The Secretary
House of Representatives Communications, Information Technology
and the Arts Committee
Suite R1, 116
Parliament House
CANBERRA ACT 2600

Dear Mr McMahon

I am pleased to enclose a submission by the Australian Communications Authority to the inquiry by the House of Representatives Standing Committee on Communications, Information Technology and the Arts into the current and potential use of wireless technologies to provide broadband communications services in Australia. The submission encompasses both radiocommunications and telecommunications issues relevant to this work of the Committee.

The ACA contact officer in regard to this matter is Mr John Haydon of the ACA's Melbourne office. His contact details are:

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Yours sincerely

A J SHAW

24 May 2002

Encl.

Submission

by the

Australian Communications Authority

to the

House of Representatives Standing Committee on Communications, Information Technology and the Arts

Inquiry into

The Current and Potential Use of Wireless Technologies to Provide Broadband Communications Services in Australia

May 2002

Introduction

The Australian Communications Authority (ACA) is pleased to provide this submission to the House of Representatives Standing Committee on Communications, Information Technology and the Arts inquiry into the current and potential use of wireless technologies to provide broadband communications services in Australia.

This submission:

- provides an overview of Australian radiofrequency spectrum management
- describes some of the practicalities of use of radiocommunications for broadband access
- reviews the range of technologies that could be applied to broadband services
- describes the regulation of telecommunications in so far as it is relevant to broadband access
- presents examples of ACA treatment of applications of radiocommunications in this context

The paper does not comment on the commercial viability or prospects of operating potential systems. Rather it focuses on the technical operations and regulatory aspects of service or potential systems.

This ACA submission and separate correspondence raise and describe some particular issues associated with current policy settings and their impact on applications and operators in Australia.

Should the Committee seek any clarification in regard to the material within this submission the contact officer is Mr. John Haydon, Executive Manager, Universal Service Obligation. His contact details are as follows

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1. ACA SUBMISSION

ACA Approach to Regulation

Through its management of radio frequency spectrum under the *Radiocommuications Act 1992* and its administration of the *Telecommunications Act 1997* the Australian CommunicationsAuthority (ACA) seeks to:

- assist and encourage the deployment of the widest possible range of technologies for the most diverse of applications and telecommunications service arrangements;
- anticipate to the extent possible features of different technologies in different applications and environments so that it may minimise administrative barriers to supply, and identify any issues such as unforeseen policy outcomes;
- apply approaches to its management and administration that maximise the role of the market in determining the success or development of applications using radio frequency spectrum or any other national asset managed by the ACA;
- promote consumer choice as the key market mechanism subject to reasonable consumer safeguards by judicious use of regulation; and for aspects outside of specific regulation, focussing on consumer awareness;
- foster the extension of competition in all new areas by applying sensible, legal interpretations of provisions of the legislation.

Making Spectrum Available

As a general principle, the ACA seeks where possible to align spectrum management arrangements in Australia with those of the rest of the world. This alignment is achieved through Australian interactions with and participation in the International Telecommunication Union (ITU), an organ of the United Nations. The ITU maintains the international Radio Regulations which allocate the various bands to various types of services. Australia is a signatory to the ITU Convention which imposes an obligation on Australia to conform to the Radio Regulations. A description of the nature and typical applications and usage constraints of radio frequency spectrum is at Parts 2.1 and 2.2.

Radio frequency spectrum is a sovereign asset, which in Australia is managed by the Commonwealth Government through the ACA. The regulation of radiocommunications under the *Radiocommunications Act 1992* (the Radiocommunications Act) provides the local management and coordination of applications using the radiocommunications spectrum. Under the Radiocommunications Act, there are three varieties of radiocommunications licence under which all spectrum is made available for use. These are:

- **Apparatus licences** –apparatus licences are usually site-based and issued subject to satisfactory frequency coordination with existing users, and specify many parameters of use. They are usually issued over-the-counter, attract a fee, and represent the majority of licensing activity.
- **Spectrum licences** – these are geographic area and bandwidth based licences that are intended to be technology and service neutral to the extent possible (i.e. the type of service to be provided is not specified). They are generally allocated by spectrum

auction and are fully tradeable, and can be sub-divided or amalgamated in the geographic and the frequency band domains. Technical frameworks are established to manage interference across the area and spectrum boundaries of adjacent licensees.

- **Class licences** – these licences provide 'public parks' for authorised use of devices that have a low interference potential. Examples of equipment operated under class licences are garage door openers, remote car door locks and intruder alarms, wireless microphones, wireless LANs, automatic tollway systems and tag security systems. Provided users comply with the conditions of the relevant class licence, individual licences are not required. No fees are payable.

Parts 2.3 – 2.5 of this document more completely describe Australia's radio spectrum management and its alignments with the international usage arrangements.

Using Spectrum for Telecommunications

The grant of a radiocommunications licence provides for access to the spectrum. However should the intended application be for the provision of services which are separately regulated under the *Telecommunications Act 1997* (the Telecommunications Act), a separate carrier licence under that Act may also be required. This legislation is also administered by the ACA. Requirements of telecommunications legislation as they relate to providing telecommunications services by means of radiocommunications are described at Parts 5.1 and 5.2.

A carrier licence is required by any person who uses a "network unit" to provide communications services to the public. This requirement is intended to be technology neutral and to apply equally to any means of provision of such services (whether by wire, optical fibre, satellite or radio system).

The grant of a carrier licence under the Telecommunications Act is an administrative process, subject to an application fee ($10 000) and an annual licence fee based on recouping the cost of telecommunications regulation (a "rule of thumb" estimate is $10 000 plus about 0.08 per cent of revenue). Possession of a carrier licence additionally entails other responsibilities (contribution to the Universal Service Obligation (USO) and the National Relay Service (NRS) — about 0.16 per cent of revenue — provision of number portability and pre-selection where relevant and submission of various reports and plans) and confers certain rights (e.g. relating to the construction of infrastructure used for public telecommunications).

Indirect (e.g. leased) use of radio communications infrastructure for broadband telecommunications is available under the Telecommunications Act service provider regime. Service providers are not individually licensed or registered and, subject to compliance with the service provider arrangements of the regulatory regime, conduct their operations as their needs dictate.

Radiocommunications for Broadband Services

There are a range of radio-based technologies and systems that are potential candidates for the provision of broadband service access. These operate in various frequency bands between about 800 MHz through to about 31 GHz. One additional development proposes to use spectrum at about 47 GHz. The design and intended applications of these technologies also varies and it may be possible to apply a technology intended for one application to another. The practicalities of use of radio frequencies for delivery of broadband services is outlined in Part 3.

Technologies that operate at frequencies that are coordinated (either apparatus or spectrum licensed), may be more likely to provide for interference free operation and a managed quality of service for customers. Coordination rules applied in such frequency bands generally mean fewer challenges being presented in relation to the use of spectrum by such technologies. Part 4.2 provides an overview of general performance of systems that operate in the coordinated spectrum bands. Of the systems described, two (those described in the next following paragraphs) are identified as proven technologies, and technologically suitable for broadband services delivery. Business structures surrounding their use, however, are an operator matter (outside the ACA's role) that would be very pertinent to successful deployment of such technologies.

Examples of such systems are the Microwave Distribution Systems (MDS) family (MDS/MMDS and LMDS) and third generation mobile systems. The MDS family is capable of providing high capacity (3 to 45 Mbits/s) and high quality services to customers in fixed locations at ranges between 5 and 40 km with a trade-off between range and data speed. Third generation mobile systems are designed to provide services up to 2 Mbits/s subject to range and rate of movement. Other systems are available for providing fixed services at less than 2 Mbits/s. Characteristics and some applications of MDS technologies are discussed at Part 4.2.7.

Satellite systems can also provide broadband services to customers, and may be especially important in low population density and remote environments where the economics of other alternatives are poor. Equipment for such services, however, has to date been more expensive than the alternative technologies available in larger population centres. Performance can also be affected by rain and for geosynchronous satellites, time delay (where this is an issue for the service e.g. voice). Satellite systems characteristics and broad comparison to terrestrial systems are discussed at Part 3.4. Some applications relevant to Australia and broadband are discussed more completely at Part 4.2.8.

Other technologies that are capable of delivering digital services of various data speeds (these include 3G mobile and existing mobile systems) are discussed at Parts 4.2.1 – 4.2.5. These are generally established technologies (except for 3G mobile) that could provide sub broadband performances. 3G mobile may be considered to be relevant to a community accepting of the necessary double trade off between data speed and both distance and speed of motion.

<u>Wireless LAN for Broadband Access</u>

Recent times (and especially since the spread of Code Division Multiple Access (CDMA) technologies), have seen the introduction of new products that have raised issues in the administration of both the Radiocommunications and Telecommunications Acts. Some particular issues have arisen in relation to devices that use class licensed spectrum.

Because of their low cost and class licensed (no charge) access to the radio spectrum, these CDMA technologies have become contenders for a range of access applications, sometimes outside of their design intent.

Most Wireless Local Area Networks (WLANs) are in this category (CDMA systems using class licensed spectrum) and there are several variants that use different class licensed frequency bands. Each provides a different range and data rate trade-off (with longer range associated with lower data rate). The IEEE 802.11 and 802.15 families of standards are examples of such systems. Part 4.1 provides a description of the intended useability of WLANs and the provisions for increasing their use.

An issue from a radiocommunications spectrum management perspective is that in a class licensed environment their extensive use could result in increasing mutual interference. This is not a breach of the regulatory regime, as the class licensing system does not offer users any protection from interference. However unrealised expectations of new users of class licensed spectrum, and subsequent degradation of services, could result in pressures to alter the regime to the detriment of current uses. Notwithstanding communication applications, Industrial Scientific and Medical devices (ISM) which are not radiocommunications devices, share these bands internationally and are not coordinated by the licensing regime described above but rather fall into the electromagnetic compatibility (EMC) regime.

Telecommunications Regulation Issues

Aspects of the telecommunications regime relevant to licensing of operators proposing to use radiocommunications equipment for providing any kind of telecommunications services are discussed at Parts 5.1 and 5.2.

How new applications of WLANs in particular have highlighted some rigidities in the telecommunications regulatory regime is discussed at Part 5.3. In general, the phraseology and approach of the regime presume large scale operations and it is built around precise interpretation of the legislation. These features mitigate against niche operators. For example the grant of a carrier licence imposes a set of obligations that is necessarily inflexibly applied. These require reporting and contribution to the USO, provision of pre-selection and number portability for telephony, annual licence fees based on turnover not profit and a number of reporting requirements that represent a significant burden to any small scale operation.

Additionally there are discrepancies in the legislation between wireless and wireline systems. Wireline systems may incorporate a cable distance of 500 metres for a single section or 5kms in multiple sections without any requirement for a carrier licence to cover these line links. No distance provision exists for wireless systems, with any wireless connection between two points requiring a carrier licence if the wireless link is used on a commercial basis for providing services to the public.

While this latter issue has arisen in relation to applications involving Wireless Local Area Networks operating in class licensed spectrum, the principles would have been equally valid regardless of the technology or spectrum used for this style of provision of telecommunications services.

Recognising these telecommunications regime limitations and lack of any discretion in application, the ACA has, to the limit of flexibilities available under the Telecommmunications Act, devised at least partial solutions to allow the operation of such small-scale telecommunications services. It has also separately proposed that resolution will require an exemption under s51 of the Telecommunications Act for some wireless equipment and an amendment to the Telecommunications Act.

