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Report to

Ministry of Business, Innovation and Employment,

RSM Policy and Planning

Proposed Methodology and Rules for Engineering Licences in Managed Spectrum Parks

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1 Executive Summary

The report recommends an approach to efficient spectrum use of Managed Spectrum Parks. It includes recommendations for proposed inclusion in PIB39 for engineering MSP licences. The report suggests a consistent approach to determining the maximum permitted interfering signal (MPIS) for receivers. The report recommends a single value for the minimum field strength to determine the edge of coverage. The report also encourages efficient spectrum use of the MSP resource by recommending a maximum transmitted power, and recommends reducing this when base stations are located closer to neighbouring areas thus enabling optimum spectrum re-use between neighbouring systems. The report also recommends providing clear description on each licence, of the system's technical parameters to facilitate technical co-ordination with subsequent proposed systems. The report includes a pragmatic approach to analysing potential inter-system interference by initially using conservative assumptions for the initial technical co-ordination analysis, with more detailed analysis only in the event of an initial negative result.

Contents

2 Background

This report is in response to the Ministry of Business, Innovation and Employment (MBIE) request for recommended engineering methodology and preferred parameters for certification of spectrum licences in the Managed Spectrum Parks (MSP).

The objectives of MSPs are to facilitate local and regional wireless services, and to encourage a flexible, cooperative, low cost and, as far as possible, self-managed approach to allocation and use of the radio spectrum resource. In addition, the aim of MSPs is to encourage: efficient use of spectrum, innovation and flexibility, and provision of low-cost compliance and administration.

With these objectives in mind, as well as the requirements of the Radiocommunications Act (1989), the following recommendations are proposed.

3 Recommendations

The report recommends that:

- PIB39 should provide a **default MPIS value of 34 dBµV/m** for receivers with isotropic antennas, and should indicate how to adjust that for systems with antenna gain and feeder loss.
- AREs should be required to observe a **minimum receive signal level of -89 dBm** at the input of the receiver to define the edge of coverage in order to avoid setting unreasonably low MPIS values that would inhibit spectrum sharing. Where more accurate information is available from the manufacturer, that could be used instead of -89 dBm.
- AREs should be required to observe a **minimum field strength of 40 dBµV/m** for determining the edge of coverage. This figure allows for a receiver with a nominal +17 dBi antenna gain.
- AREs should be required to limit the **maximum radiated power of base stations to +10 dBW eirp** in order to avoid unnecessarily high overspill into neighbouring areas.
- AREs should include on the licence, detailed information about transmitter and receiver equipment configurations, including receiver antenna details, and actual frequencies or channels to be used, to enable good co-ordination with subsequent systems and hence efficient spectrum use in MSPs.

- When using antennas with gain, the corresponding beam width should be clearly identified on licences and should be used for co-ordination.
- AREs should not use a single licence for all of the sectors of a base station when individual sectors or set of sectors use separate frequency sub bands. Each sub band should have a separate licence showing the frequency range and aggregate HRP of the set of sectors. This will identify the antenna nulls in each sub band to facilitate efficient spectrum use through better technical co-ordination with subsequent systems.

4 Technical parameters for MSPs

4.1 Coverage and protection

The minimum receive signal level (RSL_{min}) depends on the modulation type. ETSI EN 302 326-2 Table 7 gives minimum RSL values for a range of modulation types and modulation orders corresponding to a threshold gross bit error rate (BER) of 10^{-6}. These are reproduced in the following table where the RSL_{min} is in dBm at the receiver input, i.e. immediately at the output of the antenna feeder, or of the antenna output terminal in the case of an integrated antenna-receiver unit.

Table of minimum receive signal levels for 10^{-6} threshold BER

Frequency Range	Base station Equipment Type	Equivalent Modulation Order	User Terminal Equipment Type	Minimum receive signal level (dBm) for BER 10^{-6}
1-3 GHz	FDMA	2	FDMA	-89
		3	FDMA	-86
		4	FDMA	-82
	TDMA	2	2Mbit/s	-88
			4Mbit/s	-85
		4	8Mbit/s	-79
	TDMA/OFDM	2	Any	-88.5
		4	Any	-80.5
		6	Any	-74.5

In order to determine what value to put on a licence for the MPIS, it is first necessary to interpret RSL_{min} (within the particular receiver equipment) in terms of the minimum field strength (E_{min}) in free space immediately in front of the receiver's antenna.

