
# Response to UK Independent Radio Spectrum Management Review

19 September 2001

## 1.0 About FuturePace Solutions

Spectrum Management International Pty Limited, trading as FuturePace Solutions, is a private jointly owned company operating since 1997 and headquartered in Canberra, Australia. Michael Whittaker, now a FuturePace Director, was principally responsible for designing the Australian 500MHz, 800MHz, 1.8GHz, 3.4GHz and 28/31 GHz spectrum licensing technical frameworks.

Our company specialises in the certification of RF regulatory compliance (see Attachment A). We have developed the services in Attachment A in response to the out-sourcing by Government of much of their certification liability risk. We were the first company to certify and register devices under Australian spectrum licensing rules in December 1998. FuturePace has a long-term commitment to professional research and the development of general and cost effective spectrum solutions for network, regulatory and public interest matters. FuturePace Solutions has no contractual obligations towards any particular type of equipment, does not endorse products and does not own spectrum.

In addition to this submission, we ask the Review to take account of recent relevant substantive studies authored by FuturePace[1] as well as a publicly available round-by-round description and candid commentary of the Australian 2 GHz auction to be found at:
futurepace.com.au/auctionresults/auctionbackground.htm

Another FuturePace paper is to be published by the IEEE later this year and we are at present preparing a paper concerning a comparative study of the Australian, USA and NZ systems of spectrum licensing.

[1] Whittaker M.J. "Establishing an Interference Management Framework for Spectrum Licensing in Australia" IEEE Communications Magazine, April 1998; and Whittaker M. J. "Australia's Airwaves for Sale" Mobile Asia-Pacific February/March 1999 Vol. 7 No. 1.

## 2.0 Spectrum Licensing for the UK

FuturePace notes a desire in the consultation paper, and we endorse it, to loosen the restrictions placed on the uses to which particular blocks of spectrum may be put in the UK. And we wish to provide a short form description of how technologically neutral spectrum licensing management methods, now generally welcomed and accepted by industry[2], operate in Australia. Whether or not the UK Government decides to mandate a certain technology standard as part of a strategic industrial and trade policy, successful spectrum management techniques that are technologically neutral are already in use and could also be designed for Europe.

A commonly heard view from overseas observers is that it is easy for Australia to implement spectrum licensing because the country is so large and cities so well separated. These observers often argue that the system would not work as well in situations where national boundaries impinge on allowable radio transmissions. In practice, however, in Australia there are a full range of situations requiring the licence conditions to handle both high density deployment and high grade of services within small geographic areas as well as very narrow frequency bands.

The form of boundary conditions adopted in Australia would be suited to adoption as a means of controlling radio emissions across national boundaries. However, the real difficulty is often finding the will to solve entrenched attitudes rather than technical problems. FuturePace supports the consultation paper's proposal to recommend policies which seek progressively to maximise, through unilateral and international action, the opportunities to exercise the considerable scope for increasing regulatory

[2] In establishing spectrum licensing in Australia a certain amount of opposition has come from the pre-existing incumbent apparatus licensed services. They are usually given a 2 year period in which to relocate. The 2 year period is considered to be a form of compensation which may be traded for the cost of relocation with the new spectrum licensee. In addition, the ACA allows, and FuturePace has developed software to locate, non-standard channel centre frequencies and Tx/Rx frequency separations within existing fixed service bands.

flexibility, including within its standards regimen, while staying within the interpretation of the international radio regulations.

## 3.0 Spectrum and Apparatus Licensing

In Australia, apart from class licensing which grants unlicensed spectrum access, there exists spectrum and apparatus licensing. Spectrum licensing provides a means of authorisation for management of a space by a single licensee. Once the Australian Communications Authority (ACA) carves the space of a licence out of the continuum, the remaining space then also becomes defined. This remaining space continues to be managed by the ACA which for practical purposes itself becomes an effective 'spectrum licensee' utilising apparatus license conditions to provide a means of authorisation for multiple licensees within that remaining space.

### *3.1 Private Spectrum Administrators*

In an analogous manner, an actual spectrum licensee may authorise multiple operators through the facility of third party authorisation, although, only limited use of this facility has occurred to date. However, it would be possible to provide a spectrum licence to a private spectrum administrator for the sole purpose of offering an 'apparatus-licence' type service to multiple clients, introducing competition with the ACA and likely reducing[3] costs.

