THE RADIO SPECTRUM - THE EFFECT OF INTERNATIONAL REGULATION

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This is an edited version of a paper which was prepared in 1996 as part of the review of the Radiocommunication Act by the Ministry of Commerce. At that time the legislation had been in place for six years and was unique by world standards, in that it provided for tradable long-term rights in relation to radio spectrum access, plus administered annual licensing for some radio services. A number of other radio administrations have emulated elements of this approach, but not to the same extent as New Zealand. The discussion document in its entirety, some 150 papers, may be accessed on the Ministry of Commerce home page on the internet at http://www.govt.nz. Legislative changes, as a result of this Review process are still pending. The International Telecommunication Union (ITU), is a specialised agency of the United Nations, headquartered in Geneva. It had its genesis in 1865 as the European Telegraph Union which was created to permit telegraph traffic to pass freely between European countries using common standards. New Zealand became a member in 1867 when a cable was established between Sydney and Nelson/Wellington, which permitted access to the international telegraph network. The ITU has currently some 190 member governments as signatories to its Constitution and Convention. This paper looks at some of the issues involved.

I INTRODUCTION

The New Zealand Government, as a party to various international treaties governing worldwide use of the radio spectrum and the geo-stationary orbit, has certain obligations at international law. To the extent that these have been incorporated into the

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Radiocommunication Act 1989 and associated regulations, these obligations also exist at national law in New Zealand. The process of international decision-making is ongoing, and there are important spectrum issues under discussion, or scheduled for discussion, that are likely to affect options for spectrum management in New Zealand.

II NEW ZEALAND'S INTERNATIONAL OBLIGATIONS

The New Zealand Government is a member of the International Telecommunication Union (ITU) and has ratified the ITU's Constitution and Convention. The effect of this is to make these provisions binding at international law. New Zealand is also a member of the International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO).[1]

ITU members are bound to abide by the provisions of the ITU's Constitution, Convention and Administrative Regulations (which comprise the International Radio Regulations (IRRs) and International Telecommunication Regulations) in:[2]

> all telecommunication offices and stations established or operated by them which engage in international services or which are capable of causing harmful interference to radio services of other countries . . ."

They are also bound:

> to take the necessary steps to impose observance of these provisions upon operating agencies authorised by them to establish and operate telecommunications and which engage in international services or which operate stations capable of causing harmful interference to the radio services of other countries.

Under the Constitution, ITU members are required to:[3]

> endeavour to limit the number of frequencies and the spectrum space used to the minimum essential to provide in a satisfactory manner the necessary services. To that end they shall endeavour to apply the latest technical advances as soon as possible.

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1 ICAO and IMO are primarily concerned with setting mandatory standards for aeronautical and maritime safety. Spectrum aspects are given effect through the ITU.

2 ITU Constitution, Article 6, Nos. 37-8; also Article 54, Nos.215-6.

3 IRRs, Article 6, "General Rules for the Assignment and Use of Frequencies".

New Zealand's management of the radio frequency spectrum is, to a very large extent, in accordance with these provisions, consistent with the sovereign right of every country to regulate its own telecommunications and radiocommunications services.

III PURPOSE OF THE INTERNATIONAL RADIO REGULATIONS

Article 4 of the International Telecommunication Convention, Nairobi, 1982, provides that:

> the Union shall in particular effect allocation of the radio frequency spectrum and registration of radio frequency assignments in order to avoid harmful interference between radio stations of different countries; and
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> coordinate efforts to eliminate harmful interference between radio stations of different countries and to improve the use made of the radio frequency spectrum.

In Chapter III of the Convention a number of "Special Provisions for Radio" are outlined. These relate to:

- the rational use of the radio frequency spectrum and of the geostationary satellite orbit (nos 153 and 154);
- intercommunication (nos 155, 156 and 157);
- harmful interference (nos 158,159 and 160);
- distress calls and messages (no 161);
- false or deceptive distress, urgency, safety or identification signals (no 162); and
- installations for national defence services (nos 163, 164 and 165).

