) = 43.5 dB.

This value is consistent for the different base station receiver types in the standard where as the unwanted signal level varies for each receiver type. Each receiver type has a different sensitivity and a different specified ACS unwanted signal level but the ratio of wanted to unwanted signals is always 43.5 dB. The frequency offset is specified in ETSI TS 136 104 is from the wanted signal edge to the centre frequency of the unwanted signal rather than from the licence or block edge. The ACS specified in the technical standard is for a single offset and does not reflect the additional attenuation necessary at larger offsets such as the FDD diplexer filter or the filtering necessary to allow TDD stations to operate within the uplink band.

The European BEM was developed with reference to the FDD TDD sharing studies of ECC report 119 and uses an ACS level of 46 dB in the first adjacent 5 MHz channel. A minimum performance LTE base station receiver would require additional filtering of about 2.5 dB to meet this level. A slightly better performing receiver might require none. Taking into account the difference between the spectrum licence co-siting licensee interference management zone of 200 m and the 100 m minimum BS separation distance used in the development of the BEM it is proposed to relax this level to the level specified for a minimum performance LTE receiver within the adjacent 5 MHz.

Sources of unwanted signal within this 5 MHz band include mobiles and restricted block devices. Proposed arrangements for devices operated in the restricted block (guard band) of the mid-band gap include a maximum EIRP of 0 dBm/30kHz (15 dBm/MHz) and a maximum antenna height of 3 m. These requirements minimise the risk of interference.

ECC report 119 also found however that additional base station receiver filtering would be required to protect the receiver from high level signals from possible BS transmitters in the 2nd adjacent (5 MHz) channel. ECC report 119 proposing a second adjacent channel ACS value of 99 dB. Updating the reference parameters from ECC report 119 to reflect the modelling used in CEPT report 19 and the development of this technical framework taking account the 200m interference management zone and the ETSI LTE base station receiver test conditions leads to a typical case ACS value of 85 dB.

Base Station eirp	39	dBm/30kHz	54	dBm/MHz
FSL at 200 m			86.5	dB
Level at Rx antenna			-32.5	dBm/MHz
Rx Antenna Gain (hor.)			14	dBi
Level at the receiver			-18.5	dBm/MHz
Rx Test level	-96.5	dBm/5MHz	-103.5	dBm/MHz
Required ACS			85	dBm

This suggests the need for an additional filter requirement of 41.5 dB over the 43.5 dB LTE ACS value. The use of more additional filtering would allow less separation as would building blockage or antenna directivity.

Note however that the ACMA is not mandating receiver performance and licensees may for commercial reasons decide not to fit such a filter.

For example: a licensee might evaluate the risk of future TDD services in the FDD uplink band to be minimal at least in the near term and that the proposed receiver site is not in an area frequently used by ENG services.

However should in the future the licensee experience interference to a receiver not fitted with this filter and being unable to resolve the problem themselves call on the ACMA to resolve the issue, the ACMA, where the interference is related to the absence of the filter, may resolve the issue in the favour of the transmitter even if the receiver would have otherwise had first in time priority.

The proposed minimum adjacent channel selectivity requirement for the notional receiver for unwanted wideband emissions in the band described by frequency offsets of:
0 to 5 MHz from the receiver licence band edge is 43.5 dB; and
5 MHz or greater from the receiver licence band edge is 85 dB.

8.2 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. Blocking occurs where high levels of unwanted signal outside the wanted channel change the operating point of the RF amplifier or mixer stages of the receiver reducing the receiver's sensitivity and effectively blocking the reception of low level signals in the wanted channel.

Likely causes of this type of interference to the receiver are high level emissions from TDD and FDD BS transmitters outside the band of the receiver but within the band 2500-2690 MHz and high power services outside this band.

ETSI TS 136 104 V9.3.0 has a general blocking requirement for wide area base station receivers in the form of tolerance to an unwanted wideband (5 MHz) signal of at least -43 dBm/5MHz within the band 2480 to 2590 MHz. This TS standard requirement is based on wideband unwanted signals from adjacent channel mobiles. This level does not take into account the additional filtering required by the receiver to prevent blocking from emissions from possible future TDD base stations in the FDD uplink band. The specified band also incorporates some of the spectrum to be used for TDD/ENG transmitters in the mid band gap.

ETSI TS 136 104 V9.3.0 also has a limit applicable outside the band 2480 to 2590 MHz of a minimum unwanted CW carrier test signal level of -15 dBm. This limit is designed to protect the receiver from high level signals away from the FDD uplink band. The CW carrier test signal level representing the total power of an individual unwanted signal independent of bandwidth or offset outside this band.