Using the fundamental equations for an isotropic antenna:

The area of an isotropic antenna A_i at frequency f is

$$A_i = \lambda^2/4\pi = c^2/4\pi f^2 \qquad (m^2)$$

Power flux density (PFD) in front of the antenna with area A_i and RSL_{min}, is

$$PFD_{min} = RSL_{min} / A_i \qquad (W/m^2)$$

Field strength (E) for a given PFD is:

$$E_{min} = \sqrt{(Z_0 \, . \, PFD_{min})} \qquad (V/m)$$

Parameter	Linear	Unit	dB	Unit
c	3.00E+08	m/s	169.54	dB(m^2/s^2)
f	2.60E+09	Hz	188.30	dB(Hz^2)
Z_0	377	Ohms	25.76	dB(Ohms)
4π	12.57		10.99	dB
W/mW	1.00E-03		-30.00	dB
µV/V	1.00E+06		120.00	dB

For an isotropic receive antenna at 2.6 GHz:

$$E_{min} \text{ (dB}\mu\text{V/m)} = RSL_{min} \text{ (dBm)} + K$$

where:

$$K = 10Log(4\pi Z_0/c^2) + 20Log(f \text{ (Hz)}) - 30 + 120 \qquad \text{(dB)}$$

$$K = 145.5 \text{ dB}$$

Using this conversion factor K, we can show the RSL_{min} values from the previous table in terms of the equivalent minimum field strength FS_{min}, for the threshold BER of 10^{-6} for receivers using isotropic antennas, for each type of modulation identified in ETSI EN 302 326-2 Table 9. These are shown in the following table, along with the S:I for a threshold degradation of 1 dB. The final entry in this table for OFDMA/TDD is for WiMAX system parameters described in ITU-R Report M. 2039-2 Table 9B for a 5 MHz user terminal.

Base Station Type	Equivalent Modulation Order	User Terminal Type	Minimum receive signal level for BER 10^{-6} (dBm)	Minimum field strength for isotropic antennas (dB(μV/m))	S:I for 1 dB threshold degradation (dB)
FDMA	2	FDMA	-89	56.5	24
	3	FDMA	-86	59.5	27
	4	FDMA	-82	63.5	30
TDMA	2	2Mbit/s	-88	57.5	23
		4Mbit/s	-85	60.5	23
	4	8Mbit/s	-79	66.5	23
TDMA/ OFDM	2	Any	-88.5	57.0	23
	4	Any	-80.5	65.0	30
	6	Any	-74.5	71.0	37
OFDMA/ TDD	2	OFDMA/ TDD	-91	54.5	17

4.2 Maximum permitted interfering signal (MPIS)

We can determine the MPIS value corresponding to a minimum field strength minus the signal-to-interference ratio for 1 dB threshold degradation.

In an ideal world, in the above two tables, the equipment types used by ETSI to determine typical minimum receive signal levels and S:I thresholds, and the WiMAX specification would all result in the same isotropic MPIS, corresponding to the same N:I of -6 dB. However different noise figures, implementation margins, and channel bandwidths are likely to have resulted in the small variations in MPIS that result from subtracting S:I from the minimum field strength in the above table. To be pragmatic, the following table of conservative nominal parameters from the above should be used to derive and specify the MPIS for receivers with isotropic antennas.

Minimum receive signal level for BER 10^{-6} (dBm)	Minimum field strength for isotropic antennas (dB(μV/m))	S:I for 1 dB threshold degradation (dB)
-89	56.5	23

These nominal values for minimum field strength and S:I indicate that the value (rounded to the nearest whole number) for the MPIS of a receiver with an isotropic antenna should be specified as 34 dBμV/m.

When interpreting the MPIS at a particular protection location, the right to have no harmful interference cannot be interpreted as applying to that value of MPIS for unwanted signals arriving from any and all directions unless the receiving antenna is isotropic. In all cases where the receiver has an antenna with gain greater than 0 dBi, co-ordination analysis must take into account the antenna discrimination for the angle of arrival with respect to the bore-sight. For arrival angles outside the main beam, this raises the effective value of MPIS above the “bore-sight” value on the licence by the magnitude of the antenna discrimination for that arrival angle.

4.3 Receivers with antenna gain

The above sections determine a recommended MPIS value for a receiver with an isotropic antenna that should be applied to all types of modulation being used by the point-to-multi-point systems in the MSP bands. This section discusses determining MPIS for receivers with antenna gain and possible feeder loss.