Issues the Committee might consider

The ACA in its administration of the radiocommunications and telecommunications regulatory regimes encounters circumstances that potential telecommunications providers represent as difficulties. Nonetheless in many instances these are a policy balance between competing outcomes. Some issues that are relevant to this enquiry and could be considered by the committee in its work are summarised below.

- Impact of the carrier licensing regime on small scale or secondary telecommunications services provision. The current regime provides for only one scale of carrier operation however many potential new entrants are, at least initially, small scale. Businesses would wish to apply telecommunications technologies as conveniences to complement their primary business. In this they do not see themselves as a telecommunications operator of any kind, although the regulatory regime classes them as such. A dual tier licensing regime could be considered in order to assist entry. For example, some requirements of being a carrier under the current regime could be set aside until a threshold of scale (customer base or revenue) is reached. Requirements that could be considered for setting aside (or reduction) include:

    - annual licence fee and licence application fee;
    - contribution to the USO, NRS (and associated reporting);
    - provision relating to aspects of telecommunications interception, number portability and pre-selection (where the latter two are relevant);
    - compliance with the Customer Service Guarantee.

- Improved Technology Neutrality. Notwithstanding the objective of technology neutrality there are differences in the legislation in its expression of requirements on wireless and wireline services provision. Under a wireline based provision of service, cabling that is on the customer side of the network boundary on one premises, or even across premises but less than 500m, does not require a carrier licence. If identical services are provided by wireless, no distance based or single premises based exemption from the requirement for a carrier licence is available. The objectives of the *Telecommunications Act 1997* would be served by aligning the wireless provisions to the wireline provisions. In particular, setting range or premises based tests provides another threshold below which regime requirements are reduced.

- Provision for discretion in application of the regime. There are instances where a business proposes to make available a telecommunications service to some constrained sub sets of the public (its customers) as a complement to its primary business. Similarly, there may be instances where small amateur like start up enterprises should be encouraged. Scale and circumstance should be considerations in assessing whether such a business or enterprise should be required to hold a "full" carrier licence. Some relevant exemptions already exist as Ministerial regulations, and a devolution to the ACA would be a logical additional flexibility for the regime.

2. RADIOFREQUENCY REGULATION

2.1 The Nature and Use of Spectrum

Electromagnetic energy, comprised of rapidly oscillating electric and magnetic fields, can be transmitted along metal wires or optical cables, or can be radiated through space. Radio waves, visible light, X-rays and cosmic rays are all electromagnetic emissions of different frequencies. The particular propagation characteristics of different frequencies mean that some frequencies are more useful for one purpose than another.

Coding information onto Radio Frequencies - Information (in the form of speech, music or data) can be coded or impressed onto a carrier radio wave by "modulating" a carrier frequency with the information signal. This is the mechanism by which information can be sent to other locations without the need for physical connections.

The earliest form of modulation was simply to switch a transmitter on and off to transmit data with short or long bursts; this provided the first form of digital modulation (Morse Code). Transmission of voice and music became possible when a way was found to vary the power or the frequency of the transmitted carrier signal in harmony with the information signal (amplitude or frequency modulation). Digital modulation is a variation of these techniques and, with increased computing availability, is being increasingly used to increase the data rate capability of any carrier frequency. This means that efficient spectrum management is a continually evolving task.

Radio frequencies: Bands and Propagation - The radio spectrum extends from the lowest useable frequencies around 9,000 Hz[1] to around 3,000,000,000,000 Hz, which approaches infrared light. By international agreement, bands of frequencies are referred to as:

- VLF Band below 30 kHz (Very Low Frequency)
- LF Band 30-300 kHz (Low Frequency)
- MF Band 300 kHz-3 MHz (Medium Frequency)
- HF Band 3-30 MHz (High Frequency)
- VHF Band 30-300 MHz (Very High Frequency)
- UHF Band 300 MHz-3 GHz (Ultra High Frequency)
- SHF Band 3 GHz-30 GHz (Super High Frequency)
- EHF Band 30 GHz-300 GHz (Extra High Frequency)

Bands above 1 GHz are generically referred to as “microwave bands”.

Radiowave propagation in the atmosphere can be affected by humidity, rainfall and solar activity. Radio waves can be bent, scattered, reflected or absorbed depending on frequency. All of these phenomena introduce variation in the way that different frequency radio waves propagate. Lower frequencies generally propagate longer distances and penetrate some materials, while higher frequencies are more suited to shorter range "line-of-sight"

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[1] Hz is the abbreviation for the term Hertz. One Hz is one oscillation, or cycle per second. 1 kilohertz (kHz) is 1,000 Hz. 1 Megahertz (MHz) is 1,000 kHz. 1 Gigahertz (GHz) is 1,000 MHz. 1 Terahertz (THz) is 1,000 GHz.

applications. These characteristics are taken into account in service planning and frequency coordination.

Examples of use are:

- 10-20 kHz (VLF) for communication with submarines just below the sea's surface. A few high powered transmitters provide worldwide coverage but at a low information rate.
- 526-1606 kHz (MF) for AM broadcasting. Coverage varies between day and night depending on the ionosphere (a region of the upper atmosphere which can reflect radio waves).
- 4-30 MHz for international shortwave (HF) radio services, amateur radio, maritime, aviation and defence. These frequencies can communicate over thousands of kilometres depending on reflection off the ionosphere which is directly affected by solar radiation. Usable frequencies change during each day and seasonally.
- 45-230 MHz for VHF television and FM radio. These frequencies can travel over hilly terrain to some extent. Mobile radio uses separate segments within this range for many different purposes. Useful coverage is 40-100 km.
- 526-820 MHz for UHF Television. More affected by hilly terrain. Useful coverage 40-100 km.
- 820-960 MHz for cellular mobile telephone and other similar services. Useful coverage depends on design and type of service, from a few kilometres up to around 100 km.
- 1-3 GHz for aviation and marine radar, trunk route microwave telecommunication links, and multipoint video distribution. Mobile telephone services are expanding into these bands, and parts may be used for Digital Sound Broadcasting services in the future. Useful range is generally limited to line-of-sight.
- 3-30 GHz for navigation and traffic control radar, satellite communications, satellite broadcasting, space research, microwave telecommunication links and other line-of-sight bandwidth demanding communications. Signals can be adversely affected by rain attenuation and atmospheric absorption due to water vapour, dust, or oxygen at particular frequencies.

With advances in technology higher frequencies can be successfully used, initially for research followed later by practical use for communications services. Progress to higher frequencies is also driven by growth in use of lower bands, which causes congestion in some urban situations.

2.2 The Need to Manage the Radio Frequency Spectrum

The radio frequency spectrum needs to be managed in order to optimise its use and to manage interference between users. Generally speaking, radio receivers are not able to distinguish between multiple transmissions on the same frequency where these are of similar strength.

Because of this potential for interference, spectrum is described in economic terms as being a finite, instantly renewable, natural resource. As a limited resource, it has significant economic value and this value is maximised by managing interference.

The other reason for managing the spectrum relates to harmonisation between countries. Generally speaking, Australia's various industry sectors, and ultimately consumers, benefit from internationally agreed spectrum arrangements and standards; costs are lower through larger economies of scale and the market place is more competitive. For example, the international transport sector relies on global harmonisation of spectrum arrangements (and technical standards) to support the safe control and free movement of aircraft and shipping between countries.

Spectrum is an increasingly important national economic resource, as it is increasingly used to provide communications services. Current uses continue to expand and new uses are found.

2.3 Australian Management of Spectrum

The following items identify the essential ingredients of spectrum management in this country.

The Radiocommunications Act 1992

The radio spectrum is a sovereign asset, which in Australia is managed by the Commonwealth Government. The Australian Communications Authority is an independent statutory authority within the Commonwealth Government's Communications portfolio.

The ACA must manage the spectrum in accordance with the Radiocommunications Act, which sets out the objectives and the tools available to it. These tools include powers relating to frequency planning, licensing and technical standards. The Radiocommunications Act also contains provisions on public consultation and rights of appeal.

International Telecommunication Union

In most countries, including Australia, planning is coordinated internationally through the International Telecommunication Union (ITU). The ITU is an organ of the United Nations and maintains the international Radio Regulations, which set out the allocations of various bands to various types of services.

Australia, like many other countries, is a signatory to the ITU Convention. This means that Australia has obligations under international law regarding compliance with the Radio Regulations. In essence, Australia must not cause interference to the services of other countries where those services operate in accordance with the Regulations; conversely, Australian services are entitled to protection against interference from other countries only when our services operate in accordance with the Radio Regulations.

Domestic Technical Planning

<u>The Australian Radiofrequency Spectrum Plan</u>

The Australian Radiofrequency Spectrum Plan (ARSP)[2] is the broadest level technical document showing the allocation of bands to various types of services. It is analogous to town plan subdividing land areas into zones. As well as giving the first layer of spectrum

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[2] See http://www.aca.gov.au/frequency/spectrum.htm

resource allocation, there is a degree of interference avoidance built into the service allocation relationships and associated regulations.

The ARSP is drawn from, and kept current with, the ITU Radio Regulations, which are revised every few years at World Radiocommunication Conferences.

The ARSP is the first document that should be consulted regarding spectrum arrangements in Australia. It is the starting point and is not usually sufficient for assigning specific frequencies to users; two lower levels of planning are usually necessary.

Band Plans and Channel Plans

Band plans[3] and channel plans[4] take a band (portion) of spectrum and provide a more detailed description of how the band is allocated. Band plans provide detailed allocation of the spectrum resource between types of services. They usually contain detailed frequency channelling arrangements and build in a number of specific interference avoidance measures. These plans are developed as and when necessary.

2.4 Managing the Risk of Interference

2.4.1 Frequency Coordination

To avoid interference, radio receivers need to be adequately separated in frequency or in geographic distance, or in some combination of both, from undesired transmissions. How far services need to be separated in frequency and/or distance depends on the characteristics of the services and technologies concerned as well as on the propagation characteristics of the frequency band.

It is usually necessary to establish and codify these relationships to enable frequency assignments[5] to be made and interference to be avoided. In this way new users are reasonably assured that they will not cause interference to existing users or suffer interference from other users. Documentation is available on the ACA web site[6] for various frequency coordination scenarios of this kind. A feature of successful coordination is public registration of the technical details associated with the new user's operations so that other prospective users can take them into account. Nomadic (random, ad hoc) operations are not readily able to be addressed through frequency coordination processes.

2.4.2 'Public Park' spectrum

With some kinds of radiocommunications (and most WLAN systems) it is possible for users to share spectrum without formal frequency coordination between users – this is akin to communities sharing public parklands for a range of purposes, the initial compatibility of which is a matter for those users of the park.

Under the 'public park' approach, the planning objective is for all users to be able to access a small portion of the total resource (a frequency band) and to share that resource in a way

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3 See http://www.aca.gov.au/frequency/bands.htm for band plans

4 See http://www.aca.gov.au/frequency/fx3/fx03.htm for microwave fixed link channel plans

5 Frequency assignment means an authorisation for a radio station to use a radio frequency/channel under specified conditions.