To facilitate the purposes of the International Radio Regulations, the ITU has a number of organs specifically related to radio. These are world administrative radio conferences (WARCs), the International Frequency Registration Board (IFRB) and the International Radio Consultative Committee (CCIR).

Over time, agreement has been reached within the ITU membership on partitioning of the radio frequency spectrum into bands, according to use or uses. These bands are contained in the Table of Frequency Allocations, or article 8, of the Radio Regulations. New Zealand spectrum use is largely in accordance with article 8. The International Master Frequency Register, maintained by the IFRB, contains registrations which reflect New Zealand's use of the spectrum.

Registration of frequency usage with the IFRB provides protection for those assignments from harmful interference created by other usage. Registration also provides a mechanism for shared use of assignments under certain circumstances.

The duties of the CCIR are to study technical and operating questions related specifically to radiocommunication, without limit of frequency range, and to issue recommendations. The studies should not generally address economic questions, but where they involve comparing technical alternatives, economic factors may be taken into account. CCIR Recommendations do not come under the treaty status of the ITU Convention or Radio Regulations.

Over the past 20 years or so there have been World Administrative Radio Conferences covering specific radio services, such as HF broadcasting, maritime mobile, aeronautical mobile, space services and the like. In addition, Regional Administrative Radio Conferences have been held such as the Region 1 and Region 3 LF/MF Broadcasting Conference, 1975. These conferences have in some cases drawn up a priori frequency plans which ensure equitable access for all countries to a portion of the spectrum allocated to that particular service. Such arrangements apply at MF, HF, VHF and in UHF/SHF bands. These revisions of the Regulations and the frequency allocation plans contained in them have treaty status.

An example of the ITUs influence, both in treaty status and in the use of recommendations (in CCIR terms) can be summarised as follows:

The task of implementing a new FM broadcasting service:

- from the Table of Frequency Allocations (Article 8), the band 88-108 MHz is recognised for this purpose. (New Zealand has a footnote in the Table which reflects the land mobile usage of the band100-108 MHz);
- from Appendices 6, 7 and 8 of the Radio Regulations, determination of necessary bandwidth, transmitter frequency tolerances and maximum permitted spurious emission levels
- from CCIR Recommendation 450-1 (Study Group 10) the system modulation and coding is obtained;
- from CCIR Recommendation 370 (Study Group 6) propagation characteristics which are appropriate for planning;
- from CCIR Recommendation 412-4, receiver characteristics, in terms of protection ratios and channel spacing parameters;

- from CCIR Recommendation 412-4, the necessary field strengths for monophonic or stereophonic coverage can be derived.

The above is but one example of the building block approach to the provision of radiocommunication services through the area of international regulation and cooperation through the ITU.

IV PROVISIONS OF THE ACT

Section 101(c) of the Radiocommunication Act makes it a requirement that right holders comply with provisions of the First Schedule of the Act and this includes a requirement to comply with the IRRs.

In the case of apparatus licences issued pursuant to Part XIII of the Act, regulation 16 of the Radiocommunications (Radio) Regulations 1993 makes it a requirement to comply with the terms, conditions and restrictions specified in the First Schedule of the Regulations. This, too, includes a requirement to comply with the IRRs.

Technical and operational compliance with provisions of the IRRs is required as a licence condition for holders of radio apparatus licences.

Licence conditions are clearly stated in a schedule attached to each licence, and in some cases a certificate of proficiency is required before a licence is issued. Non-compliance would almost certainly result in the licence being revoked, although no actual cases have arisen.[4]

V INTERNATIONAL DEVELOPMENTS

The full range of spectrum, from 9 kHz to 275 GHz, is subject to regulation under the IRRs. In addition, "usage" of spectrum at 275-400 GHs is permitted for experimentation and development of active and passive services.[5]

Parts of the spectrum are subject to planning to ensure access to allocations for all countries, and planned bands have finite parameters and technical conditions placed on them. For example, the AM broadcasting band at 526-1606 kHz uses 9 kHz channelling, with the band

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4 Only a few licences have been revoked in recent times and these have been for breaches of New Zealand legislation rather than for breaches of the IRRs.