It is interesting to note that in the past (prior to 1984) the UK has provided self-managed point to point bands to BT and Cable & Wireless. The ACA also has an internal arrangement where since 1993 three 15 GHz point to point channels[4] have been accessed only by Optus in both Sydney and Melbourne. In this case, because of more controlled coordination capacity,

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[3] Industry based licence processing fees for point to point services in Australia are about half the ACA fees.

[4] 14.578/15.222 GHz, 14.592/15.236 GHz and 14.606/15.25 GHz

the private spectrum administrator has been able to extract a much greater spectrum utility. Even higher utility is possible when, in addition to having more detailed information, a higher likelihood of interference probability is acceptable in a coordination calculation because interference will only result to, and be managed by, the proposed licensee. A government coordinator, or where the government directs the coordination of a private administrator, is often more risk averse, resulting in a loss of spectrum utility and efficiency.

## 4.0 The Important Role of Spectrum Access Conditions in Defining a Spectrum Licence

Spectrum licensing provides a means of device authorisation anywhere within a defined spectrum space. The space is defined not only in terms of geographic area, frequency band and time, but, most importantly and often overlooked, through access conditions that manage those boundaries which are in practice, 'fuzzy' because neither electromagnetic radiation nor interference immediately stop at those boundaries.

To fully understand the working of a spectrum licence, its associated technical framework which constitutes, in effect, the access conditions of the spectrum license, are just as important as the core conditions of geographic area and frequency band. The access conditions contribute significantly to the level of utility of the product and hence to it's value. The access conditions create the basis of the coordination of devices across both the area and frequency boundaries of spectrum licences. They incorporate levels of receiver protection in either a direct or indirect manner and usually, there is equitable spectrum access on both sides of the area and frequency boundaries.

### *4.1 Managing In-Band Interference*

For managing in-band interference[5] across area boundaries, the access conditions may be defined solely in terms of maximum power spectral density as a function of effective antenna height and distance to the licence boundary. The resulting actual signal level at the boundary can be arbitrary. However, area-adjacent licensees, knowing the maximum level that is allowed to be radiated from a specified site in an adjacent area can then determine on a risk assessment basis, how far a co-channel receiver at a certain location must be set back from the boundary in order to cope with that allowed maximum level. Importantly, the access conditions do not seek to fully manage interference, but draw 'a line in the sand' for the licensee to then manage the interference based on this known reference point.

A system like this operates on equitable spectrum access on both sides of the area boundary and the resulting level of interference must be accepted on both sides. This approach may present initial challenges in the UK where international cooperation has been historically used to manage interference. However, even in Australia similar situations exist where exceptions to equitable access on both sides of a boundary have been successfully managed.

Note that under spectrum licensing, in-band interference can also be caused by devices over short distances operating under frequency adjacent spectrum licences. In these cases the interference is managed by the steady state and transient emission limits that are applied outside the frequency band of the adjacent licence.

[5] ***in-band interference,*** for a receiver, means those levels of emissions from a transmitter that are permitted under the conditions of the licence under which it operates and emissions at frequencies within the frequency band of the spectrum licence;

When interpreting 'in-band interference' it is important to keep in mind that 'those levels of emissions from a transmitter that are permitted under the conditions of the licence' relate to in-band as well as emission limits outside the frequency band of licences that fall within the frequency band of adjacent licences.

### *4.2 Managing Out-of-Band Interference*

Out-of-band interference[6] (note that we not discussing out-of-band emission in this section) across frequency boundaries may be managed by applying deployment constraints based on transmitter effective antenna height. The deployment constraints are applied within certain bands following typical FDD configurations. However, the deployment constraints may be broken and TDD situations may also be managed. In the TDD case (and for any situation requiring receivers that are close in terms of both frequency and distance, for example, FDD repeaters or point to point services) the access conditions may be defined in terms of the detailed physical characteristics of a minimum receiver performance. This includes a full description of the RF and IF selectivity and a compatibility requirement[7] defined on the basis of a maximum likelihood for a specified unwanted power spectral density being received. This receiver model, together with models for non-linear interference, inform a licensee of how close in both distance and frequency, transmitters and receivers should be placed. Of course a licensee is able to use receivers not exhibiting the minimum performance but would provide more or less guard space (guard distance and/or guard band) using the minimum receiver performance as a reference.

These assessments are made and certified by industry operatives who have mostly assumed the Government's frequency coordination role, though it would be possible to retain an in-house management role if that were the UK policy disposition.

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[6] ***out-of-band interference*** means interference:

(a) relating to selectivity, blocking, intermodulation immunity and spurious response immunity; and

(b) caused by emissions at frequencies outside the frequency band of the spectrum licence;

This definition of out-of-band interference should not be confused with 'out-of-band emission', a term used in apparatus licensing to refer to emissions at frequencies outside a channel.