6 See http://www.aca.gov.au/frequency/frqassrq.htm

that requires minimal regulatory intervention. This avoids the need for ongoing individual frequency coordinations and for registering of locations of equipment as the number of users increases. Access to the band by all potential users is then relatively unconstrained. To support this objective, the general conditions of operation (including technical conditions for equipment) that apply to all users are constructed to limit the risk of interference between users under most likely situations. However, because the locations of users are not coordinated or registered, operations in 'public park' bands do not carry guarantees of interference-free operation. Citizens Band radio is perhaps the most familiar form of this arrangement.

Whether radiocommunications equipment is being operated in a frequency coordinated environment, or an environment in which operations are uncoordinated (e.g. 'public parks'), interference between users may still arise from time to time. This is usually because of circumstances particular to the case, although sometimes such things as anomalous (freak) propagation events can give rise to more widespread problems.

2.4.3 Licensing

Generally, the Radiocommunications Act requires that the users of transmitters must be licensed. The Radiocommunications Act provides for three forms of licences:

- Apparatus licences – these specify the category of service, eg, fixed, mobile or broadcasting, and the technical characteristics including the location, power, frequency of operation and the radiofrequency emission type. Apparatus licences are usually site-based and issued subject to satisfactory frequency coordination with existing users, are usually issued over-the-counter, attract a fee, and represent the majority of licensing activity. Apparatus licences may be traded. More information on licensing categories[7] and fees[8] is available electronically. An on-line database of current licensees is also available[9].
- Spectrum licences – these are geographic area and bandwidth based licences and are intended to be technology and service neutral to the extent possible (i.e. the type of service to be provided is not specified) so as to give maximum flexibility to the licensee. Once allocated, these spectrum assets are fully tradeable, and can be sub-divided or amalgamated in the geographic and the frequency band domains. This allows licensees to acquire, through participation in auctions or through trading in the secondary market, whatever spectrum space is necessary to deploy the type of service required. To support this approach, technical frameworks are established to manage interference across the area and with adjacent licensees. These frameworks build in any applicable frequency coordination requirements.
- Class licences[10] – typically these are umbrella licences designed to provide 'public parks' for the authorised use of various devices that have a low interference potential. Common examples of devices operated under class licences are garage door openers, remote car door locks and intruder alarms, wireless microphones, WLANs, automatic tollway systems and tag security systems. Provided users are operating transmitters that

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7 See http://www.aca.gov.au/licence/apparatus/index.htm

8 See http://www.aca.gov.au/licence/fees/index.htm

9 See http://www.aca.gov.au/database/index.htm

10 See http://www.aca.gov.au/licence/class/index.htm

comply with the conditions of the relevant class licence, then individual licences are not required. No fees are payable.

2.4.4 Radiocommunications Standards

Radiocommunications standards[11] are developed as necessary to ensure compatibility or to contain emissions from transmitters.

2.4.5 Interference Management Options

Interference is managed by the combined effects of licensing, regulations, standards and frequency co-ordination procedures. The three forms of licensing described above all manage interference but have different mixes of these essential ingredients. Deciding on the appropriate form of licensing for a particular application requires consideration of many factors.

2.5 International Differences in Spectrum Use

For reasons of history and the interests of various countries that wish to support or create markets for national electronics industries, equipment standards and spectrum use arrangements for radiocommunications equipment often differ in different parts of the world.

In many areas of radiocommunications technology, Australia is faced with a need to choose between spectrum arrangements that are aligned with Europe or with North America; occasionally we also face a third (Japanese) option.

Recognising Australia's balance between major world trading blocks, Australia has argued in the ITU that international radio spectrum arrangements should be based on consistent world wide allocations rather than allocations that differ between the three ITU Regions[12]. This would ensure the largest possible markets for equipment and should thereby promise lowest cost and widest choice for users. It would also lead to simplifications and efficiencies in developing spectrum sharing arrangements since it avoids the need to study and plan around unique national sharing situations.

Notwithstanding these ideals, we still face many situations where different spectrum use arrangements apply in each of the ITU Regions.

[11] See http://www.aca.gov.au/standards/index.htm

[12] These are: Region 1 – Europe, Africa and the Middle East; Region 2 – North and South America; and, Region 3 – Asia and Oceania.

3. PRACTICALITIES OF RADIOCOMMUNICATIONS FOR BROADBAND

3.1 Meaning of Broadband

The following definition of "broadband" was included in a recent report to Industry Canada titled "*The New national Dream: Networking the Nation for Broadband Access*"[13].

> Based on today's technology and applications, high-speed broadband is defined as a high-capacity, two-way link between end user and access network suppliers capable of supporting full-motion interactive video applications delivered to all Canadians on terms comparable to those available in urban markets by 2004. A minimum symmetrical speed of 1.5 megabits per second per individual user is currently required to support these applications. Leading up to 2004 and beyond, new applications such as peer-to-peer file interactions and video conferencing will increase individual user demand for symmetric bandwidth in the 4-to-6 Mbps range. Public and commercial facilities will require much higher bandwidth, ranging from this minimum to several hundred times more, depending on their size and user needs.

While it may not be practical or realistic to deliver a symmetrical data rate of 1.5 Mbit/s to all parts of Australia, it is clear that for users to be able to access "broadband" services they will need access to data rates well above those needed for basic voice communications.

Other definitions of "broadband" may also exist, but any definition is likely to imply significantly higher data rates than most users are currently accessing. The required increases will probably be greatest for rural and remote area users. Irrespective of the definition adopted, the cost and difficulty of providing broadband services to all Australians is expected to be significant.

Provision of broadband access or carriage is most efficiently achieved at relatively high frequencies (more than 1 GHz and at present up to around 40 GHz). As candidate radio broadband systems all operate in this region it is appropriate to consider the issues of operation at these frequencies.

3.2 Frequency, Propagation and Availability Issues[14]

As frequency increases, the signal loss per unit distance increases. However as frequency increases the effectiveness of a given antenna will increase. In many situations these effects will offset each other so communication distances are constant for a wide range of frequencies. Where small antennas are mandated for aesthetic or other reasons, there can be advantages in using higher frequency bands, however these need to be weighed against the potentially more costly technology required to use these bands.

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[13] http://broadband.gc.ca/Broadband-document/english/table_content.htm

[14] Material on propagation effects has been drawn from "Microwave Radio Spectrum Trends: Accommodating the demands of growth, new technologies and relocation - an ACA Information Paper Radiofrequency Planning Group, February 2000"

The above effects apply for radio wave propagation in "free space". However signals propagating in the atmosphere near the surface of the earth are subject to other effects. Multipath fading (reflections), and rain attenuation are the most commonly encountered of these.

1 to 10 GHz range

The principal propagation constraint for terrestrial systems at the lower end of the microwave spectrum (1 GHz to 10 GHz) is multipath fading, a complex self interference propagation mechanism that degrades link performance, especially over long paths and particular types of terrain (e.g. bodies of water). The self interference is caused by reflection and refraction over the transmission paths, causing the signal to be received via multiple paths, each arriving at slightly different times. Multipath fading is an important factor in determining link performance and achievable path length; higher capacity wideband systems are more sensitive to this phenomenon.

Frequency bands in the range between about 1 to 10 GHz are well suited to long distance applications due to their favourable propagation characteristics and the availability of relatively low cost hardware and infrastructure. Consequently, these bands, especially those at the lower end of the range, are already heavily utilised by a number of telecommunications services (e.g. mobile telephony, fixed point-to-point links, fixed point-to-multipoint services, etc).

Above 10 GHz

Frequency bands above about 10 GHz are subject to significant rainfall and atmospheric attenuation (which generally increases with frequency). As rain attenuation is related to rainfall, this is of greatest concern in the tropical parts of Australia.

These effects limit the achievable range of terrestrial systems and will increase the number of transmitting sites needed to achieve particular coverage requirements. In turn this increases network infrastructure costs. While in most cases this is a clear disadvantage, for high bandwidth urban networks and local access (i.e. broadband wireless) applications this can in fact be an advantage.

Spectrum can be used more efficiently the more that the same frequency can be reused. The re-use distance (i.e. the minimum geographic separation for reuse) depends on how far the signal propagates. At the higher frequencies, reuse distances become significantly smaller, making these frequencies better suited for service delivery in a high density urban environment.

In satellite systems operating above 10 GHz, rainfall and atmospheric attenuation act to limit system availability[15] and hence continuity of service. In critical situations, larger antennas providing more link margin, or alternatively site diversity, can improve system availability. However, ultimately satellite systems cannot economically achieve the very

[15] Availability is one of the factors that contributes to the overall "Quality of Service" of telecommunications networks. Where telecommunications services are being provided under the *Telecommunications Act* it is [important] or even [a requirement of carrier licence conditions] that they meet defined Quality of Service levels.

high availability rates available from well engineered optical fibre systems and terrestrial point-to-point microwave systems.

Terrestrial microwave systems can also suffer reduced availability due to rainfall attenuation and multipath fading. In point-to-point link applications careful design (e.g. limiting path length to achieve large link margins) and techniques to increase power during signal fading allows high availability to be obtained. In terrestrial point-to-multipoint (broadcast like) applications (likely to be used for delivering broadband services to end-users) similar techniques can be used but the end result is likely to be less dependable because it will be harder to closely engineer each remote station of the point-to-multipoint system.

Noise

An issue of concern is that the Sun can act as a source of radio noise. This would not usually be a problem for terrestrial systems, but satellite systems may suffer from dramatically increased noise levels for short periods at times when the satellite receiving antenna is pointing toward the sun as it passes overhead.

3.3 Fixed vs Mobile

Achievable data rates for mobile communications systems depend on basic physics and system operation constraints. Data rates for mobile systems are generally lower than for communications systems employing fixed receivers[16]. To ensure that moving receivers can reliably receive a given data rate, designers of mobile systems limit the maximum transmitted data rate based on assumptions about the maximum speed of receivers. The maximum data rates achievable in this situation will be lower than those that would apply if a system had been planned on the basis of fixed transmitters and receivers.

Fixed terminals can be more readily optimised to avoid obstacles and obstructions. Systems that operate between fixed locations can employ directional antennas. Thus, a fixed system can achieve higher gain and therefore operate further away from the base or hub terminal. By contrast mobile terminals must be able to receive from any direction relative to the base station. Thus mobile terminals have to employ omni-directional antennas that are not as sensitive (i.e. have lower gain) to ensure that some level of communications with the base is achieved. Given a fixed amount of transmitter power in a mobile terminal, the lower gain antenna will set a limit on the range and/or signal strength (which eventually sets a limit on possible data rate) that can be achieved.

Also, the antennas of mobile terminals (especially if they are hand held or are on vehicles) will in general be at lower heights above ground level than the antennas of fixed terminals that may be mounted at roof-top level. A higher antenna will (usually) encounter fewer obstructions and receive higher signal strength.

This means that a technology designed to achieve an acceptable near broadband performance while mobile may well achieve an even better performance if used as for fixed broadband access (i.e. no movement).

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[16] This is because all moving receivers are subject to Doppler effect, which shifts the frequency spectrum of the received signal.