5 The upper limit of the regulated usable spectrum is largely dependent on the rate of technological progress. In 1938 (Cairo) the upper limit was 200 MHz; in 1947 (Atlantic City) it was 10.5 GHz; in 1959 (Geneva) 40 GHz; and today 400 GHz.

segmented into high and low power allocations. This plan had a "design life" of 15 years when dimensioned in 1975 and introduced in 1977. Other examples include allocations to the maritime mobile service and the aeronautical mobile service, with highly complex allocative mechanisms and band planning throughout the high frequency bands between about 3 and 30 MHz. The IRRs provide for a number of discrete allocations for particular countries or regions. It should be noted that mobile services are completely dependent on the use of the spectrum, unlike other services which also have available to them transmission by copper and fibre optic means.

VI BROADCASTING-SATELLITE SERVICE

The broadcasting-satellite service, occupying the bands 11.7-12.2 GHz in Region 3 and 11.7-12.5 GHz in Region 1, comprises 40 channels. These are highly managed in order to ensure that the countries and regions concerned have fair access to spectrum and orbital positions. New Zealand has six channels, three of which are at 128 degrees and three at 158 degrees. These are shared with about 30 other countries.

Feeder links for the broadcasting-satellite service in the bands 14.4-14.8 GHz and 17.3-18.1 GHz are treated similarly, with three allocations to each of the two orbital positions identified above. With progress being made on technical aspects of digital broadcasting and compression, this spectrum may be suitable to support high definition television (HDTV).

The 1992 World Administrative Radio Conference (WARC-92) made an allocation to the broadcasting and broadcasting-satellite service for digital audio broadcasting (DAB) in the band 1452-1492 MHz, which is a spectral gap between the go and return paths of a heavily used fixed service band.

Use of the frequencies for the broadcasting-satellite service is subject to a planning conference which is required to meet before 1998.

VII MOBILE-SATELLITE SERVICE

In the bands between about 300 MHz and 3 GHz, there is intense international pressure to accommodate increasing mobile-satellite services in already heavily used bands. This pressure is mainly directed at the 2 GHz portion of the spectrum, where the band 1896-2300 MHz is used in New Zealand for the fixed service.

At the 1995 World Radiocommunications Conference (WRC), it was decided that use of the bands 1980-2010 MHz and 2170-2200 MHz was not to commence until the year 2000. Use of the band 1980-1990 MHz in the Americas is not to commence until 2005, however.

Currently, there are allocations to the fixed-satellite service in both earth-to-space and space-to-earth directions. To a large extent these recognise the use of the geo-stationary satellite orbit (GSO) where the static parameters make it possible to share spectrum fairly readily with, say, the fixed service. However, non-GSO systems (various low and medium elliptical or circular orbit systems), while having known parameters, make sharing with the fixed service difficult because of their continuous movement and the low angle of arrival of their downlink signals.

A feeder link allocation in the bands 5091-5150 MHz and 6725-7075 MHz was made at WRC-95. The fixed-satellite service currently uses this spectrum in the opposite direction. It also forms part of a heavily used fixed service band in New Zealand, and the impact of space-to-earth transmissions from non-GSO space stations is of concern.

VIII FUTURE PUBLIC LAND MOBILE TELECOMMUNICATION SYSTEMS

The bands 1885-2025 MHz and 2110-2200 MHz are being planned on a worldwide basis for future public land mobile telecommunication systems (FPLMTS), with implementation expected by the year 2000. A satellite component of FPLMTS may also involve the sub-bands 1980-2010 MHz and 2170-2200 MHz by the year 2010.