[7] Based on either practical or if necessary, theoretical equipment performance criteria, all that is necessary is that a performance is specified, another 'line in the sand' with which all other receivers may be referenced.

 

### *4.3 National Centralised On-line Database*

The availability of a national and centralised on-line database is critical to a scheme where coordination of devices at the boundaries is performed by industry. So too is a policy of interference settlement based on first-in-time receiver registration where a clear definition of responsibility is provided.

Carriers in Australia are quite comfortable with a requirement to register their devices on a publicly available database with services related to national security held on a separate database administered by the ACA. The database requirements do not interfere with commercial sensitivities and have served to significantly reduce the cost of interference management through out-sourcing to industry.

## 5.0 The Generic Standard

The spectrum access conditions in effect create a generic equipment standard and is (usually) selected such that access is not biased towards any particular actual standard. If the access conditions are biased then it usually means that additional spectrum space, in the form of guard space will be required for the operation of other standards.

The generic standard of a spectrum licence well suits the future 3G generic software defined radio by providing the necessary optimisation flexibility at the radio interface.

## 6.0 The Continuing Need for Both Spectrum and Apparatus Licensing

The fundamental difference between spectrum and apparatus licensing primarily lies in the number of licensees rather than service type:

- Spectrum licensing better serves a single licensee; whereas
- Apparatus licensing better serves multiple licensees.

This fundamental product differentiation lies in the fact that there will always be large and small users of the radiocommunications spectrum and both spectrum and apparatus licensing is likely to be required to serve them for a long time into the future[8].

These two very necessary and flexible products to Australian industry:

- apparatus licensing for spectrum space managed by the ACA providing flexibility with regard to devices operated by multiple licensees; and
- spectrum licensing for spectrum space managed by private industry providing flexibility with regard to multiple service types.

The rules associated with:

- Spectrum licensing tend to facilitate the use of multiple service types without managing the complexity of multiple licensees; and
- Apparatus licensing tend to facilitate use by multiple licensees without managing the complexity of multiple service types.

Generally speaking, spectrum licensing rules provide a basis for the management of interference at the area and frequency boundaries between dissimilar groups of devices operating within separate defined spaces. Apparatus licensing rules define exactly how to operate a single device in the presence of other similar devices in the same space.

The reason that a hybrid 'Appar-ectum' licence is not necessary is that, while the task is not impossible, the cost of interference management between multiple service types operated by multiple licensees tends to become extremely high as more and more types operate in close proximity. This economic consideration has led to the product differentiation of spectrum and apparatus licensing.

[8] A 'single more flexible' licensing system is being suggested in Australia, referred to jokingly as Appar-ectum licensing but we believe it is simply not required.

While spectrum licensing facilitates the introduction of multiple service types there are economic reasons why that introduction will be sequential over a long period rather than concurrent.

Since the introduction of spectrum licensing it is obvious that the spectrum licensees are, in the main, utilising their spectrum for a single service type with the internal task of interference management already solved for them by the equipment standard. This is also what happens with apparatus licensing. We are not saying that non-homogeneous services can not concurrently operate under a spectrum licence, rather that there is an economic and market based tendency to operate the same type of service whether it be apparatus or spectrum licensing.

However, what is facilitated by a spectrum licence is licensee initiated change of service type, whereas under apparatus licensing a change of service type would require the consent of many licensees and, in the Australian context, the agreement of a number of Government and consultative groups. It is obviously easier, in a practical sense, for a single licensee to decide to change equipment. Again, the focus comes back to the flexibility available to a single licensee as opposed to what is practical with multiple licensees. Spectrum licensing allows an individual licensee to vary the business case and equipment type within their own spectrum, for their own reasons and without initially exposing their business case to competitors. It is conducive to industry inspired innovation and the delivery of excellence.

## 7.0 Harmonisation and Spectrum Licensing

The attitudes of most people to standards have been formed by past use in the ITU to limit access to spectrum. In this case standardisation effectively became a long term contract for the use of spectrum. Long term contracts can stifle the creative use of valuable national and community resources. The generic standard of spectrum licensing, when designed for full flexibility in an unbiased manner, essentially achieves '*harmonisation'* by breaking any

 

nexus between the equipment standardisation process and obtaining regulatory approval to access spectrum, avoiding delays and effectively harmonising spectrum use.

