Submission on *Proposed Methodology and Rules for Engineering Licenses in Managed Spectrum Parks*

Introduction

General

This is a submission on the discussion paper entitled proposed methodology and rules for engineering licenses in the managed spectrum park (hereafter referred to as the discussion paper). This report may be circulated in full without redaction.

Perspective

This report is written from the perspective of a number of operators that have currently deployed versions of the *Institute of Electrical and Electronic Engineers air interface standard 802.16* (IEEE 802.16) colloquially known as WiMAX or *3rd Generation Partnership Project Long Term Evolution Time Domain Duplexing*[1] (3GPP LTE-TDD) equipment within the Managed Spectrum Park (MSP). It should be noted that the majority of WiMAX 802.16 equipment manufacturers are currently producing equipment that is software upgradeable to the LTE-TDD standard. Thus there is a considerable volume of equipment already deployed within the park that is LTE-TDD capable even if it is currently operating in a WiMAX mode[2].

Method

This report contains five main sections containing comments and analysis of the discussion

[1] It should be noted that despite the name this is a 4th generation standard!

[2] The primary reason for LTE-TDD capable equipment remaining in WiMAX mode relates to the required packet core upgrades and is not air interface (radio) related.

paper, these being as follows with the relevant sections of the discussion paper shown in parenthesis:

- Maximum Power (4.5)
- MRSL[3] and MPIS[4] derivation (4.1 through 4.4)
- Coordination and Mitigation (4.6 & 4.7)
- Licensing & Information Requirements (4.8 & 4.9)
- Channel Plan (4.10)

This report primarily focusses on the impact of the proposed methodology on current and future LTE-TDD operations within the MSP. This report is not intended to be a detailed explanation of LTE-TDD technology.

MSP License Structure and Definitions

The MSP spectrum is intended for use as a point to area band and as such each and every application consists of two licenses. The first license specifies the base station *transmitter* **point** location servicing remote station *receivers* located within an **area** in which they are protected from interference. The second license is the inverse of the first and specifies an **area** within which remote station *transmitters* may be located to service a base station *receiver* located at a **point** which is also protected from interference. All of the licenses within the MSP have this structure.

In this report the base station is referred as the Radio Base Station (RBS) and the remote station as the User Equipment (UE). The respective licenses are referred to as the RBS point license and the UE area license.

[3] Minimum Receive Signal Level

[4] Maximum Permitted Interfering Signal

Maximum Power (4.5)

The most concerning aspect of the proposal is the limitation of maximum output power to **+10** dBW eiRP. The analysis used to support this contention suggests that a maximum power of **0** dBW is a suitable maximum power for MSP operations, but a further allowance of 10dB is applied to allow for additional terrain losses and/or lower equipment sensitivities.

Technical Issues

When viewed from the perspective of LTE-TDD operations within the MSP this limitation is unworkable.

By way of background, the nature of the LTE-TDD system is a downlink channel Orthogonal Frequency Division Multiple Access (OFDMA) technology whilst the uplink is based on Single Carrier – Frequency Division Multiple Access (SC-FDMA) technology[5]. The purpose of this technology split within the LTE-TDD (and indeed LTE-FDD) system is to minimize the complexity of the mass produced User Equipment (UE) by comparison the Radio Base Station (RBS)[6]. Simplistically this technology split yields a UE with a lower output power transmitter and less sensitive receiver. The RBS conversely has a higher output power transmitter and a more sensitive receiver to compensate for the UE's performance in both the uplink and downlink (this is a characteristic of all 1st, 2nd, 3rd & 4th generation cellular systems). In the case of LTE

[5] This is also known as Discrete Fourier Transform Orthogonal Frequency Division Multiple Access (DFT-OFDMA)

[6] This may also be referred to as the e-NodeB.

systems the difference in receive reference sensitivities between the two technologies in use is typically around 4.5dB[7].

The maximum UE power specified by 3GPP TS 36.101 is +23dBm. The power transmitted per Resource Block[8] (RB) reduces to 21.5dBm under the typical assumption of a 1.5 RB uplink payload. To compensate for the reduced sensitivity at the UE by comparison with the base station the RBS must transmit at 26dBm per resource block to maintain a balanced link budget (all other factors being common to both paths).