Where the receiver has an antenna with gain A dBi, the MPIS will be lower than the value in the above table by A dB, and similarly a feeder loss of L dB would require an adjustment of the above isotropic MPIS values as follows:

$$\text{MPIS} = \text{MPIS(isotropic)} - \text{A (dBi)} + \text{L (dB)} \qquad (\text{dB}(\mu\text{V/m}))$$

Typical antenna gains for broadband wireless access systems range from 10 to 25 dBi for both base stations and user terminals. Integrated receiver-antenna equipment has typically 0 dB coupling and feeder loss. For a receiver with a feeder and coupler, their combined loss value must be added for the MPIS value. Appropriate MPIS values are given in the next table for net antenna gain, i.e. gain minus feeder loss.

The table also shows nominal conservative values for beam width. It is important that AREs include receive antenna beam width or HRP information on all MSP licences to ensure that when antennas with gain are used, that the resulting lower MPIS values do not simply impose a constraint on neighbouring operators co-ordinating their systems. A high gain antenna is by definition, directional. The narrower beam widths of antennas with gain will provide essential antenna discrimination to compensate for the more restrictive MPIS values.

Other spectrum users need to determine the antenna discrimination, and hence need to know the direction of the antenna bore-sight as well as the beam width. Both the antenna gain and the beam width values should be clearly given in the text of the Conditions section of the licence. SMART includes a comprehensive database of antennas. If the antenna is not described by one of those in the database, the ARE should provide the antenna parameters to RSM at info@rsm.govt.nz for inclusion in the antenna database, and should enter that antenna type when registering the licence.

Not all equipment manufacturers provide detailed specifications of important parameters such as antenna radiation patterns. It will be useful to provide in PIB39 some conservative default values such as the beam width from the following table for use in co-ordination analysis.

Effective antenna gain (including feeder loss) (dBi)	MPIS (dBµV/m)	Conservative -3 dB beam width (degrees)	Conservative -6 dB beam width (degrees)
0	34	360	360
10	24	180	200
15	19	40	50
20	14	23	30
25	9	14	18

For the initial conservative co-ordination analysis an antenna can be assumed to have a gain of 0 dBi beyond the -6 dB beam width, although beyond 180°, high gain antennas usually discriminate below 0 dBi.

Where the manufacturer does not provide full antenna details, and more sophisticated antenna models are required, it may be helpful to AREs if a reference to the ITU-R Recommendations F.699, F.1245 and F.1336 listed at the end of this report are included in the MSP engineering rules.

4.4 Minimum wanted field strength

While the above interpretation of the ETSI and ITU-R tables shows that performance parameters for the range of equipment and modulation types correspond to MPIS values closely clustered around the proposed default value of 34 dBµV/m, the same cannot be said of minimum signal strength. Minimum signal strength varies by up to 16.5 dB across the range of equipment and modulation types. However, in the interest of ensuring efficient sharing of the spectrum resource, a conservative figure should be set as a minimum signal level for an ARE to determine the edge of coverage.

The nominal receiver in the ETSI and ITU-R tables that we have used for a default MPIS value has a minimum receive signal level of -89 dBm, corresponding to a minimum received field strength of 56.5 dBµV/m for a receiver with an isotropic antenna. Allowing for a nominal 17 dBi receive antenna, the minimum field strength for determining edge of coverage should be set at 40 dBµV/m.

4.5 Maximum power

To optimise the use of the MSP spectrum resource, it is important to set a maximum eirp power for the band. This will prevent the licensing of excessive power levels that would make co-ordination in neighbouring areas unnecessarily difficult. Unfortunately, there is a wide range of parameter variation for different types of broadband wireless equipment that would result in widely varying power requirements for both base stations and user terminals. The most significantly variable parameter is the minimum received signal level (RSL_{min}) for different modulation types that an earlier table above shows can vary between -74.5 dBm and -91 dBm. In addition, the network operators may have different performance objectives in terms of network outage, and that influences the necessary margin above the minimum required to meet the minimum receive signal requirement of the particular equipment.

Despite these potential differences, setting a maximum power has the benefits of ensuring efficient use of the spectrum resource, and preventing future MSP operators from being denied access to spectrum in neighbouring areas. These are strong reasons for requiring that a maximum power should be imposed for all MSP systems, but one that uses conservative nominal parameter values, so that operators should have no reason to find the limit unreasonable.

The following outage analysis (based on ITU-R Recommendations P.453 and P.530), for a typical BWA path illustrates the expected worst month availability performance. This is the percentage of time (P_W) in the worst month that a fade depth of A(dB) will be exceeded.