To accommodate possible future TDD BS within the FDD uplink band, in line with the European model it will be necessary to alter the level and band over which the general wideband unwanted signal is applicable. This can be achieved through adjustment of the diplexer filter or the addition of a base station receiver filter. Within the first 10 MHz band adjacent to the receiver licence band edge the blocking requirement is effectively covered off by the ACS requirement and the framework power restrictions.

The blocking requirement is relevant beyond 10 MHz offset from the receiver licence band. The likely sources of emissions in these bands are TDD base stations in the uplink band and TDD/ENG stations in the mid-band gap. The necessary level of blocking protection in this band can be calculated as below:

TDD BS EIRP	54	dBm/MHz
Free Space Path Loss 200 m	86.5	dB
	-32.5	dBm/MHz
Receiver Antenna Gain (hor.)	14	dBi
Level at the Antenna Connector	-18.5	dBm/MHz

The additional filtering by the ACS requirement easily achieves this requirement building on the minimum wideband blocking figure of -43 dBm/5MHz (-50 dBm/MHz) at specified in the ETSI TS136 104 so it is proposed to round this figure up to -18 dBm/MHz.

The proposed minimum notional receiver blocking requirements outside the band of the licence:

within the band 2480 to 2590 MHz at frequency offsets greater than 10 MHz from the band edges of the licence is tolerance to unwanted wideband signal levels of at least -18 dBm/MHz; and

outside the band 2480 to 2590 MHz is tolerance to unwanted signal levels of at least -15 dBm.

8.3 Receiver Intermodulation Rejection

Receiver intermodulation rejection is a measure of the receiver's ability to receive the wanted signal in the presence of two or more high level out-of-band signals of related frequencies that can if mixing should occur in the front end of the receiver produce an on-channel interfering signal. The receiver intermodulation rejection is a function of the receiver front end linearity and filter characteristics.

Likely sources of the high level unwanted signals necessary to generate intermodulation products in the front end of the base station receiver are typically limited to those within the FDD uplink band to diplexer filtering. The additional ACS filtering for the 2nd adjacent (5MHz) channel and beyond will typically limit the sources of unwanted signals to: for the close in signal to that from mobiles or devices operated in the restricted block (guard bands) and the outer typically to a TDD base station located in close proximity.

ETSI TS 136 104 V9.3.0 specifies for a wide area base station receiver, two unwanted signals with mean powers of -52 dBm and -44 dBm. But this does not take into account the possibility of a TDD base station. ETSI TS 136 104 V9.3.0 specified for different offsets depending on the type of unwanted signal. The first is a test carrier at the edge of the 2nd adjacent (5 MHz) channel comparable to a mobile SCOFDM signal and the second signal a wideband signal with a centre frequency a further 10 MHz away.

The proposed level below is based on worst case signal level from a TDD base station under a 2.5 GHz spectrum licence framework at a minimum offset specified with reference the additional filter requirement necessary to support a TDD base station in the uplink band beyond the 1st adjacent 5 MHz channel. The fitting of the notional filter to meet the notional 2nd adjacent (5 MHz) channel ACS value easily achieves this requirement.

The proposed minimum notional receiver intermodulation rejection requirements outside the band of the licence, (with a close in signal of -52 dBm in the adjacent 5 MHz channel) at frequency offsets of greater than 10 MHz from the receiver licence boundary is tolerance to unwanted signal levels of at least -12 dB/MHz at the antenna connector .

8.4 Compatibility Requirement

The compatibility requirement has been specified in different spectrum licence technical frameworks as either a maximum accepted unwanted signal or as the minimum wanted signal level at the registered receiver. While there are a range of receiver and modulation types that could be used under the 2.5 GHz framework it is proposed to specify a minimum wanted signal level at the receiver as the compatibility requirement.

This discussion paper deals primarily with interference caused by emissions from transmitters operating on frequencies outside the frequency band of the licence and within the same geographical area. It is proposed to specify a minimum wanted signal level for the compatibility requirement based on the receiver test levels for wide area BS taken from ETSI TS136 104 the technical standard for LTE used to derive the notional receiver performance values above. ETSI TS136 104 specifies the receiver minimum wide area base station test levels as the sensitivity + 6 dB. For a receiver of 5 MHz or greater bandwidth the receiver sensitivity is -101.5 dBm and the test level is -95.5 dBm.

The expected paths for the out-of-band emissions causing receiver interference will typically be short distance near line of sight paths rather than over the horizon paths. These short line of sight paths typically have small signal level variation with time suggesting that for unwanted signals a median or 50% of time figure. However the proposed compatibility requirement is a wanted signal level and the time percentage needs to reflect the needs of the digital modulation techniques in use.

The proposed compatibility requirement is a minimum wanted signal level at the receiver of -95.5 dBm/5MHz for 90% of time in any 1 hour period.