However the RBS is of course transmitting to more than one UE. The nature of the OFDMA downlink is such that individual UE's are allocated Resource Blocks (RB) in accordance with a scheduling algorithm. A downlink resource block consists of 180 kHz (12 x 15 kHz sub carriers) in the frequency domain and 0.5mS (7 OFDM symbols) in the time domain. When utilizing a 10MHz carrier there are a maximum of 50 RB's available for allocation[9]. The total power transmitted by the RBS is therefore approximately 43dBm. When using a standard 16dBi gain base station antenna this yields an RBS equivalent isotropic radiated power of 59dBm or **+29** dBW.

[7] 3GPP TS 36.104 states that the receive sensitivity for base stations is -101.5dBm (QPSK modulation) & 3GPP TS 36.101 states that the receive sensitivity for UE us -97dBm (QPSK modulation).

[8] An allocation of resources in both the time and frequency domain (explained further later).

[9] The total downlink throughput available to an individual UE is a function of the number of RB's allocated during the timeslot and the sub-carrier modulation schema.

MSP licensees are competing with operators using LTE technology in private management rights. The effect of this power limitation proposal would be to force MSP operators to complete with a maximum available path loss that is significantly less than that available to competing operators. It would also artificially limit as shown in Table 1 the capabilities of RBS and UE equipment already purchased to output powers significantly less than those permitted by the standard with which the equipment complies.

Table 1 - Maximum UE power output comparison (MSP 10dBW EiRP Limit)

LTE-TDD Channel Bandwidth (MHz)	MSP Base Station EiRP (dBW)	MSP UE power output (dBm)	Non MSP Base Station EiRP (dBW)	Non MSP UE power output (dBm)
5	10	7	No Limit	23
10	10	4	No Limit	23
20	10	1	No Limit	23

The net effect of the proposed power limitation would be to limit the MSP ability to deliver quality local and regional wireless services.

Economic Issues

The annual resource rental paid by MSP operators for access to the spectrum is directly related to the valuation of the adjacent 2.6GHz private management rights. Specifically the valuation of the spectrum is the average price per MHz paid in auction 9. This valuation was established on the basis that there were no EiRP power limitations as proposed in the discussion paper. Nonetheless MSP operators would continue to be contractually bound to pay for a resource that they could not fully utilize.

Derivation of maximum power limit in the discussion paper

Although implied above, the issue with the analysis used to derive the 10dBW EiRP power in the discussion paper in an LTE-TDD context is twofold.

Firstly the analysis assumes that the link budget parameters for the uplink and downlink path are identical, when in fact they are two separate technologies (OFDMA and SC-FDMA). Secondly and more importantly the analysis neglects to account for the total power required at the base station due to the point to multi-point nature of the base station transmissions.

MRSL and MPIS derivation (4.1 through 4.4)

General

The derivation of MPIS and MRSL (expressed as both a receiver input power and a field strength assuming a 17dBi gain antenna) in section 4.1 through 4.4 of the report is based on generic or nominal receiver sensitivity performance data provided in ETSI standard EN 302 326. This data is different to the technology specific receiver sensitivity thresholds specified for LTE-TDD in 3GPP Technical Standard 36.104 (Base Station) and 3GPP Technical Standard 36.101 (User Equipment) receiver. This is not an unknown issue when comparing standards

If, as believed, the stated MPIS and MRSL values are default values to be used in the absence of more specific data such as either:

- a specific technical standard to which the equipment complies; or

- vendor specifications; then

there are no general issues with the values derived in section 4.1 through 4.4 of the discussion document. There is a more specific issue discussed further below.

RBS MPIS and UE MPIS

As previously noted the technologies used for LTE-TDD uplink and downlink channels are different. This will naturally result in different values for RBS MPIS and UE MPIS when using LTE-TDD technology. The discussion document seems to imply that the uplink and downlink MPIS will be symmetrical in nature when this is not actually the case.