IX THE NEED FOR INTERNATIONAL REGULATION AND STANDARISATION

The decisions and recommendations of the ITU provide a basis on which countries can, according to the Article 8 provisions, apportion the use of spectrum in their region. Countries have flexibility within the Table to develop national spectrum plans, to accommodate specific national requirements, but care must be taken to avoid interference to other members' radio services. National spectrum management is obviously influenced by the topography, demography, economy and culture of individual nations. In New Zealand spectrum management concerns are vastly different to those of, say, Switzerland.

Given New Zealand's geographical isolation it may be asked why it is necessary to adhere to the international radio regulatory environment? The need for international "rules", with respect to spectrum utilisation, is dictated, to a very large extent, by the laws of science. The application of these laws on particular frequency bands relates to the propagation characteristics of those bands, plus technological advances, which may open up hither-to-for unused spectrum and improve current usage of existing bands by narrower channelling, tighter technical tolerances and improved sharing capabilities.

With the advent of satellite communications techniques, the use of frequency bands where propagation is said to be "line of sight" in countries like New Zealand has become constrained by the worldwide planning mentioned earlier. Satellite systems tend to be global in coverage, ie from a geostationary satellite positioned 36 000 kms above the Equator, the "line of sight" arc of that system covers some 120 degrees of longitude and 150 degrees of latitude. In the case of polar orbiting systems, the arc of visibility can be as large as 5 000 kms. The "line of sight" propagation characteristics apply in general, to VHF bands and particularly those above, say, 100 MHz. Given this fact, consideration must be given to those bands which are used for space radiocommunications, notwithstanding New Zealand's relative terrestrial isolation.

What are the advantages of adherence to international planning and standards? Manufacturing of radiocommunication apparatus is big business, but not so in New Zealand. There is some manufacture of equipment, but largely for specialised applications. Worldwide frequency usage makes for equipment to be produced in substantial volumes, thus reducing costs to the purchaser.[6]

X IMPLICATIONS FOR NEW ZEALAND

A large percentage of the spectrum subject to ITU allocations provides for multiple use. For example, much of the spectrum allocated to the fixed-satellite service is shared on an equal basis with the fixed service and the mobile service. The ability to provide for multi-service utilisation, however, is dependent on various factors, including the work of the ITU's Radiocommunications Sector on technical parameters such as emissions, bandwidths, power levels and sharing criteria, and frequency management techniques within individual countries. The work of the ITU's Telecommunications Standardisation Sector (ITU-T) and regional standards organisations such as the European Telecommunications Standards Institute (ETSI),

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6 A couple of illustrations:

If, in its isolation, New Zealand decided to allocate a band other than 88-100 MHz for FM broadcasting (non-standard), receivers and transmitters would need to be specially developed for our small market.

In the early days of the development of television in New Zealand (1959) the channelling plan adopted for Band 1, and particularly Channel 1, was different to the rest of the world - the cost of special New Zealand tuners represented a significant incremental cost in television receivers. Technology has overcome the problem, but not until the advent of colour television. There are a number of television transmission systems throughout the world, such as PAL and NTSC. There are problems with compatibility between those Systems.

is also relevant since adherence to common standards is essential for the interconnection and interoperability of services.

In many cases, however, it is possible to depart from international practice. An example is VHF-FM broadcasting in the internationally recognised band 88-108 MHz, where for many years the whole band was used for land mobile services in New Zealand. This usage was consistent with the IRRs because the segment 87-100 MHz has enabling provisions for fixed, mobile and broadcasting usage, with the remainder of the band (100 108 MHz) having an annotation which recognises land mobile usage in New Zealand.

The flexibility inherent in the IRRs is further demonstrated by the creation in New Zealand of management rights suitable for multipoint distribution system (MDS) allocations in the band 2300-2396 MHz. The band 2300-2450 MHz is allocated internationally to the fixed, mobile and radiolocation services. New Zealand usage on this basis would be entirely consistent with the IRRs as MDS is a fixed service application. The 12 channels at 8 MHz each have been registered and are therefore recognised under the IRRs.