3.4 Terrestrial vs Satellite

Coverage and capacity aspects

Terrestrial wireless and satellite wireless systems differ in a number of important ways. Terrestrial wireless systems that operate in bands above 1 GHz have maximum coverage areas that are essentially line of sight. To a small degree, coverage can be improved by increasing the height of the transmitting antenna. This helps to "see further" and "see over more obstructions". But obstructions such as hills, mountains, buildings and even trees will eventually limit the coverage of terrestrial wireless systems. On the other hand, satellites can be viewed as extremely high masts; as a result they can "be seen" by most receivers and so will be much less likely to be obstructed by hills or mountains. In most cases buildings and trees will present less of a problem than they do for terrestrial systems.

Terrestrial systems can potentially achieve high levels of spectrum productivity, because a given set of frequencies can be re-used many times. A terrestrial system that is beyond the line-of-sight of another system can re-use the same frequencies as the first system without risk of mutual interference[17]. The same principles apply for satellite systems, however current satellite systems have relatively large coverage areas that do not achieve high levels of frequency re-use. If all users in a given area access the same block of spectrum then the available spectrum divided by the required bandwidth per user will determine the maximum number of simultaneous users. In practice this means that to achieve the same end-user capacity a satellite system will require a greater amount of spectrum than a terrestrial system. (Of course in a complete analysis other factors including total system cost and speed of deployment would also need to be taken into account.)

Proposed newer generation satellite systems that use smaller coverage spot beams can achieve higher levels of frequency re-use (and may use higher frequency bands where more bandwidth is available) and therefore will achieve higher capacity.

Infrastructure costs and deployment rates

In comparison with satellite, terrestrial wireless systems have lower start up costs and their deployments can be immediately applied to the areas of greatest or most immediate need. Also, deployments can be staged to match budgetary or equipment delivery schedules. Against this, full national deployments of new technologies or capabilities may require time-frames of several years and for some instances involve costs commensurate with satellite systems.

Terrestrial wireless systems that deliver services to end-users require supporting infrastructure (communications backbones to the hub station, as well as roads — to allow construction and maintenance access — and electricity, although solar or wind power can be more practical in remote areas). In areas where communications sites do not currently exist, the cost and time needed to establish new sites can be considerable.

Although satellites have high launch costs (typically several hundred million dollars for GSO satellites), once launched and deployed in orbit satellites provide a quick, full capacity

[17] Carefully engineered systems using directional antennas and modern digital modulation methods can support even closer re-use distances.

at day-one, solution. In other words, this capacity is available to all points in the service area. The only limitation is the availability of the necessary earth station equipment.

Eventually there are limits on satellite capacity if a two-way service is to be provided. Satellites may not be able to support large numbers of separate users. Also, once the communications capacity is reached, augmenting the capacity is usually a major exercise.

3.5 Urban vs Rural Issues

While the principles of radiophysics obviously apply equally in urban and rural areas, demographic differences between the areas can lead to different wireless approaches.

In urban areas higher frequency bands have advantages because they offer wider bandwidths, and atmospheric losses are not a major concern if coverage cell sizes are small. (Higher atmospheric losses actually help achieve good levels of frequency re-use as they reduce the chance of interference from distant cells operating on the same frequency.) Higher frequencies also imply smaller and less obtrusive antennas (this would assist in addressing such matters as town planning and environmental regulations).

In rural areas where longer distances are needed to capture enough users in a coverage cell to make a service economically viable, path loss is a major consideration. For this reason there is a strong preference to operate on lower frequency bands to support larger sized cells. Fortunately, however, in rural areas the competition for spectrum is less strong, so this may be more practical than in urban areas.

3.6 Backhaul Network Considerations

In addition to the systems for delivering broadband services to end-users, the provision or upgrading of core telecommunications backbone network capacity is expected to be a major issue in achieving access to broadband services in rural and remote areas.

"*The National Bandwidth Inquiry*"[18], April 2000, concluded that many regional areas of Australia are poorly served for bandwidth, with most telecommunication bandwidth and service delivery competition concentrated around the low-risk, high volume urban markets. While the gradual expansion of optical fibre networks into larger regional and rural centres will, over time, address some of the deficit, terrestrial point-point microwave links are expected to retain a key role in the provision of backbone telecommunications infrastructure to regional, rural and remote areas into the foreseeable future.

In areas where optical fibre network infrastructure is not available, provision of the significantly increased capacity needed to support the delivery of true broadband services to end users will require a commensurate major expansion in the capacity and reach of the radio based backbone infrastructure. This will be an expensive exercise (although usually less expensive than providing the capacity by optical fibre). Many existing parts of the backbone network could be upgraded to provide additional capacity, however expanding the capacity and reach of the backbone network is likely to also require the establishment of

[18] A Department of Communications, Information Technology and the Arts (DCITA) study into the likely availability and price of bandwidth in Australia over the next five years – see http://www.noie.gov.au/bandtask/bandwidt.htm.

many new radio relay sites. This will represent a high up front cost/low rate of return investment for carriers/operators.

In contrast to the situation in rural and remote Australia, urban centres are generally well served with telecommunications backbone infrastructure. High capacity infrastructure within and between major urban centres is being provided via fibre, microwave radio and, less frequently, satellite technologies. The high capacity internal backbone networks within major urban areas provide a good platform for deploying wireless or cable services that will be able to deliver broadband services to end users.

3.7 Point to Multipoint

"Point-to-multipoint" is a network architecture type where a high site, high powered, omni-directional hub station (that is connected by a high capacity link to the main telecommunications backbone network) will send and receive signals to and from a large number of low site, low cost, relatively low power, directional subscriber terminals. This architecture is well suited to delivery of wireless broadband services. It promises considerably lower costs than alternative arrangements (e.g. point-to-point) because fewer sites need to be acquired and established, and because the hub stations consolidate transmission and reception equipment that would otherwise be spread over a very large number of point-to-point transmission sites.

3.8 Satellite Communication

Satellite based communications can carry a wide variety of communications services including: television broadcast, Internet communications, remote area telephony and data services, corporate data, videoconferencing, aggregated telecommunications data traffic, weather forecasting, and Global Navigation Satellite Systems (GNSS) such as the Global Positioning System (GPS).

Types of satellite orbits

Satellite systems can be categorised according to the type of orbit they follow.

Geostationary Orbit (GSO) satellite systems follow a circular orbit in the equatorial plane with a height of 36000 km above the earth. At this height the satellite appears at a fixed location in the sky relative to an observer on earth. From this location almost 1/3 of the earth's surface is visible to the satellite, so near global coverage can be achieved with a minimum of three satellites in orbit. However, in most GSO applications coverage areas are smaller than this — typically national or sub-national. There is a trend to even smaller coverage beams, but with switching so that traffic can be redirected according to changing traffic demands. GSO satellites are currently the dominant type of communications satellite.

Non-Geostationary Orbit (NGSO) satellite systems employ constellations of satellites, usually in a circular orbit at a constant altitude that is lower than that of a GSO satellite. NGSO satellites are further classified, depending on the altitude of their orbit, into Low Earth Orbit (LEO) and Medium Earth Orbit (MEO). The constellation is arranged in such a way that, from any point on the earth at any time, at least one satellite is visible. In recent years there has been considerable interest in the concept, and a few deployments of constellations of NGSO satellites. Iridium, Globalstar and Teledesic are examples of NGSO systems.

NGSO satellite systems require a large number of satellites to be manufactured and launched within a fairly short space of time, although the satellites themselves are usually smaller and cost less to place in orbit than GSO satellites. Because they operate in lower orbits than GSO satellite, NGSO satellites have lesser delay and attenuation. This makes them attractive for applications involving mobile terminals, especially voice applications where delay and variable signal loss due to obstructions are serious design issues.

The key features of satellite systems are:

- capability to provide communications to all points of a coverage area (satellites are a very effective way to provide communications to remote areas);
- very well suited to point-multipoint applications (e.g. broadcasting);
- once launched and operational, services are immediately available in all parts of a coverage area, the only impediment is the availability of user terminals.

Areas where current satellites are less well suited are:

- when large coverage areas are used, they achieve low frequency re-use levels (as a result their capacity to provide for very large numbers of independent users is more limited than that of terrestrial services);
- providing two-way communications to large numbers of users is difficult;
- GSO satellites are not well suited to providing delay sensitive services (e.g. telephony);
- areas where there are signal path obstructions such as urban canyons or inside building.

Services and Capacity

Distance independent communication and wide area coverage, means that satellite systems are well suited to providing point-to-multipoint services such as television broadcasting and services to remote areas.

Current generation GSO satellites usually have design life-times of about 15 years[19].

NGSO satellites, because of the harsh radiation environment they exist in and the amount of fuel used for station keeping, last 5 to 8 years.

The achievable capacity of satellites and their footprints depends largely on the application and the reception equipment used, but it usually ranges from a couple of Mbit/s up to a theoretical capacity of several thousand Mbit/s. Satellites currently providing services within Australia have a maximum theoretical capacity of several thousand Mbit/s. Considering a minimum broadband capacity per channel and the number of independent users that might need to be supported, it is difficult to see that any satellite network currently servicing Australia would have enough capacity to provide independent two-way

[19] Nowadays this period is largely determined by requests from satellite operators. Longer periods are not likely to be advantageous because of the increased risk of technological obsolescence over the life of the satellite and the requirements of financiers to achieve returns on investment in the shortest possible time.

broadband services to a large percentage of the Australian population. They may, however, be useful for delivering services in areas where it is impractical or uneconomic to deliver such services by terrestrial means.

A key issue that needs to be addressed if true interactive broadband capacity is to be provided via satellite is the provision of return-channel communications capacity from the user back into the wider telecommunications network. In areas that are poorly served by terrestrial infrastructure, satellite is the only real option, but two-way earth stations are expensive and current satellite architectures do not support very large numbers of simultaneous wideband uplinks.

4. SYSTEMS FOR WIRELESS BROADBAND SERVICES

The range of wireless systems for broadband services fall into two broad categories:

- those designed to operate in class licensed (uncoordinated) spectrum (2.4, 5.2 and 5.8 GHz)
- those in the apparatus and spectrum (coordinated) licensed bands.

Systems that operate in the class licensed bands are generally characterised as low cost, short range, for single enterprise application. Additionally, recognising the potential for interference from other users, quality of service considerations are likely to set limits to workability over longer range or commercial application involving any significant customer base.

Systems designed for operation in the coordinated bands are generally designed for commercial application (larger geography, managed quality of service, larger customer base etc.).

The following sections describe particular technologies that may be considered for delivery of wireless broadband capabilities to end-users. The provision of backbone telecommunications capacity to feed and receive broadband signals from these end-user delivery technologies is an important additional consideration (see section 3.6).

4.1 Systems Operating under Class Licenses (uncoordinated)

4.1.1 2.4 GHz, Class Licensed Systems

Frequency Band Regulatory Arrangements

Australian class licensing for the 2.4 GHz band are similar to those of most overseas jurisdictions. The band is established for open usage subject to constraints set down in a class licence. Provided devices operate within these terms, users may deploy and operate any devices, but they must accept that other users may also use the band and must self manage any radio interference. The arrangement permit devices that operate in the frequency band from 2.4 GHz to 2.463 GHz with a maximum radiated power of 4 W equivalent isotropically radiated power (EIRP) and from 2.463 GHz to 2.4835 GHz with a maximum radiated power of 200 mW EIRP. The band 2.4 – 2.4835 GHz is the same band as is available in many other countries for "WLAN applications at 2.4 GHz".

