Concerning the Size of a Spectrum Licence

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1.0 Introduction

This paper outlines all the factors that contribute to the size of the spectrum space available to a spectrum licensee for the operation of devices.

2.0 Defining the Size of a Spectrum Licence

It is not often appreciated that, in conjunction with the definitions of geographic area and frequency bandwidth of a spectrum licence, limits for in-band and out-of-band emissions at those boundaries also determine the useable size of the spectrum space. This is because at the area boundary, put simply, a certain emission limit at one location is equal to a lower limit at a more distant location. A similar argument applies to the frequency boundary. Put another way, the useable size of a licence depends on the size of the space required for the operation of a particular device. And the maximum size available for a device depends on the maximum levels of the emissions allowed at the frequency and geographic boundaries.

This relationship is often not kept in mind, especially when discussions centre inappropriately around “managing interference”. For example, in a recent Australian Communications Authority (ACA) consultation paper we find “the interference management framework (is) designed to minimise interference with surrounding services”.

3.0 Primary Purpose of the Technical Framework

The framework is **not** primarily designed to minimise interference.

The framework is primarily designed to establish a clear definition of what has been purchased in a price-based allocation – the spectrum space. While that definition subsequently relates to certain levels of interference protection, it is

not the primary objective. This confusion has arisen because much of the definition of licence size (in terms of emission limits) is presently contained in the relevant s.145 Determination[1] which is couched in terms of "unacceptable interference" because of the inherited requirements of the Radiocommunications Act.

4.0 Choosing the Propagation Model

The out-of-area (in-band) limits should be specified using technology neutral parameters based on radiated power in order to maximise flexibility. And, keeping in mind the interchangeability of emission limits and boundaries, the limits may be based on real propagation models but they may also, with equal logical validity, be based on your laundry list. **All that is required is a predefined benchmark, initially for sale and then, later for negotiation with an adjacent licensee**. However, to minimise the need for negotiation, the limits are usually based on actual propagation models. Ideally, the emission limits should also be defined in a manner providing ready and agreed parameters for licensee negotiation.

A mathematical model for propagation loss is used, because it is not practical to determine compliance by measuring emission levels in the field. Similarly, it can never be the prerogative of licensees to decide how the obligations of core conditions will be met. Prescriptive guidelines can not be replaced by more generalised statements of unacceptable interference because the size and utility of the spectrum space has to be defined exactly by the Regulator, in both the role of vendor defining a product for sale and as mediator in the event of post auction disputes between licensees, not by what an accredited person or licensee might think to be a fair thing after the auction.

[1] In Australia, the s.145 Determination describes conditions with which a transmitter should comply before it may be authorised to operate.

5.0 When Your Neighbour Defines Your Licence Size

The operation of types of transmitters requiring significant amounts of spectrum space to operate (or, put another way, those types capable of creating significant levels of interference) require precise definition of the size of that necessary space, so that a licensee can determine if someone else is using their spectrum space, or if they are intruding into an adjacent licence. The calculation of that spectrum space is defined in the s.145 Determination. It is not appropriate to have a system where each licensee decides the (useable) size of the space they have acquired, because in doing so they effectively decide the size of their neighbour's space.

This inappropriate consequence (your neighbour defining your space) is currently occurring in the USA with their system of spectrum licensing and the negative market impact is bringing about a search for change in the USA. The recent speech by FCC Chairman, Powell[2] confirms that the FCC believes a greater level of definition is required for spectrum licensing in the USA. For example, Powell suggests there may be a place for the definition of a notional receiver. In comparison, Australia has, with the agreement of industry, utilised a notional receiver from the inception of its spectrum licensing technical framework.

It is worthwhile noting that while Australia is engaging in storms of negativity over it's spectrum management system, the USA is moving to the Australian model. Perhaps we might save ourselves the pain of later reversion, since it is clear from all studies emerging from the US that the laissez faire system, currently being mooted from a couple of consultancies, presents major practical difficulties which can be obviated by moving closer to the present Australian model. The FCC are seeking upfront definition of conditions,

[2] "*Not all gaps in the Commission's current interference approach are quite as obvious as the lack of receiver standards*." See Michael K. Powell, "*Broadband Migration III: New Directions in Wireless Policy"*, University of Colorado, Boulder, 30 October, 2002

including a notional receiver. Unfortunately, the notional receiver was not fully defined at 2GHz in Australia, possibly in the misguided pursuit of USA modelled simplicity.