Parameter	Note	Value	Unit	Reference
dN1	for 1% of time	-200		Rec P.453 fig 12 for NZ
K	10^(-4.6-0.0027*dN1)	8.710E-05		Rec P.530 equation (5)
hr		20	m	
he		100	m	
d		20	km	
|e|	|e| = |he-hr|/d	4		Rec P.530 equation (6)
f		2.6	GHz	
h_L		20	m	Lower site height
A	Fade depth	10	dB	

P_W = the product of terms “X” below to power “index Y” Rec P.530 equation (8)

Term	Term X	Index Y	X^Y	Notes
K	8.710E-05	1	8.71E-05	
d(km)^3.1	20	3.1	10794	
(1 + |e|)^-1.29	5	-1.29	0.125	
f(GHz)^0.8	2.6	0.8	2.148	
10^(-0.00089h_L-A/10)	10	-1.0178	0.096	
Pw	Worst month outage		0.0243	% of time
	Worst month outage		10.85	minutes per month
100 - P_W	Worst month availability		99.9757	% of time

For this typical 20 km path from a Tx at height 100 m AGL to a Rx at 20 m AGL with an RSL_{min} of -89 dBm, an antenna A_{Rx} gain 17 dBi and feeder loss -3 dB, the following Tx powers, and corresponding fade margins, will result in the respective expected availability and outage performance at the edge of coverage.

Tx power (dBW eirp)	Fade margin (dB)	Worst month availability (% of time)	Worst month outage (% of time)	Worst month outage (minutes)
-3.2	3	99.88	0.12	55
-0.2	6	99.94	0.06	27
3.8	10	99.98	0.024	11

This raises the question: What is a suitable fade margin at the edge of coverage? The fade margin influences the service availability. We can compare the performance objectives for state of the art cellular mobile networks that are designed to provide 95% availability. In both cellular mobile and BWA networks, traffic congestion tends to dominate the unavailability, while atmospheric propagation effects will contribute a smaller proportion of percentage unavailability. This suggests that a fade margin of 3 to 6 dB (where the percentage outage in the worst month is very much less than the 5% unavailability target) would be suitable for BWA services in an MSP. This initial analysis suggests that a maximum radiated power of 0 dBW eirp might be reasonable for the nominal equipment parameters. However to allow for a greater margin for such factors as additional terrain losses, or lower equipment sensitivity, this report recommends that the maximum power be set at +10 dBW eirp.

Existing MSP licences have powers ranging from 10 to 29 dBW eirp. This suggests that either over-enthusiastic fade margins are being used, or inappropriate low gain user terminal antennas are planned for the edge of coverage.

When a base station is located relatively close to a boundary of the territorial local authority for the MSP licence, the HRP must be reduced in that direction to ensure that excessive power is not being transmitted into the neighbouring territory and thus obstructing that MSP operation. Considering the shorter path length, a margin of 6 dB is more than adequate to ensure highly reliable propagation for the service. The eirp registered on the licence in the direction of boundary should be calculated to achieve no more than 6 dB above the MSP minimum field strength at the boundary.

It is acknowledged that not all broadband wireless base station equipment has the ability to back off the transmitter power level. In such cases, the licensee must employ innovative techniques, such as: omitting the transmitter for that sector and relying on the side lobes of adjacent sector antennas to provide the lower eirp, or strongly down-tilting the antenna to use the VRP roll-off.

4.6 Co-ordination

Having determined the base station location and service area, and the main parameters of the proposed new service for both the user terminals and base station, (including: MPIS; transmit power; antenna polarisation, gain and beam width or HRP); it is necessary to check the co-ordination of the proposed service with existing and planned systems licensed in the vicinity.

An ARE certifying a licence is reminded of the Act's requirement in 25A(a)(ii), to have regard to the International Radio Regulations. Article 3.3 of those Regulations is pertinent to co-ordination in the MSP bands:

> *3.3 Transmitting and receiving equipment intended to be used in a given part of the frequency spectrum should be designed to take into account the technical characteristics of transmitting and receiving equipment likely to be employed in neighbouring and other parts of the spectrum, provided that all technically and economically justifiable measures have been taken to reduce the level of unwanted emissions from the latter transmitting equipment and to reduce the susceptibility to interference of the latter receiving equipment.*

Co-channel co-ordination between a proposed system and an existing or planned system relies mainly on two aspects of discrimination: geographical separation and antenna discrimination.

In the 2.6 GHz MSP band, most systems will use time division duplex (TDD). Where the proposed new and existing or planned systems use TDD, these separate systems will not be synchronous with regard to up-link / down-link timing. This means that with all transmissions in the same frequency band, there are eight possible interference paths to be analysed between all combinations of new and existing base stations and user terminals or customer premises equipment (CPE).