WLANS that operate in the 2.4 GHz band share it with a broad range of other users. Other radiocommunications devices known to be operating under the ACA's *Radiocommunications Class Licence (Spread Spectrum Devices)* include short range fixed links, cordless telephones, wireless medical telemetry equipment and Bluetooth™ short-range wireless applications. There is also a diverse range of radiocommunications devices operating under the ACA's *Radiocommunications (Low Interference Potential Devices) Class Licence 2000.* Supported devices would include video security links and radiofrequency identification tags.

The 2.4 – 2.5 GHz band is also designated in Australia and internationally for industrial, scientific and medical (ISM) applications. ISM devices are non-radiocommunications devices that use radiofrequency energy for such purposes as heating, drying or welding. The most common ISM device in the 2.4 GHz band is the domestic microwave oven. Under international agreement, radiocommunications services operating in ISM-designated bands must accept any harmful interference caused by ISM applications.

The operation of WLAN devices using spread spectrum modulation in the 2.4 GHz band is authorised by the *Radicommunications Class Licence (Spread Spectrum Devices).* There is currently no ACA mandated radiocommunications equipment standard for these devices. The class licence authorises the use of equipment meeting the requirements of either the European Standard ETSI 300 328 or the Federal Communication Commission (FCC) Rules and Regulations section 15.247 except for conditions relating to frequency band of operation, radiated power and antenna gain. The class licence is currently being updated to incorporate the latest revisions to these standards.

General Description of WLANs

WLANs, also known as Radio LANs (RLANs), provide wireless networking between computers. Their design is based on operations within the one organisation (i.e. functions such as billing, customer care etc. must be separately arranged). The devices currently operating in the 2.4 GHz band are low power short-range devices, and are typically used indoors. WLANs are characterised as having data rates around 1 to 11 Mbit/s, operating over short distances (<100 m typically - although up to 20 km is very occasionally possible). Their associated communications protocols do not support use while moving. They have been increasingly employed in factories, offices and university networks in Australia since 1996.

WLAN devices were initially developed in the 900 MHz band to support specific applications rather than general computer networking and for this reason no standards were initially developed. These applications included hand held or transportable terminals for inventory control in factories and pricing terminals in grocery stores. As the market expanded into general computer networking applications WLAN technology has moved towards the 2.4 GHz Industrial Scientific and Medical Equipment (ISM) band. The growing need for data speed together with developments in technology is shifting the focus towards higher speed implementations at 2.4 GHz and to the 5.8 GHz band.

Standards Maturity

In 1997 the Institute of Electrical and Electronic Engineers Inc. (IEEE) created the IEEE 802.11 standard for WLAN technologies. The development of the IEEE 802.11 WLAN standard has been an important driver in bringing (relatively) low cost WLAN equipment into the marketplace. Development of the technology is continuing, as can be seen in the ongoing development of the IEEE 802.11 standard series to include the existing 802.11b and soon to be released 802.11g standards that provide higher and higher data speed services.

Sharing Mechanisms and Issues

WLANs operating in the 2.4 GHz band use spread spectrum modulation to reduce the impact of interference between users as the number of systems in any local area increases. Because every user is a source of interference to every other user, the communications range over which each user is able to operate shrinks as the number of users grows. The licensing arrangements of the *Radiocommunication Class Licence (Spread Spectrum Devices)* provides a "public park" regulatory environment where users receive no guarantee of protection from interference from other services, and users must not cause interference to services.

4.1.2 Bluetooth

The Bluetooth system operates in the class licensed band 2.4 – 2.4835 GHz. In Australia use of these devices is authorised under the *Radiocommunications Class Licence (Spread Spectrum Devices)*. The radiated power for the system ranges between 1 to 100 mW EIRP, but is typically 10 mW. The Bluetooth system is expected to operate effectively at 10 m, and systems up to 100 m are being discussed. The system supports data rates of up to 1 Mbit/sec.

Bluetooth™ is a recognised standard, IEEE 802.15.1, that supports very short distance radiocommunications. The main purpose of Bluetooth is to replace short wire connections (i.e. a few metres) with wireless connections, as well as providing communication and control facilities. Whilst its data rate is sufficient for a broadband communications service, Bluetooth's restricted range limits its potential to provide a "last mile" broadband communications service.

Bluetooth enables links between various devices such as mobile computers, mobile phones, portable handheld devices, and connectivity to the Internet. Essentially, any device with a Bluetooth chip is able to communicate with any other device with a Bluetooth chip. Hardware that complies with the Bluetooth wireless specification ensures communication compatibility worldwide.

4.1.3 5 GHz / WLAN Systems

The 5 GHz spectrum regulatory arrangements are similar to those of the 2.4 GHz spectrum. WLANs at 5 GHz are supported by the *Radiocommunications (Low Interference Potential Devices) Class Licence 2000* (the LIPD class licence) and the *Radiocommunications Class Licence (Spread Spectrum Devices)* (the spread spectrum class licence). The LIPD class licence authorises the use of WLANs in the 5.15-5.35 GHz frequency range with a maximum radiated power of 200mW EIRP, with the restriction that operation must be indoors. It also authorises operation in the 5.725-5.825 GHz frequency range with a maximum radiated power of 1W EIRP and permits outdoor operation. The spread spectrum class licence authorises operation in the 5.725-5.875 GHz frequency range with a maximum radiated power of 1W EIRP and permits outdoor operation. These bands are consistent with bands available in many other countries for "WLAN applications at 5.8 GHz".

A 5 GHz WLAN operated indoors can be expected to have a range of between 30 and 150 m. Operated outdoors this range might extend to 2 to 3 km depending on the choice of antennas and required quality of service. To work at such ranges the radio path must not be obstructed by buildings or heavy foliage and service outages can be expected and must be accepted.

The two major existing standards that support WLAN technologies at 5 GHz are IEEE 802.11a and HIPERLAN Types 1 and 2. Both IEEE 802.11a and HIPERLAN Type 2 support data rates between 6 and 54 Mbit/sec, with the average throughput available to a user of around half the supported data rate. HIPERLAN Type 1 supports data rates up to 24 Mbit/sec with an average throughput of up to 20 Mbit/sec, and is intended for indoor use only.

Whilst there are more IEEE 802.11a products than HIPERLAN Type 2 products in the marketplace, 802.11a does not match HIPERLAN Type 2 in terms of quality of service suitable for reliable multimedia support.

4.2 Systems Operating under Apparatus or Spectrum Licensing

4.2.1 Third Generation (3G) Mobile Telecommunications Systems

Current international planning for 3G services has assumed operation in frequency bands around 2 GHz[20]. Within the international community, studies are underway to determine the feasibility of operating 3G systems in existing mobile bands at 800 MHz, 900 MHz and 1800 MHz. Also, at the international level, a frequency band around 2500 MHz has been identified as a potential 3G expansion band. All of these bands are subject to coordinated frequency management, and unlike 2.4 GHz and 5 GHz access to the bands is not free. 3G spectrum in Australia has been allocated by spectrum auctions and is managed under spectrum licences.

Due to the technology neutrality embodied in the spectrum licensing process, companies are not required to use the spectrum specifically for 3G services. An example of this is the company CKW Pty Ltd., a subsidiary of Arraycomm. Arraycomm acquired spectrum licences in the 2.1 GHz band in all State and Territory capital cities. In that spectrum, Arraycomm intends to deploy Time Division Duplex technology, known as *i-Burst* to provide a high rate, wide-area, broadband wireless service to fixed and portable (i.e. laptop computer) terminals. Arraycomm has claimed that the use of this technology will offer a low cost method of providing wide-area broadband wireless. The potential market segments for the *i-Burst* service includes the mobile professional, vertical corporate, broadband residential and small office/home office. Arraycomm intends to launch its services progressively from late 2002.

3G telecommunications systems are intended to provide capabilities beyond the voice and low rate data services that are supported by current second generation personal communications systems. Among the new capabilities to be provided by 3G systems is the provision of multimedia and high-speed data services in a mobile environment. It is expected that 3G services should, generally, be receivable in the same sorts of situations that second generation systems are currently received. Both the "packet switched" (well suited to "always on" applications like Internet) and the "circuit switched" (well suited for telephony applications) methods of transferring data will be supported by 3G.

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[20] In major capital cities frequencies allocated were: 1900-1920 MHz (notionally for Time Division Duplex use); and 1920-1980 paired with 2110-2170 MHz (notionally for Frequency Division Duplex use).

User data rates to be provided by 3G systems range up to a few hundred kbit/s for mobile applications[21] and up to 2 Mbit/s for low mobility indoor applications. However, as the number of users in a 3G cell increases and/or the users are further from the base station the actual data rate available to a user will be reduced. By comparison with current second generation systems, 3G systems will be capable of providing higher data rates but to realise this capability they will require more base stations that are more closely spaced.

Only a few countries have 3G systems operating at the moment. The most notable of these countries is Japan. The Japanese carrier DoCoMo has been operating its system for approximately 6 months. Some Australian carriers have indicated that they intend to commence operating initial 3G services later this year.

Hutchison acquired spectrum licences in the 2.1 GHz band in the five major capital cities and has announced plans to deploy a third generation mobile service in that spectrum in late 2002.

In the auction of spectrum licences in the 2.1 GHz band, conducted in March 2001, six companies were successful in obtaining licences, including Arraycomm and Hutchison 3G Australia whose plans are described in this section. Other successful bidders were Optus Mobile Pty Ltd, Vodafone Pacific Pty Ltd, 3G Investments Australia (Qualcomm), and Telstra. These companies are yet to announce their deployment plans and timeframes.

In addition to the 2.1 GHz spectrum, Telstra has nationwide spectrum licences in the 800 MHz band which it uses to provide a CDMA mobile service. The CDMA service is capable of being upgraded to full 3G functionality, although a decision to do so would rest on commercial decisions by Telstra and no announcement on upgrading has been made to the present time.

4.2.2 Second Generation Mobile Telephony Systems

Australia's second generation cellular mobile systems (both GSM and CDMA) have the potential to serve both fixed and mobile customers. Suppliers of both GSM and CDMA handsets have variants that present as a fixed network phone but have the voice and data features of a mobile. Their digital switches have the capability to function simultaneously as the mobile switching centre of a cellular mobile system and as the local exchange for wireline and/or FWA system[22]. The cost of subscriber terminals would be expected to be similar to mobile handsets on current cellular systems.

Current cellular networks cover up to 97 per cent of the Australian population. These second generation (2G) mobile systems support up to 14 kbit/s for circuit switched data. The upgrading of these networks would allow for data rates of 100 kbit/s (2.5G) with future developments increasing this further to between 500 – 2000 kbit/s (3G) depending on the subscriber density, distance and propagation characteristics in the service area.

The range of a cellular system is typically limited by the technology it uses. A CDMA system operating in the 800 MHz band (which has more favourable propagation

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21 Actual values depend on the particular 3G technology used.

22 "*Europe's Wireless Futures*", Stephen McClelland, *Microwave Journal*, 9 September 1999, p.95.

characteristics than the 2 GHz band) could have a maximum range of approximately 100 kms under ideal conditions, but will be limited in practice by many factors such as local geography and subscriber density.