A further example of flexibility is in the bands between 404 and 430 MHz. These bands are allocated variously to the fixed service, mobile service, mobile-satellite service, radio astronomy service, space research service and radiolocation applications. The IRRs prohibit "any emission capable of causing harmful interference to the authorised use of the band 406-406.1 MHz". In New Zealand, this requirement has been spectrum engineered, allowing the band 404-430 MHz to be used both for fixed service and for mobile service (trunked despatch). To ignore this prohibition would render a satellite-based international search and rescue system inoperable in New Zealand.

While it might be possible to depart from international practice in some instances, this could have adverse consequences for users and service providers in terms of access to such services as DAB from satellites, FPLMTS, satellite-based mobile services and HDTV. Non-

adherence to accepted international standards would also be costly for New Zealand given the small size of its market and its dependence on imported products.[7]

Departure from international practice also opens up the possibility of overseas non-GSO satellite services, and terrestrial services such as AM and HF broadcasting, causing interference to New Zealand-based services. There is also the possibility that some New Zealand services could cause interference to overseas-based services. In this light, the ITUs process for the registration of radio frequencies should be seen not so much as an obligation, but as a significant benefit, particularly for smaller countries.

In the event that New Zealand practice made it difficult to accept a change to the IRRs Table of Frequency Allocations, it would be open to New Zealand to seek recognition of its departure from the approved frequency use through the insertion of a footnote in the table. A footnote was inserted at WARC-92 in relation to the mobile-satellite service for non-GSO systems in the band 148-149.9 MHz. Almost 80 countries, including New Zealand, indicated that stations operating in that band must not cause harmful interference to, or claim protection from, stations of the fixed or mobile service.

A further significant factor is the time required to bring about changes to the Table of Frequency Allocations, and the consultative process used to implement change in the ITU.

Agendas for conferences are developed on a four-year cycle, with WRC-95 developing a draft agenda for WRC-99, which was refined between 1995 and 1997 as a result of proposals by member countries. Acceptance of changes to the IRRs based on decisions of WRCs normally take at least a year before they enter into force. Amendments with respect to frequency

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7 Another example is VHF-FM broadcasting in the band 88-108 MHz which, for many years, was used for land mobile services in New Zealand. In Japan, like New Zealand, only a portion of the band is available for broadcasting, and vehicle receivers in that country tune only over this limited portion. Consequently, New Zealand purchasers of Japanese imported vehicles, if they wish to tune the 88-100 MHz band, must fit an extension to the tuning range of the imported receiver.

Research and development is a major cost factor in spectrum utilisation. There is little R & D in New Zealand in the field of radiocommunications. Standards for radio equipment are developed and published by the Ministry of Commerce's Communications Division. These standards define the technical parameters of particular radiocommunications equipment, including the range of frequencies over which they operate. This need for standards is primarily based on the need to minimise the interference potential, but also recognises the need for acceptable levels of quality (engineering) from manufacturers and cost to the procurer.

utilisation are normally treated conservatively from a timing point of view to allow administrations and users time to make the necessary changes.[8]

IX CONCLUSION

ITU obligations have not been a significant constraint on effective spectrum management in New Zealand. On the contrary, they offer significant benefits to New Zealand, particularly with respect to control of interference. New Zealand has a strong interest in adhering to internationally defined rules and procedures. In situations where New Zealand practice differs from internationally agreed allocations, there is provision for this to be recognised by the ITU.

8 For example, the introduction of single sideband techniques in the high frequency broadcasting service was approved in 1987, but does not become mandatory until 2016. Changes to frequency utilisation around 2 GHz decided in 1992 do not come into effect until 2000. The introduction of FPLMTS, also decided in 1992, is based on spectrum being required by about 2000 for terrestrial systems, and 2010 for satellite-based elements. Consequential frequency changes as a result of decisions taken in 1979 affecting mobile service and fixed service usage at high frequencies took over five years to complete.