9. Comment Period

The comment period for this initial release of the discussion paper closes the 16th of December 2011. Comment should be placed on the 2.5 GHz Spectrum Licence TLG SharePoint site.

Appendix 2 TABLE 1

ITU-R Propagation Prediction Methods

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.370	Broadcasting	Point-to-area	Field strength	30 MHz to 1000 MHz	10 to 1 000 km	1, 5, 10, 50	1 to 99	*Tx:* effective height from less than 0 m to greater than 1 200 m *Rx:* 1.5 to 40 m	Distance Tx antenna height Frequency Percentage time Rx antenna height Terrain clearance angle Terrain irregularity Percentage locations
Rec. ITU-R P.452	Services employing stations on the surface of the Earth; interference and coordination	Point-to-point	Path loss	700 MHz to 30 GHz	Not specified but up to and beyond the radio horizon	0.001 to 50 Average year and worst month	Not applicable	No limits specified	Path profile data Frequency Percentage time Tx antenna height Rx antenna height Latitude and longitude of Tx Latitude and longitude of Rx Meteorological data
Rec. ITU-R P.526	Fixed	Point-to-point	Field Strength	Not specified but generally >30 MHz	Not specified but up to and beyond the radio horizon	Not specified but dependent on k-factor chosen	Not applicable	No limits specified	Path profile data Frequency Tx antenna height Rx antenna height Latitude and longitude of Tx Latitude and longitude of Rx Meteorological data
Rec. ITU-R P.528	Aeronautical mobile	Point-to-area	Path loss	125 MHz to 15 GHz	0 to 1 800 km (For aeronautical applications 0 km horizontal distance does not mean 0km path length)	5, 50, 95	Not applicable	H1: 15 m to 20 km H2: 1 to 20 km	Distance Transmitter height Frequency Receiver height Percentage time

TABLE 1 (Continued)

ITU-R Propagation Prediction Methods

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.529	Land mobile	Point-to-area	Field strength	30 MHz to 3 GHz (Limited application above 1.5 GHz)	VHF: 10 to 600 km UHF: 1 to 100 km	VHF: 1, 10, 50 UHF: 50	Unspecified	Base: 20 m to 1km Mobile: 1 to 10 m	Distance Base antenna height Frequency Mobile antenna height Percentage time Ground cover
Rec. ITU-R P.530	Line-of-sight Fixed links	Point-to-point Line-of-sight	Path loss Diversity improvement (clear air conditions) XPD	Approximately 150 MHz to 40 GHz	Up to 200 km	All percentages of time in clear-air conditions; 1 to 0.001 in precipitation conditions	Not applicable	High enough to ensure specified path clearance	Distance Transmitter height Frequency Receiver height Percentage time Path obstruction data Climate data
Rec. ITU-R P.617	Trans-horizon fixed links	Point-to-point	Path loss	>30 MHz	100 to 1 000 km	20, 50, 90, 99 and 99.9	Not applicable	No limits specified	Frequency Tx antenna gain Rx antenna gain Path geometry
Rec. ITU-R P.618	Fixed satellite	Point-to-point	Path loss. Diversity gain and (for precipitation condition) XPD	1 to 30 GHz	Any practical orbit height	0.001, 0.01, 0.1, and 1 (for both rain attenuation and XPD)	Not applicable	No limit	Meteorological data Frequency Elevation angle Height of earth station Separation and angle between earth station sites (for diversity gain) Antenna diameter and efficiency (for scintillation) Polarization angle (for XPD)

TABLE 1 (Continued)

ITU-R Propagation Prediction Methods

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.620	Earth station frequency coordination	Coordination distance	Distance of which the required propagation loss is achieved	1 to 40 GHz	100 to 1 200 km	0.001 to 1	Not applicable	No limits specified	Frequency Percentage of time Earth-station elevation angle
Rec. ITU-R P.681	Land mobile satellite	Point-to-point	Path fading Fade duration Non-fade duration	0.8 to 3 GHz	Any practical orbit height	Not applicable Percentage of distance travelled 1 to 20%	Not applicable	No limit	Frequency Elevation angle Percentage of distance travelled Approximate level of optical shadowing
Rec. ITU-R P.1146	Land mobile Broadcasting	Point-to-area	Field strength	1 to 3 GHz	1 to 500 km	1 to 99	1 to 99	Tx: ε = 1 m Rx: 1 to 30 m	Distance Frequency Tx antenna height Rx antenna height Percentage time Percentage location Terrain information
Rec. ITU-R P.1546	Terrestrial	Point-to-area	Field strength	30 to 3000 MHz	1 to 1000 km	1 to 50	1 to 99	Tx:= up to 3000 m Rx: none	Distance Frequency Tx antenna height Rx antenna height Percentage time Percentage location Terrain information