Outward interference

1. New Base Station to victim existing CPE
2. New Base Station to victim existing Base Station
3. New CPE to victim existing CPE
4. New CPE to victim existing Base Station

Inward interference

5. Existing Base Station to victim new CPE
6. Existing Base Station to victim new Base Station
7. Existing CPE to victim new CPE
8. Existing CPE to victim new Base Station

Each of these interference paths can be analysed in a similar way. A pragmatic approach to co-ordination or interference analysis is to simplify the analysis while making conservative assumptions. If this analysis meets the MPIS requirement of the victim, no further analysis is required, however if the interference level just exceeds the MPIS, more sophisticated "sharper pencil" analysis can be used. The following table sets out a typical simple conservative analysis.

Parameter	Note	Value
Tx power eirp (P)		dB(W)
Tx bore-sight angle Txθ to victim Rx	(degrees)	
Tx antenna angle discrimination ($A_{Tx\theta}$)	(1)	dB
Tx eirp toward Rx (P')	$P' = P - A_{Tx\theta}$	dB(W)
Tx to Rx distance (D)	(metres)	
Free space loss (L_{fs})	$L_{fs} = - 10 \log(4 \pi D^2)$	dB
Terrain obstruction loss (L_{obstr})	(2)	0 dB
Power flux density (PFD) at the Rx	$PFD = P' - L_{fs} - L_{obstr}$	$dB(W/m^2)$
Convert PFD to Field Strength (E)	$E = PFD - 10 \log(Z_0) + 120$ dB = PFD + 94.2 dB(μV/m)	dB(μV/m)
Rx bore-sight angle θ to culprit Tx	(degrees)	
Rx antenna angle discrimination, or polarisation discrimination ($A_{Rx\theta}$)	(3) (4)	dB
Equivalent bore-sight field strength (E_{Rx0})	$E_{Rx0} = E - A_{Rx\theta}$	dB(μV/m)
Victim MPIS		dB(μV/m)
Margin	$MPIS - E_{Rx0}$	dB
Positive margin = pass, negative = fail		[Pass ?/ fail ?]

Notes

(1) In the case of a base station as the Tx, the net eirp can be determined directly from the licence HRP for the bore-sight angle Txθ.

(2) The terrain obstruction is that attenuation for the path profile in excess of the free space attenuation, such as that due to diffraction over ridges, foliage attenuation etc.

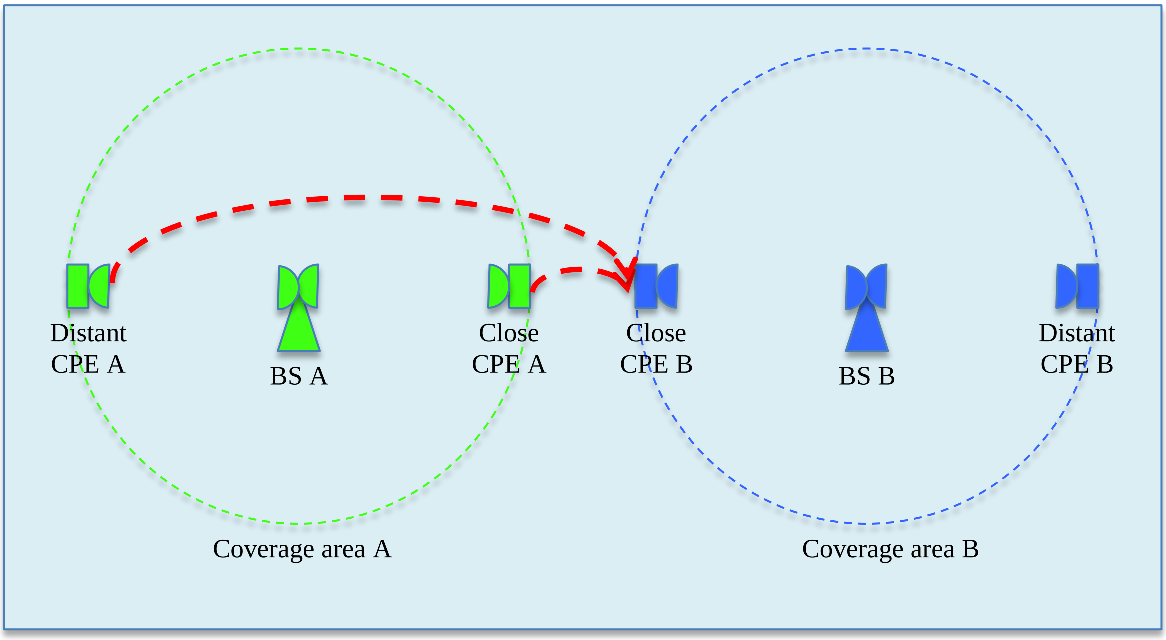
(3) In the case of a base station as the Rx, the equivalent angular discrimination can be determined by the ratio of the maximum eirp versus the eirp at the azimuth towards the Tx.