4.2.3 WLL/FWA

Telstra, Optus, Vodafone and Hutchison are the only Australian operators of 2G systems. However worldwide 2G systems in the form of GSM and CDMA dominate mobile telecommunications. The Australian operators, especially Telstra, are known to be experimenting with different upgrades to their networks.

The term Wireless Local Loop (WLL) was traditionally a generic term for an access system that uses a wireless link to connect subscribers to their local exchange in place of conventional copper cable. The term WLL is now used interchangeably with the term "*wireless access*" which is defined by the ITU as an "*End-user radio connection to a core network*". A 'core network' in this context might be a Public Switched Telephone Network (PSTN), Integrated Services Digital Network (ISDN), Internet or Local/Wide Area Networks. The 'end user' might be a single user or a user accessing services on behalf of multiple users. It would be useful to consider here the following generic terms and their internationally standardised[23] definitions:

- Fixed Wireless Access (FWA) – a *wireless access* application where the location of the *end-user termination* and network access point to be connected to the end-user are fixed;
- Mobile Wireless Access (MWA) – *wireless access* application in which the location of the *end-user termination* is mobile;
- Nomadic Wireless Access (NWA) – *wireless access* application in which the location of the *end-user termination* may be in different places but it must be stationary when in use; and
- Broadband Wireless Access (BWA) – *wireless access* in which the connection capabilities are higher than 2 Mbit/s.

4.2.4 3.4 GHz Fixed Wireless Access

The 3.4 GHz band was auctioned in 2000 and a spectrum licensing regime is in place allowing operators to deploy and manage their own systems provided they comply with the licence conditions.

The 3.4 GHz band is suited to, and by virtue of equipment availability, currently supports many fixed point-to-multipoint services that are being used to provide FWA WLL services to medium density urban and regional areas. The systems deployed have a range of between 0.2 km and 15 km for urban and rural applications respectively, and are providing multiple subscriber lines, fax and data capability up to 32 kbit/s. Equipment has been developed which will provide voice telephony of up to 8 lines per terminal (includes fax and data up to 56 kbit/s) or data rates of up to 6 Mbit/s — this can be varied depending on user demand and available bandwidth allowing "always on" internet access. The

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23 ITU-R Recommendation F.1399 "*Vocabulary of terms for Wireless Access*", 1999.

equipment has a potential range of 50 km but would have a typical maximum range of 10 km.

Unwired has announced plans to develop a national fixed wireless broadband network, operating in the 3.4 GHz band, which will span more than 14 major population centres. Areas of geographic coverage will include heavily-populated metropolitan centres such as Sydney and Melbourne and selected regional areas. Unwired plans to launch its network progressively from late 2002.

Unwired plans to operate as a wholesale access provider, selling services to local carriers and Internet service providers offering combinations of high-speed Internet access (at speeds up to 6 Mbits/s) and carrier grade voice services. The services will be offered by Unwired's wholesale customers to a range of end-users, including residential customers, home-based businesses and small to medium-sized enterprises.

4.2.5 DRCS/HCRC

Spectrum for these systems is managed and made available under apparatus licensing arrangements. Each use is associated with a licence and fee.

An example of a mature (in the process of being retired) FWA WLL technology is the Telstra Digital Radio Concentrator System (DRCS). DRCS networks have been operating in rural and remote areas of Australia since the early 1980s, providing basic (low traffic density) telephony services and low speed data (2.4 kbit/s) and currently servicing approximately 19,000 customers. This FWA system operates in the 500/1500 MHz bands and is characterised by large cells (30-70 km radius) - it was developed for sparsely populated regions. The system combines hybrid fixed point-to-point and point-to-multipoint architectures in a manner that can deliver a service area of hundreds of square kilometres from a single PSTN connection point.

A traffic capacity and service quality upgrade of the Telstra DRCS network is currently underway, with the first generation DRCS equipment being replaced with newer High Capacity Radio Concentrator (HCRC) equipment. The network upgrade provides for significantly improved trunking capacity for voice, with support for much higher data speeds (19.2 kbit/s to 40 kbit/s) though still short of the speeds available to most urban PSTN users.

In general DRCS/HCRC systems are good examples of FWA WLL technologies that allow telephony provision in areas where it is either poor or non-existent. However, given that the DRCS/HCRC transmission and switching technology is dimensioned to, and optimised for, rural service delivery (i.e. large cells, low traffic density), this type of access system is not suitable for the urban environment and also cannot be considered to be a "broadband" technology.

4.2.6 1.9 MHz Digital Enhanced Cordless Telecommunications (DECT)

DECT systems as PABX extensions can be used in Australia under the class licensing regime in the 1880-1900 MHz frequency band. DECT can also be used to provide FWA WLL, although the current licensing framework does not support this application. Work is currently in progress to allow for limited use of DECT FWA in rural and remote areas.

Although it is designed for high subscriber densities DECT does not provide high data rates and so cannot be considered to be a "broadband" technology.

DECT (Digitally Enhanced Cordless Telecommunications) is a standard developed in Europe for cordless telephone systems. DECT systems were designed especially for small areas with a large number of users and are typically deployed in private residences, offices and warehouses as a wireless extension of the home phone or office PABX system. These systems have a typical range from a few hundred metres up to 15 km and can provide either voice or data rates of approximately 40 kbit/s.

4.2.7 MDS / MMDS / LMDS Technologies

General Description

Multipoint Distribution Systems (MDS) are fixed broadband wireless distribution networks designed and developed specifically for this purpose. They comprise a central hub station connected by radio to a number of customer stations in the surrounding area. Although a term previously used to describe systems distributing analogue video for pay television services, its use for two-way wide area data services is growing overseas.

MMDS stands for Microwave (or by some, Multi-channel) MDS and is generally used to refer to microwave data distribution systems below about 10 GHz. In these bands wide area coverage (20-40 km) from the central hub station site is possible. LMDS stands for Local MDS and is generally used to refer to microwave data distribution systems operating above 10 GHz. The term 'Local' derives from the limited (<5 km) coverage provided by each hub station in these bands. The main advantage of LMDS is that higher data rates are available from equipment in these bands.

All three systems can be used for cell based coverage of larger areas. They offer capacities up to 45 Mbit/s per customer.

Frequency Bands

MDS/LMDS systems have been deployed, or might be deployed, in the bands listed below. Additionally, these technologies are designed in such a way that they could be implemented in other frequency bands (e.g. 3.4 GHz) by changing the radiofrequency parts of the equipment.

Service	Band	Frequency Range	ACA Licensing Arrangement
(M)MDS	2.3 GHz	2302 MHz – 2400 MHz	spectrum licensed
LMDS	27 GHz	26.5 GHz – 27.5 GHz	spectrum licensed
LMDS	28 GHz	27.5 GHz – 28.35 GHz	spectrum licensed
LMDS	31 GHz	31.0 GHz – 31.3 GHz	spectrum licensed

Spectrum Characteristics

The spectrum characteristics depend upon the frequency band being used. All the bands are limited to line-of-sight between the customer antenna and the hub station.

Bands	Typical Radiated Power	Typical Range

2.3 GHz	1000 W	up to 30 - 40 km
27 – 31 GHz	100 W	up to 5 km

Sharing Mechanisms and Issues

The above-listed bands have been spectrum licensed. The current spectrum licensees in these bands are AAPT, Optus and AUSTAR. The 2.3 GHz band is currently being used for analogue pay television although the major licensee has indicated interest in the potential to provide new services as well. In Australia the 27, 28 and 31 GHz bands have relatively few operational services at this time.

Using its spectrum licence in the 28/31 GHz band, AAPT has established Local Multipoint Distribution Service (LMDS) facilities in various locations throughout regional Victoria. AAPT's LMDS delivers immediate coverage of services such as 2 Mbit/s data, voice and high-speed Internet to business and government users in Geelong, Bendigo, Ballarat, Shepparton, Wangaratta, Horsham and Bairnsdale. In addition, AAPT has established a small number of LMDS nodes in most State capital cities.

Austar has spectrum licences across many areas of regional Australia and in capital cities other than Darwin. The licences provide Austar with access to up to 98 MHz of spectrum in the band 2302-2400 MHz. Austar has used that spectrum to provide pay television services in regional Australia via the Multipoint Distribution Station (MDS) technology but is now progressively transferring its customers to a satellite-based delivery system. This will enable Austar to use the spectrum for other purposes including, for instance, broadband fixed wireless access. Austar is presently conducting broadband wireless trials in Newcastle to evaluate access products and customer content preferences.

Austar has advised the ACA of its preparedness to re-sell spectrum capacity to other parties. It has also advised that it is developing arrangements with Norlink (a community-based telecommunications company based in the Northern Rivers of NSW) for the re-selling of spectrum capacity for purposes including broadband wireless.

The 27/28/31 GHz bands used by these services are adjacent to, or are shared with space or satellite services. This has necessitated the development of international sharing arrangements to protect the space and satellite services.

Typical Applications

These systems currently have their greatest application in the small to medium size business sector where there is the need to connect at higher data rates than available from telephone and ISDN connections. They are often used for short-term connections while specialised cable or optical fibre based services are established.

Maturity

There has not been a lot of use of this equipment in Australia and the ACA has not mandated radiocommunications standards for these devices. In Australia the applicable technical conditions are set out as conditions of the radiocommunications licence under which they may be operated. Some standards have been developed for specific applications of these services in Europe, such as ETSI EN 301 199 *Digital Video Broadcasting Interaction Channel for LMDS*, which include radio equipment requirements. In the USA and Canada technical requirements for devices operating in these services have been broadly specified in licence conditions.

While air interface (radio) standards are not specified, there are connection standards to which these devices must comply. These are the various telecommunications data network interface and protocol standards. Typical protocol standards include SDH / SONET, ATM and MPEG2, the applicable standard depending upon the specific application carried by the network or device. Applications include telephony, video and/or Internet, along with other data streams. The lack of a common product standard suggests these services are yet to mature.

4.2.8 Satellites

Services Types currently available

Satellite services within Australia have two distinct types of applications.

- Services to end users including point-to-multipoint applications like broadcasting, and point-to-point applications such as those provided by two-way Very Small Aperture Terminals. Typically, users access these services using small (0.5 to 2 m diameter) earth station antennas.
- Backbone services linking into or augmenting the terrestrial backbone network. The connections to the terrestrial networks are made via large hub-earth stations. The stations allow better quality of service to be obtained since the extra gain of the hub station antenna can provide a greater margin against rain attenuation events and other forms of signal loss.

Operators providing satellite services to Australia include Optus, PanAmSat, New Skies and Intelsat. All of these systems operate in the 12/14 GHz frequency bands.

Optus satellites provide analogue and digital services including networking, point-to-point communication, point-to-multipoint communication, free-to-air and pay television and data services (e.g. Internet access). The existing Optus satellites offer several coverage options: North Eastern, South Eastern, Central and Western Australia, full National coverage, coverage focussed on the eastern coastal strip plus Perth and Darwin, together with South West Pacific, Papua New Guinea and New Zealand coverages. Standard digital service offerings from Optus provide a maximum multiplexed capacity of 4 Mbit/s, however the theoretical data capacity of the system is in the order of several thousand Mbit/s per satellite[24].

PanAmSat (PAS) has a global system comprising 19 satellites that provides coverage of the Americas, Europe, Africa the Middle East and Asia. Two of these satellites have beams that are specifically targeted at Australia and currently provide maximum capacities of 240 Mbit/s and 280 Mbit/s respectively. These spacecraft provide video, telecommunications and Internet access throughout the Asia-Pacific region.