Coordination and Mitigation (4.6 & 4.7)

Interference Scenarios

The discussion document section 4.6 correctly identified the 8 separate interference scenarios present between unsynchronized TDD systems. For simplicity sake these are re-expressed as the following four scenarios with the discussion document references in parenthesis.

- RBS to RBS (2 & 6)
- RBS to UE (1 & 5)
- UE to RBS (4 & 8)
- UE to UE (3 & 7)

Each of the above scenarios has two variants depending on the victim and/or interferer status of the new and old system (as indicated in the discussion document)

Time Synchronization

The IEEE 802.16 air interface & 3GPP TDD-LTE air interface both allow operators with adjacent systems to synchronize the uplink and downlink timeslots with reference to a common source (most usually the Global Positioning System time reference). When this feature is used the RBS to RBS and UE to UE interference scenarios (2,3,6 & 7) are eliminated. The discussion document does not reference the use of this technique as a potential interference mitigation measure.

Interference Analysis

The discussion document suggests an acceptable method for performing coordination calculations in section 4.6. However the document also (correctly) identifies that performing this analysis is difficult for all interference scenarios except the numbers 2 & 6 (the RBS to RBS scenarios) due to the unknown nature of the UE location (albeit within a defined area). The discussion document offers little in the way of effective guidance to resolve this problem. The solution to this problem is to firstly ensure that the RBS protection area is correctly designed and secondly to adopt an area analysis technique.

Protection Area Design

The PIB39 document provides some guidance with respect to the design of protection locations (areas) for spectrum licenses. This guidance is primarily that the receiver protection area must

effectively represent the coverage generated by transmitter. In the context of the MSP the defined polygon will represent the MRSL used to define the edge of coverage.

In the case of MSP protection areas the following additional requirements should be added:

- A maximum spacing between protection area vertices of 200m for any protection area border perimeter less than 30km long.
- A maximum spacing between protection area vertices of 500m for any protection area border perimeter more than 30km long but less than 75km long.
- A maximum spacing between protection area vertices of 1000m for any protection area border perimeter more than 75km long and less than 150km long
- A minimum of 150 vertices for any other protection area.

Area Approach (for scenarios 1,4,5 & 8)

For interference scenarios 1, 4, 5 & 8 the analysis should be conducted on a grid basis to or from a set of points arranged in squares within the defined area. The required grid resolution (distance between points) will be specified as follows:

- Urban areas – 25m
- Rural areas – 100m

UE to UE approach (for scenarios 3 & 7)

Interference scenarios 3 & 7 would require *Monte Carlo* type analysis techniques. Time limitations preclude a full discussion of this approach in this submission. However from experience the UE to UE interference scenarios are typically not limiting conditions within the MSP.

Licensing and Information Requirements (4.8 & 4.9)

There is general agreement with the views expressed in sections 4.8 & 4.9 of the discussion document regarding licensing and information requirements. However there should be more specific requirements with respect to protection area design as outlined above in the ***Protection Area Design*** section.

Channel Plan (4.10)

The channel plan mooted in section 4.10 of the discussion document would have been a good idea if implemented at the genesis of the park. However there have already been significant deployments within the park of non-standard bandwidths that would not be compliant with this plan. Additionally in the more mature park areas there are significant amounts of overlap between the various license protection areas belonging to a single operator. This indicates that the full 40MHz of available spectrum is in use. There would therefore be a considerable administrative effort to implement a channelization scheme with conversely very little improvement in park efficiency.

Summary

This submission offers the following conclusions.

- The proposed maximum power limitation of +10dBW EiRP suggested in the discussion document is not compatible with current and proposed LTE-TDD operations within the MSP and should be dropped.
- The method described within the discussion document for setting default MRSL and MPIS values is acceptable.

- A more stringent regime for the design of protection areas should be implemented.

- The method described for interference analysis within the discussion document is generally acceptable but should be modified so that the base station to CPE cases are analyzed on a grid basis across the defined area.

- The increased information requirements for MSP licenses suggested within the discussion document is acceptable.

- The proposed channelization plan should be dropped.