(4) Only the greater of the polarisation discrimination or the angle discrimination should be used; i.e. not both.

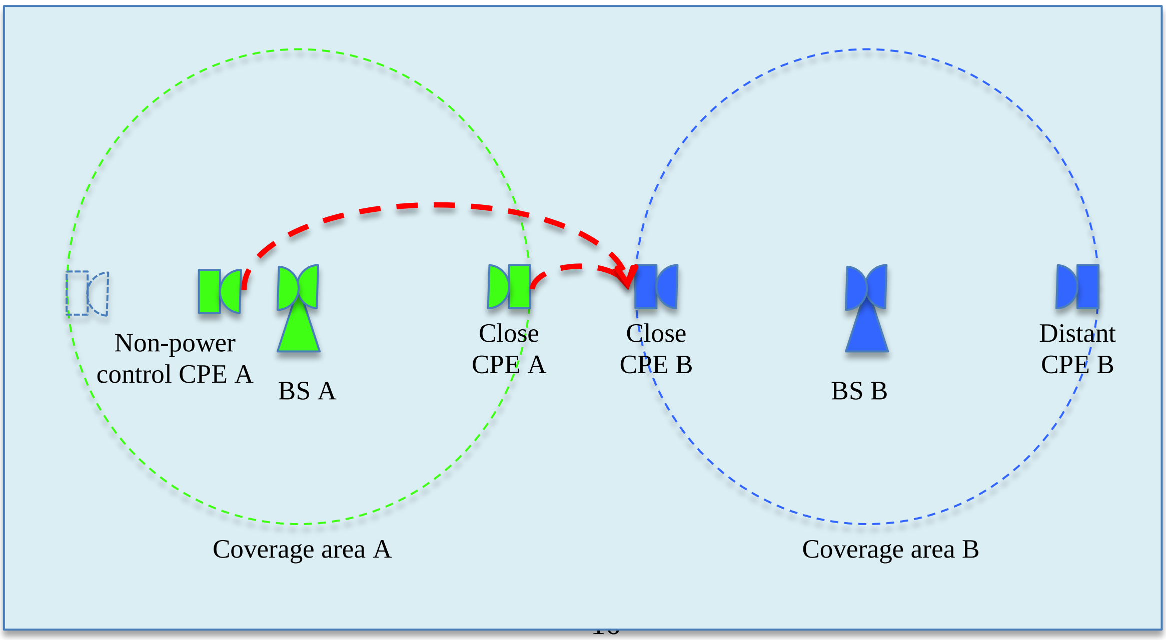
In the above simplified conservative analysis using free space path loss, the terrain obstruction loss can initially be set to 0 dB, and only replaced with a value determined by path profile analysis if the margin fails to be positive.

For the free space loss, the distance between base stations in cases 2 and 6 is easy to determine. However in the other six cases involving a CPE as either Tx, Rx or both, CPEs are located throughout the coverage area of their respective base stations, and it is not obvious whether to choose the closest distance or some other value.

The following diagram illustrates this question for cases 3 and 7, i.e. for new (or existing) CPE to victim existing (or new) CPE. It shows two CPE terminals in each of two systems A and B. In each system, one CPE terminal is located close to the other system, but has its antenna bore-sight pointing away from that system, while the CPE terminal more distant has its bore-sight aimed at the other system. The question is whether the more distant CPE has greater path loss to the other system, or whether the closer CPE has greater antenna discrimination because of its antenna front-to-back ratio. Two of the four possible CPE to CPE interference paths are illustrated in red. To avoid clutter, the two other paths (Close A to Distant B and Distant A to Distant B) are not shown, but they also have the potential to be critical. Analysis will be needed to determine which of the four interference paths is most critical.



The expectation in the above example, that a CPE terminal at either of the positions: "distant" or "close" may be more critical assumes that the system employs power control. With power control, CPEs closer to the base station are reduced in power to maintain a constant received power level at the base station. When a system does not feature power control, CPEs closer to the base station transmit at full power. As illustrated in the figure below, a "non-power control CPE A" on the same radial as the "distant CPE A" in the above figure, but closer to the base station, will also be closer to the other system, and would be more critical than a "distant CPE" at the edge of coverage.