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24 Indicative number only, based on crude calculations of number of transponders per satellite and potential bit rate per transponder. Obviously there are many technical and commercial factors that would influence the actual capacity that could be made available to prospective users.

Satellite networks New Skies and Intelsat also operate to a limited extent in Australia, providing mostly "backbone services" as described above.

Future Services

To give an indication of possible future capabilities, several planned or potential future satellite systems are described below. The Optus and New Skies proposals represent significant increases in capacity based essentially on existing satellite design approaches. The Shin Satellite, and more particularly Teledesic, approaches are different in that they propose satellite architectures that are targeted particularly at delivering broadband services.

Optus currently plans to launch a new "C series" satellite in late 2002. This satellite will provide significantly more capacity in Australia than is available on their current satellites.

New Skies plan to provide satellites that will cover the Asian region but which will provide full Australian downlink coverage for applications such as Direct To Home (DTH) reception. They will also have some capacity to deliver broadband media to small business, Internet Service Providers (ISP) or domestic rooftop antennas in south-eastern Australia.

Shin Satellite Public Company Limited has, for the last 4 years, been developing a low-cost, high-capacity satellite system, the "iPStar Broadband Satellite System". The iPStar satellite system plans to provide telecommunications and multimedia services to households, businesses and public organisations across the entire Asia-Pacific region with a maximum capacity of 35 Gbits/s for two-way applications such as video-on-demand and Internet access[25]. These numbers describe total system capacity, only a percentage of this total actual capacity would be available over Australia.

In 1999, the ACA reduced the rate of fees applying to apparatus licences used for broadband NGSO satellite services operating in spectrum above 8.5 GHz. The decision to reduce the applicable rate of tax reflected the potential benefits which such satellite systems would offer to Australia and in particular to rural and remote communities. Following the reduction in the fees, licences for a broadband NGSO service were taken out by Teledesic. The ACA understands that Teledesic intends to launch test satellites in 2003 and to commence commercial services in 2005.

The Teledesic proposal is to provide LEO satellite broadband services in the future that would effectively cover all the inhabited areas of the world with broadband services provided to small fixed satellite dishes. The Teledesic network will use a constellation of up to 30 NGSO satellites to provide global access to a wide range of data, voice and video communication capabilities. A variety of user terminals accommodating "on-demand" single channel rates from 128 kbit/s to 100 Mbit/s on the uplink and up to 720 Mbit/s on the downlink have been proposed[26].

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25 http://www.thaicom.net/ipstar/system.html

26 http://www.teledesic.com/about/about.htm

4.2.9 HAPS

High Altitude Platform Stations (HAPS) are elevated communications platforms that operate at altitudes of typically around 20 km to provide services over a wide area, for example a large metropolitan area like greater Sydney. Several different implementations including Zeppelin-like airship technologies and a range of high altitude aircraft technologies have been proposed.

At this stage all the HAPS projects are in developmental or experimental stages. One HAPS proponent (Sky Station) has stated that its first deployment will commence in 2004[27]. No HAPS systems have been licensed for operation in Australia. However, the ACA has indicated that it would be prepared to allocate spectrum if demand emerges.

A number of technical/operational questions remain. A critical issue is the development of a long term, reliable station keeping system that can operate in an environment where winds of up to 200 km/hr may be encountered. As yet no full scale trial HAPS systems have been demonstrated.

HAPS promise to overcome some of the perceived difficulties of terrestrial and satellite communications systems. By comparison with satellites, HAPS systems offer cheaper launch costs, and introduce the possibility of bringing the system to earth for refurbishment, repair or upgrading. When compared with upgrading terrestrial infrastructure, HAPS systems could provide a quick deployment, wide coverage area method to increase communications capacity.

Potential services in connection with HAPS include:

- fixed wireless access (data rates of up to 10 Mbit/s), and
- mobile services (with up to 16 kbit/s for voice and 384 kbit/s for data).

These services could be provided using conventional terrestrial wireless base station technologies located on the HAPS. Customers could use the same handsets or FWA subscriber equipment as they would use for a terrestrially based system. Internationally, the 47.2-47.5 GHz frequency range has been allocated for use by downlinks from HAPS. As well, HAPS have been proposed as an optional delivery system for 3rd Generation (IMT-2000) services in frequency bands around 2 GHz. HAPS might be able to provide other services, or operate in other frequency bands, but such uses have not been agreed by the International Telecommunication Union.

HAPS are likely to be equipped with multiple antenna arrays so that a HAPS service area can be covered with a large number of communications cells and a high degree of frequency re-use can be achieved. This means that a greater number of users can be supported within a given amount of spectrum. In this respect HAPS will achieve frequency re-use levels that are similar to terrestrial wireless systems (as opposed to large coverage area satellite systems that achieve relatively low levels of frequency re-use).

The coverage area of a HAPS is related to its altitude. Maximum coverage areas of 100-150 km diameter are expected. However, this coverage range is likely to restrict

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27 http://www.skystation.com/faq.html

deployment of HAPS in more sparsely populated parts of Australia. The economic viability of the HAPS is expected to be related to the number of users within its coverage footprint. In remote and sparely populated areas there may not be a sufficiently large number of users to amortise the costs of launching and operating HAPS.

While rain attenuation is expected to be less of a problem with HAPS than with satellites, nevertheless indoor operation is still likely to be problematical unless some form of terrestrial augmentation is included. However they could be equipped with multiple antenna systems to improve frequency reuse.

HAPS systems have short transmission paths (one way path distance approx 20 km) so they will not be subject to the transmission delay issues that apply to GSO satellite systems (one way path distance approx 36,000 km).

5. TELECOMMUNICATIONS REGULATION

Telecommunications regulation arrangements focus on the provision of services with the intent that the technological arrangements for the provision of that service do not affect the regulatory arrangements. Providers of telecommunications services are thus regulated separately from any licensing arrangements that may attach to their particular technological solution to the service that they wish to provide.

Telecommunications services are defined in very broad terms under the Telecommunications Act. They include any electronic communication between persons and persons, persons and things, and things and things.

5.1 Providers of Telecommunications Services

The ACA regulates providers of telecommunications services to the public over network units under the Telecommunications Act. Under this legislation there are two main types of providers, carriers and service providers.

Carrier licences are issued under the Telecommunications Act and authorise the use of network units for the supply of telecommunications services to the public. This carrier licensing is separate from and may be additional to any radiocommunications licensing arrangements linked to use of spectrum. Carriage service providers are not individually licensed or registered but are required to operate in accordance with provisions set down in the Act and service provider rules contained in the Telecommunications Act or made by the ACA.

5.2 Carrier Licensing under the *Telecommunications Act 1997*

Introduction

Owners of networks units used to provide telecommunications services to the public must hold a telecommunications carrier licence under section 42 of the Telecommunications Act. It is possible for the use of WLAN equipment that is class licensed under the Radiocommunications Act to constitute a network unit under the Telecommunications Act. Thus, while a spectrum or apparatus licence may not be required for use of the spectrum, the provision of telecommunications services to the public generally requires that owners of the relevant network units hold a carrier licence.

An overview of the relevant requirements and how they relate to class licensed radiocommunications equipment is outlined below.

5.2.1 Requirement to hold a carrier licence

The carrier licensing regime in Australia provides for the issue of a licence that is not restricted to specified services technology, or geography. Under the Telecommunications Act and the *Telecommunications (Consumer Protection and Service Standards) Act 1999* (the T(CPSS) Act) there is no restriction on the installation and ownership of telecommunications infrastructure. However, the Telecommunications Act provides that the <u>owner</u> of a network unit must not use that network unit, or allow other persons to use that network unit, to supply carriage services to the public unless the owner has a carrier licence or, a nominated carrier declaration or an exemption under the Telecommunications Act applies.

The issues to be determined in deciding whether or not a person is behaving in a manner contrary to the law are:

- whether there is a network unit involved;
- whether the network unit is used to supply carriage services ; and
- whether that supply is to the public.

5.2.2 Network unit

The concept of a network unit is defined in Division 2 of Part 2 of the Telecommunications Act to include:

- a single line link connecting distinct places in Australia that are at least 500 m apart;
- multiple line links connecting distinct places in Australia where the aggregate of the distances between the places is at least 5 km apart;
- designated radiocommunications facilities; and
- a facility specified in a Ministerial determination.

5.2.3 Base station that is part of a terrestrial radiocommunications customer access network

Section 34(1) provides that a base station is part of a terrestrial radiocommunications customer access network if all of the following tests are met:

(a) the base station is part of a telecommunications network; and
(b) the base station is not an exempt base station; and
(c) the base station is used for the supply of carriage services; and
(d) the service is for use wholly or principally at premises occupied or used by the end-user or in the immediate vicinity of those premises; and
(e) the customer equipment used for or in relation to the service is not in physical contact with the network; and
(f) the network does not have inter-cell hand-over functions; and
(g) the conditions (if any) specified in the regulations are satisfied; and
(h) the network is not an exempt network

Certain exemptions are also established in subsection 34(3) of the Telecommunications Act to provide that even if a base station meets the definitions above, it is not considered to be part of a terrestrial radiocommunications customer access network if the network is used, or in use, for the sole purpose of supplying carriage services on a 'non-commercial basis'.

It is important to note that the non-commercial purpose for which the base station is used must be the **sole purpose** for its use in order to attract the exemption under ss.34(3)(a).

Note that under this test there is no specific reference to the treatment of an incorporated not for profit group.

5.2.4 Suppling carriage services to the public

In relation to the supply of carriage services to the public, the test is whether the unit is being used to provide services to the public. Whether the services are being provided directly or indirectly is irrelevant to this consideration.

Under section 44 of the Telecommunications Act, a network unit is used to supply a carriage service to the public if it is used to:

(i) carry communications between two end-users both of whom are outside the *immediate circle* of the supplier of the service; or

(ii) supply a point-to-multipoint service or designated content service to end-users at least one of whom is outside the *immediate circle* of the supplier of the services.

5.2.5 Immediate circle

Under section 23 of the Telecommunications Act, a person's *immediate circle* consists of the person together with the following persons:

(i) if the person is an individual or partnership-employees of the individual or partnership;

(ii) if the person is a body corporate – an officer of the body corporate, a related body corporate and officers of the related body corporate (within the meaning of the Corporations Law);

(iii) if the person is a tertiary institution - members of its governing body and officers, employees and students of the institution; or

(iv) if the person is a Commonwealth, State or Territory government department, authority or institution – specified employees and members of the Commonwealth, State or Territory government.

The Minister has made a Determination under subsection 23(2) (No1 of 1998) that extends a person's *immediate circle* in relation to joint venturers and independent contractors. Under the Determination a person's *immediate circle* is extended to include:

(i) any other person who is engaged in a specified joint venture with the person;

(ii) any other person who has been engaged by the person as a specified contactor; and

(iii) persons who are within the *immediate circle* of any such other persons.

5.3 Application of the Regime

As already discussed the telecommunications regulatory regime set down in the Telecommunications Act does not seek to distinguish between different technologies but rather seeks to regulate at the service level. In this regard the service, its intended users and the purpose of provision dictate regulatory requirements that attach to that provision.