An outcome of the ITU standardisation process was that equipment was not often designed to be frequency agile. With the freeing up of spectrum access in the USA, Australia and elsewhere, creativity and the resultant competition is occurring. And equipment is being designed to be frequency agile with full substitution across alternative spectrum. For example, 3G subscriber equipment will operate at 2 GHz, 1.8 GHz or 800 MHz. Using multiple modes and multiple bands will increasingly be the norm. There are already software reconfigurable dual-mode WCDMA and GSM/GPRS handsets being developed and as recently as last week press reports indicate that Vodafone UK asked its suppliers to come up with network equipment and handsets that will work with both WCDMA and CDMA2000.

Under spectrum licensing, standardisation becomes more of an industry responsibility. And since, increasingly in the future, the spectrum in question may already be sold and managed privately, an industry standardisation process may consider the relevant licence conditions, but will no longer be dependent upon, obtaining permission from a regulator to access spectrum.

## 8.0 Relevance of Equipment Standards for Apparatus and Spectrum Licensing

The real and important function of equipment standards is to manage interference between similar services in a given radio environment based on specified radio noise levels and communication distances.

The two[9] currently available Australian products for licensing radiocommunication devices, apparatus and spectrum licensing provide respectively:

- flexibility for multiple licensees; and
- flexibility for multiple services for a single licensee.

And, while the fundamental objective of equipment standards for both apparatus and spectrum licensing is to manage interference between similar devices, they are also utilised in the following manner:

- in the case of apparatus licensing, to encode many technical conditions that must be made discrete in a spectrum licence, with the purpose of minimising the cost of the coordination process between multiple licensees;
- in the case of spectrum licensing, to help create a fully flexible generic standard through an averaging process that minimises bias to any one type of equipment. The process utilises not only the specifications of all currently available standards but also theoretical models and operational practicality, for example, use of transmitter filters, with the purpose of minimising the cost and maximising spectrum utility for operating multiple types of equipment by a single licensee.

## 9.0 When Access Conditions are Biased

In general, spectrum licensing is less effective when the regulator intrudes into the market place, or when the revenue aspects of spectrum auctions become paramount. In the case of the Australian 2 GHz spectrum licences, political considerations resulted in the marketing of a product with partially defined access conditions that were biased towards WCDMA[10]. This rendered the licences technologically biased, rather than neutral. The objective of spectrum licensing is to enable the licensee to achieve the best economic use of spectrum, balancing the cost of available technologies with

[9] We do not discuss class licensing in this submission.
[10] Similarly the UK 3G auction was biased towards UMTS rather than say, IMT2000.

communication requirements. When a spectrum licence is biased towards a particular technology it limits the capability of spectrum licensing to be fully effective.

Owners of biased licences tend to lever an assumed right to limit competition off the relevant Government decision to bias the licences, and the high prices paid for the UK 3G licences are likely to have ramifications for policy development for 3G services in other bands well into the future. Government can avoid these situations by providing unbiased access conditions.

Of course, the licensees may negotiate with each other for amendments to the access conditions after the licences have been issued. However, in the Australian context, major changes are likely to require the agreement of all licensees, and this could be both expensive and time consuming, if actually possible. It also leaves licensees open to litigious behaviour and caprice on the part of their competitors. This is why FuturePace advocates a fully defined product to provide certainty in the marketplace as to the technical and regulatory rules against which a licence may be utilised.

FuturePace believes that an appropriate balance between flexibility and certainty should be achieved in designing access conditions for a spectrum licence. And, that minimising the need for future negotiation between adjacent spectrum licensees is an essential requirement for certainty as well as minimising the dollar cost of ongoing management of the spectrum licence. Spectrum value will be reduced by the opportunity cost of protracted negotiation with competitors where carriers realise that spectrum vendors, in this case the regulator, have failed to provide an appropriate balance between flexibility and certainty.

## 10.0 Dimensioning a Network for a Spectrum Auction

From our perspective the auction is not an end in itself but a transitional step where spectrum is defined and packaged for sale and then licensed. When licence 'building blocks' are provided in the form of nationwide system blocks and/or component blocks for aggregation, an important task for the bidder is to dimension the spectrum requirements for their individual business plan(s) in relation to the spectrum access conditions. The UK 3G auction was biased and there was limited flexibility for spectrum dimensioning. However, for the general case, we have developed planning tools to dimension spectrum requirements. We then incorporate them into an auction purchase and monitoring strategy together with appropriate fall-back positions based on predicted profitability of different networks.

We believe that licences should be limited as to time so the community can receive maximum direct benefit from the spectrum resource. For us, 10 to 15 years seems to be generally workable and we are of the view that spectrum should be re-auctioned at the expiry of the licence period so as to help maximise return to the community.