4.7 Mitigation measures

If a proposed system fails the initial conservative technical compatibility evaluation, there are several approaches that can be taken: (a) re-analyse with less conservative assumptions or (b) amend the parameters of the proposed system to avoid the interference. The choice of approach will depend largely on the nature and magnitude of the identified interference.

A less conservative analysis could use more accurate characterisation of the antenna HRPs, and more sophisticated path loss using detailed path profile terrain data. Amendment of system parameters could include: changing polarisation; re-locating the base station; shaping the base station coverage pattern to avoid CPEs operating in critical areas; using CPEs with higher gain narrow-beam antennas; reducing base station eirp and using more robust modulation and forward error correction at the expense of data speed; using more base stations with lower eirp; accepting some level of interference where only the receivers of the proposed new system have failed to meet the MPIS criteria; etc.

4.8 Type of Licence

Managed Spectrum Parks are administered under a Crown Management Right, and hence each transmitter or receiver operating within an MSP must operate under the rights described on a Spectrum License. Each such spectrum licence typically confers a right to transmit, and a right to receive no harmful interference as defined under section 48(1)(a) of the Act. (Radiocommunications Regulations 2001 Schedule 7, Form 7, licence type A.)

4.8.1 Licensing a base station

Each type A licence for a base station, has the transmitter location of the base station, and the receive protection location or protection area of the user terminals.

4.8.2 Base station licence — Transmitter part

When a base station with separate transmitters for separate sectors uses different channels or bands of frequencies within the MSP band to avoid user terminals experiencing interference from adjacent sectors, then a single spectrum licence may be used for all of the sectors using the same channels or band of frequencies common to those sectors. The HRP shown on the licence will be the aggregate HRP of those sectors. However a separate licence must be used for each such set of sectors using other channels or band of frequencies common to that set, and with its HRP aggregated for those sectors. In this way, spectrum sharing by other MSP users is facilitated by HRP nulls between sectors providing antenna discrimination within the channels or band of frequencies for each licence.

4.8.3 Base station licence — Receiver part

It is not generally necessary to identify each individual user terminal. The Site Details - Receive Protection Location when provided on the base station licence as named protection area (PA) from the SMART site database, effectively defines the polygon describing the protection area bounded by an approximation of the minimum field strength contour, and allows for the protection of user terminal receivers anywhere within that area. Each base station sector licence must show the protection area for that sector or group of co-channel sectors from that site. This will rarely be the contiguous TLA boundary.

4.8.4 Licensing user terminals

A single type A licence may be used to cover all of an operator's user terminals within the coverage area of a base station. Licences being co-ordinated with that user terminal licence can assume that the terminals will only operate from within the coverage area. The transmit location of the user terminal licence should be described in the same way as the protection area for the base station, and the receive protection location of the user terminal licence would be shown on the licence as the base station location.

4.9 Licence information to facilitate co-ordination

Keeping in mind the objectives and purpose of MSPs, which are to be self managed in a cooperative way to efficiently share the MSP spectrum, the MSP engineering rules should require ARE's to provide the fullest technical information about the actual equipment and technical installations that will enable other MSP operators viable and efficient use of the spectrum.

A spectrum licence has detailed technical parameters describing the transmitter, that are essential for interference co-ordination analysis between that existing licensed system and a proposed new system. These include: the frequency range, emission code, and eirp throughout the horizontal radiation pattern, out-of-band unwanted emission levels. Unfortunately, the corresponding receiver parameters necessary for co-ordination are not as thoroughly detailed on a spectrum licence. There is no provision on the licence for the adjacent channel selectivity (ACS) performance of the receiver, which is as equally important for co-ordination as the unwanted emission limits (UEL) of a transmitter. MPIS and receiver antenna height are provided, but antenna horizontal pattern is not included, although a rough set of antenna parameters may be found under the data for the antenna type, provided that the antenna type has been included in the SMART field for the licence. SMART will only give the gain, front-to-back ratio and beam width, which is sparse information compared to the licensed HRP information of a transmitter.

With these limitations of spectrum licences in mind, the engineering rules for MSPs should require AREs to register antenna characteristics for their equipment types in the SMART antenna database and to include the antenna type when registering a licence.