6.0 Why the Hata Model?

The Hata propagation model (high-site to low-site) was **not** chosen in order to bias the framework towards mobile services. Rather it was chosen, inter alia, because it provided a practical solution to calculating the spectrum space required for a transmitter - its "device boundary" to ensure that there was a legal definition for the size of the geographic space used by a particular transmitter (and in doing so it indirectly established the level of in-band protection for adjacent receivers). High-site to high-site propagation models were not chosen for reasons set out in a previous paper[3].

7.0 Is the Device Boundary a Service Area?

The device boundary is **not** to be viewed as a service area for the transmitter. Rather it establishes the size of the space of the geographic area used by the transmitter under the framework. Criticism that the device boundary does not manage interference is based on a belief that the device boundary is primarily intended to manage interference. These critics have not understood basic framework design principles.

The transmitter in-band emission limits based on the propagation model indirectly set receiver in-band protection and therefore, there is no need to define this protection explicitly. There should only be one propagation model in any band because two propagation models, for example, would mean two levels of protection. The resulting confusion would be quite complex to

[3] Whittaker M. J. "Establishing an Interference management Framework for Spectrum Licensing in Australia" IEEE Communications Magazine April 1998. Also see page 103 "Calculating a Device Boundary" for more background where it explains why a high site-high site model was not used.

resolve. Note that, in the case of out-of-band emissions (managing the space at the frequency boundary), there **is** a need to define the level of receiver protection.

The two-propagation model approach is also more applicable to area-based apparatus licensing than spectrum licensing. The dis-benefits of area-based licensing have already been exposed during the recent Australian Productivity Commission review.

8.0 Ensuring Transmitters Operate within a Defined Spectrum Space

The core conditions and technical framework do not unnecessarily limit the range of services and technologies which can be operated under a spectrum licence. Rather, the issue may be restated as: when the spectrum access conditions are biased[4] towards the operation of certain equipment configurations, it requires more spectrum space to operate other configurations, often making those types non-viable because the necessary amount of spectrum space has not been allocated. Of course, this is when spectrum sharing agreements are utilised in place of the s.145 Determination.

There are models on which to design a framework, which offer a more flexible means of managing space. A basic unbiased framework could be first constructed in terms of 'guard space'. Then, if industry prefers, it could be biased. However, and most importantly, if industry later prefers, a change of bias could accommodate a change of use, and that change could be negotiated solely within industry. This would be self-regulation. We believe that bias in frameworks should always be at the behest of industry, not the Regulator. The bias of the 2GHz framework to WCDMA may provide an early example of the lack of wisdom in Government agencies continuing to pick

[4] See FuturePace paper "True Technology Neutral Spectrum Licences" for explanation of what FuturePace means by "biased" licence conditions.

technological winners, in light of the recent Telstra announcement they are to use CDMA2000 to provide quick upgrade at lower cost.

9.0 The Cost/Benefit of Certification

Some parties have argued that certification by an accredited person, based on the s.145 Determination, imposes an unnecessary financial impost on spectrum licensees as it is costly and, arguably, provides no guarantee against interference.

As previously discussed, the s.145 Determination is **not** primarily designed to minimise interference but to establish a clear definition of the 'size' of the spectrum space for device operation. Certification independently warrants that the licensee is using their own spectrum space and is an extremely small price to pay for peace of mind for a licensee in terms of the half million dollar price tag of a base station operating under a spectrum licence. This argument might be further advanced by costing the impost on industry of a certification-after-interference resolution process recently proposed in an ACA consultation paper.

10.0 The Duty Cycle Issue

Duty cycle limits are necessary to keep a group of fixed transmitters (where the location of the individual transmitters is not registered) inside the spectrum space of a licence. Under the framework the duty cycle limits are consistent with the interference probability of a group of mobile transmitters not, as sometimes assumed, for keeping the transmitters within the geographic boundary of a licence, but for keeping transmitters within the frequency boundaries of the licence. Note, in relation to this issue, that there are already facilities provided in the 3.4 GHz framework for registering as a group, multiple fixed transmitters that do **not** comply with the duty cycle constraints.