## 11.0 Spectrum Trading

FuturePace endorses the view that trading is an essential part of a viable spectrum market and we have noted the emergence in Australia of specialist industry services, often linked to venture capital, to facilitate trades. Certainly, once the process is established, trading is not a matter on which Government should be involved. However, it should have an obligation to record the results, so that all spectrum managers can coordinate and respond to possible interference situations through access to a centralised national database.

## 12.0 Different Policy Same Physics

While there will always be policy differences between countries, Australian industry, which in many cases involves the same corporate players as in the UK, has the experience of operating successfully with spectrum licences. Australian industry has been able to develop the necessary additional tools to manage the system. Allowing for policy differences, the physics remains the same, and the practical advantages of an unbiased approach to spectrum licensing, applied as a policy adjunct to a robust system of apparatus licensing, are, we believe likely to be most attractive to Ofcom as it develops new managerial and regulatory strategies.

FuturePace would be most interested to continue dialogue with the Review or its successors as to the modalities of implementing a system of spectrum licensing which allows Government, the consumer and industry to obtain maximum benefit from policy.

FuturePace
Solutions

# Attachment A: THE FUTUREPACE SPECTRUM MANAGEMENT SOLUTION

***DEVICE MANAGER*** – allows client to create and send via Internet device data files for authorisation under either multiple spectrum or apparatus licences. Receives processed files creating a stand-alone database or integrating with client network design tools. Provides a GIS facility for finding the ACA ID for a radiocommunication site and its location relative to a spectrum licence boundary.

***FSIA*** – Fixed Services Interference Analysis, a spectrum licence boundary manager tool that analyses any type of PCS by site, by channel to determine reduction of utility caused by pre-existing fixed services outside (also incumbent) but close to the geographic and frequency boundaries. Can utilise actual equipment and network (sector) characteristics.

***LINK MANAGER*** establishes site sense and overall channel availability in a microwave band for a link path, automatically assigns frequencies to proposed microwave links according to a number of different strategies, creates ACA licence application. Licence application to become fully automated when ACA develops FTP access for apparatus licensing.

***SPECTRUM MANAGER*** - bulk automatic certification and registration in accordance with spectrum licence core conditions (emission limits outside the band based on equipment measurement), section 145 Determination of Unacceptable Interference and Advisory Guidelines (eg. compatibility requirements for adjacent fixed services, guard space, spectrum sharing agreements, intermodulation checks etc.) to authorise operation of any type of transmitting device. Conveys processed *Device Manager* files to ACA via Internet for insertion into RRL. Returns data to *Device Manager*.

***SITE MANAGER*** – When FuturePace has established Site Radiation Folder, device registration information is used to upgrade the SRF and signage. Interference investigation and settlement provided as necessary.

***RRL MANAGER*** - replicates necessary data in local database via ACA monthly CDROM and overnight update facility for use by all FuturePace applications.

**ACA DATABASE**
**Register of Radio communication Licences (RRL)** – National Centralised database. Device details are inserted and registration or licence number, date and time are returned.

**Site Audit** against FuturePace data set, by either the client or FuturePace, starting with RRL extract.

**Liaison and Negotiation** between industry and Government on licensing of services outside current policy.

**Design or Evaluate** interference management frameworks for the auction or sale of re-allocated or traded spectrum.

**Establish Site Radiation Folder (SRF) –** provides basis of a documented risk management process for EMR hazards including:

a) Radio Frequency Field Hazard Drawings
b) Site Equipment List
c) Measurement Reports
d) RF Radiation Certification
e) SRF Control Register
f) Site Safety Procedures
g) Procedures for Suspected RF Over Exposure
h) Staff Log Entries
i) Visitor and Contractors Entries
j) Site Temporary Changes
k) Check of Licensing Details

**Install** signage and, if requested, licence/vary any RF devices

Quote for hazard signage and, if necessary, Licensing Compliance

***AUCTION MANAGER*** - available for assisting auction participation. *Auction Manager* presents core auction result information in a clear 'big-picture' manner, simulating alternate bidding strategies, examining all competition for lots sought by a specific bidder, providing graphical representations of auction progress, and evaluating bidding trends.

**FuturePace Internet Based Services –** On-line access to SRF for each site manager and management of daily access to site. Preliminary inquiry for space on a site, based on increased EMR level. Calculate device boundary for a given spectrum licence. Calculate intermodulation 'hits' at a site. On-line application for a point to point apparatus licence.

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