Although it would be very useful information from the point of view of technical co-ordination analysis, the rules should not make it mandatory for the certifier to include receiver ACS information in an "informative" section of the licence conditions, because from experience, BWA equipment manufacturers seldom provide this information. However, the degree of receiver and transmitter filtering are often comparable within any particular BWA equipment, and for co-ordination purposes, the UEL information can give a guide to the likely receiver ACS performance.

The rules should require a separate base station licence to be recorded for each frequency sub band where separate sub bands are used for different sectors of the base station. This is so that the net antenna discrimination for each sub band can be used to advantage by other MSP operators for efficient spectrum co-ordination. In contrast, if the HRP of all sectors were to be aggregated onto one licence covering the total occupied spectrum of all sectors, the antenna nulls in individual sub bands would not be identified and efficient spectrum use of the MSP would be denied. To be clear, a base station licence must not use the lower and upper frequencies of the whole MSP management right, but should show the frequency limits of the channel or sub band for each sector or set of sectors using that channel.

The ARE should record on a base station licence the protection locations (receive locations) that are representative of the coverage area of the system being implemented. They should be within the edge of the coverage area, and have an unobstructed line-of-sight path from the base station.

4.10 Channel plan

In the interest of efficient spectrum use, and to avoid neighbouring MSP operators using different channel arrangements that would overlap inefficiently, a simple channel plan is proposed, based on a 5 MHz, 10 MHz and 20 MHz channels.

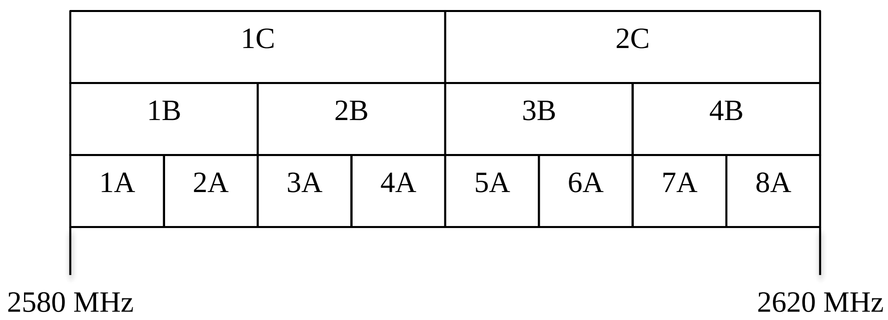
2.6 GHz MSP band 2580 – 2620 MHz

5 MHz channels	
Channel	Frequency
MSP1A	2582.5
MSP2A	2587.5
MSP3A	2592.5
MSP4A	2597.5
MSP5A	2602.5
MSP6A	2607.5
MSP7A	2612.5
MSP8A	2617.5

10 MHz channels	
Channel	Frequency
MSP1B	2585.0
MSP2B	2595.0
MSP3B	2605.0
MSP4B	2615.0

20 MHz channels	
Channel	Frequency
MSP1C	2590.0
MSP2C	2610.0

2.6 GHz MSP band 2580 – 2620 MHz



4.11 References

ETSI EN 302 326-1 V1.2.1 (2007-01) — Fixed Radio Systems; Multipoint Equipment and Antennas; Part 1: Overview and Requirements for Digital Multipoint Radio Systems

ETSI EN 302 326-2 V1.2.2 (2007-06) — Fixed Radio Systems; Multipoint Equipment and Antennas; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Digital Multipoint Radio Equipment

ETSI EN 302 326-3 V1.3.1 (2008-02) — Fixed Radio Systems; Multipoint Equipment and Antennas; Part 3: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive for Multipoint Radio Antennas

Report ITU-R M.2039-2 — Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses.

Recommendation ITU-R P.530-13 — Propagation data and prediction methods required for the design of terrestrial line-of-sight systems

Recommendation ITU-R P.1144-6 — Guide to the application of the propagation methods of Radiocommunication Study Group 3

Recommendation ITU-R P.1812-1 — A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands

Recommendation ITU-R P.2001 — A general purpose wide-range terrestrial propagation model in the frequency range 30 MHz to 50 GHz

Recommendation ITU-R F.699-7 — Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to about 70 GHz.

Recommendation ITU-R F.1245 — Mathematical model of average and related radiation patterns for line-of-sight point-to-point fixed wireless system antennas for use in certain coordination studies and interference assessment in the frequency range from 1 GHz to about 70 GHz

Recommendation ITU-R F.1336-3 — Reference radiation patterns of omnidirectional, sectoral and other antennas in point-to-multipoint systems for use in sharing studies in the frequency range from 1 GHz to about 70 GHz