There is some present debate about the treatment of IEEE 802.11 types of WLANs under the Telecommunications Act, the tests applied by the ACA would be applied to any of the technologies discussed in Part 4. That the discussion has focussed on IEEE 802.11 type of systems reflects the current attractiveness of such systems (low cost, no individual radiocommunications licence or licence fee is required etc.) to applications of particular segments of the community or to particular application circumstances.

Additionally, the Telecommunications Act does not separately treat access systems from core transmission systems. Core transmission tends to be the specialised domain of major operators that are usually carriers. However at the point of access (customer access network) conditions and arrangements are different from those of the core transmission network.

5.3.1 Recent Developments

In the access network (especially as it relates to data/internet access) the ACA has observed a marked increase in the deployment of wireless access systems by small business and the public.

Wireless access is the provision to end users of access to the services of a telecommunications network via radiocommunications. The access may be facilitated by a wireless network card in the user's personal computer or laptop or a cordless telephone which enables the connection to a base station which, in turn, connects to the network termination point and then the public telecommunications network. The equipment is low cost and designed to work within a part of the radio frequency band that is particularly suitable for short range communications applications. Some common uses of wireless access are:

- by companies in work places to connect devices to the local area network;
- by hotels and airports to provide wireless Internet connections to their customers;
- by Internet service providers to deliver the Internet to its customers in a rural or regional setting; and
- by community groups to connect its members to the Internet.

5.3.2 Analysis of the Regulatory Provisions

Although the Telecommunications Act is intended to be technology neutral, analysis of issues associated with the treatment of WLANs indicates a discrepancy between the manner in which line links and certain radiocommunications devices are assessed for telecommunications licensing purposes.

Under section 34(3) of the Telecommunications Act, a base station is an exempt network if the network is used, or for use, for the sole purpose of the supply of carriage services on a non-commercial basis.

Sole purpose test

This exemption for base stations relating to non-commercial supply of services gives rise to anomalous results. For a base station to be exempt it must form part of a network that is used solely for the purpose of the non-commercial supply of services. However a business could use its telecommunications network for its own commercial purposes. Accordingly, if the wireless equipment in question forms any part of the overall network of a business, it would necessarily fall outside the exemption, except in the unlikely event that the business is in the business of supplying carriage services on a non-commercial basis.

Similarly, where an individual has joined with others in a non-commercial arrangement for carriage services, the fact that the individual uses his or her own equipment for a purpose other than that non-commercial supply, e.g. running a small business from home, is itself enough to take the equipment outside the exemption.

These results appear to be outside the objectives of the Telecommunications Act, and the issue is not relevant to persons who are not conducting a business. The objects of the Telecommunications Act would imply and the most practical policy position should be that, even though the sole use of a network may not be for the supply of carriage services on a non-commercial basis (because the individual uses the network for his or her other, non-commercial, purposes), the individual does not require a licence.

Resolution of this issue would appear to require amendment of the Telecommunications Act.

Commercial v Non Commercial

Determining the distinction between commercial and non-commercial has proven difficult. A problematic consideration has been whether the owner of the WLAN equipment is a business. ACA legal advice is that:

- non-commercial generally means supplied gratuitously and/or not pursuant to a contract or agreement and/or not for the purpose of profit;
- it was possible to proceed on the narrow view that non-commercial meant supplied gratuitously;
- however, the particular circumstances of each particular case would need to be taken into account.

None of these factors are necessarily conclusive alone, and while it is possible to proceed on the basis of a general policy, the question of whether or not a service is being supplied on a commercial basis inevitably depends on the circumstances of each particular case. This would indicate that some discretion would permit outcomes that better reflect community standards and expectations.

A number of considerations would apply in factual situations. These considerations are:

- if there was no reward monetary or otherwise given for the use of the network to supply carriage services, then such use was likely to be non-commercial;
- if the nature of the person and their day-to-day activities was that they used the network to operate a business, then use of the network for purely non-commercial purposes was unlikely and should be scrutinised carefully;
- if there were contractual arrangements between the parties that prescribed the payment of monies in return for the use of the network, then that use would be commercial (Two

extra considerations are relevant here: contracts could be written or verbal and all contracts between the parties would need to be examined since antecedent contractual arrangements for the payment of money may exist.); and

- if any purpose of the use of the network was for making a profit then that use would be commercial. This would be indicated in the following situations. If a network owner that is a business corporation, has contracts in place with carriage service providers governing the supply of carriage services on its network and obtains monetary payments for such activities, then it is likely that they are using the network to make a profit. If the financial returns consistently exceeded the input costs of operating a network to supply carriage services then it is likely that the network is used for purpose of making a profit and is operating on a commercial basis.

The issue in relation to a business is whether the sole purpose is non-commercial, i.e. there is no direct or indirect commercial benefit. This issue becomes relevant for situations such as:

- a hotel, which provided telephony or Internet services to its guests;
- a cafe, which provided Internet services to its customers; and
- an airline, which provided telephony or Internet services to travellers in an airport lounge.

If the supply of carriage service was part of a business's activities then this supply of carriage services was more likely than not to be commercial. This applied even though end users were not charged directly or on a usage basis for the carriage service.

This approach would mean that:

- hobbyists and community users such as co operatives, as long as they could meet the tests, would not be considered as commercial, would be exempted from licensing and this would not dampen innovative use of the technology,
- small business users such as small Internet service providers (ISPs) in regional and rural areas who meet the test as being "commercial" would require a carrier licence, and
- the policy outcome is equitable in the sense that the commercial and regulatory requirements of CSPs providing Internet services using their own network units – cable or wireless – is comparable.

Wireless on a single premise

In the process of looking at commercial use of WLAN equipment, a difference was discovered in the treatment under the Telecommunications Act of cable and wireless equipment used to supply a carriage service to the public on a single premises. Where cable is used, a carrier licence is not required because:

- the cable will have crossed the property boundary of the property served by the incoming telecommunications network when it enters the premises; and
- from that point on the cable does not connect distinct places as the end users are all on the same premises.

Even if the cable had crossed a property boundary, provided the cable were less than 500 m or if several segments were involved, less than 5 km in aggregate, a carrier licence would not be required.

Where wireless equipment is used to do the same thing, a carrier licence is required regardless of distance because under the Telecommunications Act wireless equipment only has to connect two points rather than connect distinct places. The treatment of wireless facilities is different to cable even though:

- the service may be provided on single premises;
- the service arrives at the base station premises by cable; and
- the service is distributed throughout the premises by cable to wireless access points.

For wireless equipment there is no requirement to connect distinct places and no minimum distance between points which are connected. Under section 34 of the Telecommunications Act a carrier licence is required anywhere that a wireless base station is used to supply carriage services to the public.

In relation to Internet cafes, hotels or airport lounges this means that if wireless access points are used instead of sockets to enable customers to access telephony or Internet services these wireless access points require a carrier licence even though the connecting cable does not.

This analysis means that:

- wireless equipment does not appear to have the same treatment under the Act as cable and this appears to contradict the objects of the legislation to be technologically neutral; and
- if users have migrated from cable to wireless on the basis of their misunderstanding of regulations, they would now be considered to be non-compliant with the licensing requirements of the Telecommunications Act. This raises significant licensing and prospective enforcement issues for the ACA and the multitude of business users who have acted on this interpretation of that Act.

It would appear that this effect is an unforeseen outcome of the legislative provisions.

A solution would be for the Minister to make a Determination of exemption under section 51 of the Act. The Determination would exempt wireless equipment from carrier licensing where the end users are on the same premises as the wireless equipment, or alternatively, for alignment with cable, within 500 m or if relay radio links are involved, within maximum aggregate range of 5 km.

5.3.3 Example Wireless Systems in Lieu of Customer Cabling

The ACA is aware of interest in establishing "Hotspots" linked to separate commercial operations. Hotspots is a term that refers to the delivery of access to a network via the use of WLAN technology at a particular premises such as airport lounges or Internet cafes. For example, the technology could be used to connect people to the Internet in airport lounges or Internet cafes from anywhere within a particular premises. Another recent proposal is to use WLAN technology to connect people in boats while moored at marinas.

Treatment of these arrangements and proposals toward achieving the desired policy outcome under the Telecommunications Act, is described in the preceding section.

5.3.4 Potential Commercial use of WLANs

The ACA has had a number of inquiries over the last twelve months from industry in relation to the carrier licensing requirements as they relate to the use of WLAN equipment. By way of example, currently the ACA has an application for a trial certificate using WLAN technology to deliver services in a range of public venues such as airports, hotels, exhibition and convention centres and cafes. The trial certificate was sought because of uncertainty about the regulatory treatment of the proposed application.

A trial certificate exempts any organisation from the requirement to have a carrier licence in relation to network units for the duration of the trial period. A trial certificate can be issued for an initial period of 6 months and can be extended upon application for a further 6 months. The applicant has stated that the reason for trialing a range of venues is to determine which of the venues are the most suitable from a commercial perspective and whether the technology has the potential to displace dialup access in the future.

5.3.5 Community Use

The ACA was approached in December 2001 by the *Coalition Communications and Information Technology Policy Committee* on behalf of *Brismesh* in relation to the use of the 2.4 GHz band and the carrier licensing requirements. Brismesh was concerned about the operation of the carrier licensing requirements and how they applied to the use of Wireless LAN technology and approached the ACA for advice.

Brismesh proposed to create a free community network, where the members meet the costs of the installed networking hardware. The proposal was to operate the service on the fringes of Brisbane where Internet access is expensive and where broadband access such as cable or DSL is not available. The intention was that Brismesh be a not-for-profit community network.

A requirement for a carrier licence in this instance would make such a proposal unworkable and deny the intended community any benefits that a low cost broadband service could provide.

5.4 Other Requirements

Certain obligations are imposed on organisations that are required to hold a carrier licence or operate as a CSP. This is particularly so where access to the standard telephone service is being supplied. Under Clause 1 of Schedule 1 to the Telecommunications Act, a carrier must comply with the Telecommunications Act and the T(CPSS) Act. Carriers and CSPs must also comply with the following arrangements:

- industry codes and standards;

- provide for pre-selection and number portability (where relevant);
- the Customer Services Guarantee Standard;
- the Telecommunications Industry Ombudsman scheme;
- provision of access to emergency services;
- protection of communication (privacy of a communication);
- protection of national interests and law enforcement; and
- national defence requirements and disaster plans.

Carriers must additionally:

- contribute to the cost of the USO;
- pay annual licence fees;
- furnish a number of returns and plans.

These requirements have been represented to the ACA as significant issues for a small company, especially in the start up phase. Any opportunity to defer the requirements or otherwise contain their impact would assist new operators in the establishment phase. More significantly, the more innovative applications of new technologies are tested by such enterprises. Accordingly, the fostering of such start up enterprises would result in wider testing both technologically and commercially of solutions that may be attractive to initially niche and perhaps later the broader community.

5.5 Consumer Protection and Quality of Service

Wireless LAN users presently would have no protection under the Telecommunications Act or the T(CPSS) Act if they use WLAN based services where the owner of the network units has neither a carrier licence nor an 'NCD' in place. This means that as an end user they would not be covered by any of the usual consumer safeguards that apply to other licensed telecommunications services, including recourse to the Telecommunications Industry Ombudsman for complaints, and protection under the various telecommunications industry codes.