



8 - Wireless Broadband

Broadband is defined as “the ability of a single access line or wireless or satellite link, connected to a telecommunications network, to provide support for fast, always-on access to digital content, applications and a range of services, some or all of which can occur simultaneously.”¹

Wireless broadband is not a specific technology as is Bluetooth or the IEEE 802.11 standards (See Chapters 6 and 7 respectively). Instead the term refers to the rates of data that are able to be transmitted using wireless technology. This type of data transmission will be provided through a commercial telecommunications carrier as a fixed wireless access network or through a voluntary community-based fixed wireless network. In this arrangement, there is an expansion in geographic coverage that the Wireless Local Area Network (WLAN) is able to provide but wireless broadband is primarily only a point-to-multipoint arrangement (that is, a base station to fixed or mobile devices).

Most data transfer uses a telecommunications carrier network with access through a modem. The most fundamental telecommunications network uses a connection with 64 Kbps. This rate is the guaranteed wireline telecommunications connection in Australia through government regulation and can be termed as “narrow band” by comparison to broadband’s higher data rates (See Box 8.1). This data rate of 64 Kbps was designed for voice and facsimile communications and it was not until the adoption of the Internet and web services that a demand for greater data rates available through a “broadband” were recognised as being important by users. Telecommunications carriers have always had high data rates for their exchange-to-exchange (back haul) connections.

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BOX:8.1 – BANDWIDTH CLASSIFICATIONS FOR BROADBAND²

Basic Higher Bandwidth Service (64 Kbps to 128 Kbps) – This basic service level is suitable for standard Internet applications such as file transfer, web browsing and email. Customers would normally be either residential users or small enterprises. This service level would typically be delivered by an ISDN link. For the less than four per cent of Australians for whom Integrated Services Digital Network (ISDN) is not available, the service can be delivered via one-way satellite.

Intermediate Higher Bandwidth Service (approximately 256 Kbps to 600 Kbps) – this intermediate service level is suitable for more bandwidth intensive applications such as streaming video and audio. It also allows for the fast download of large files. This type of connection could be suitable as a gateway for small Local Area Networks (LANs). Customers would normally vary from residential users up to small to medium enterprises including smaller schools and health centres. This service would typically be delivered through either an Integrated Services Digital Network (ISDN), an Asynchronous Digital Subscriber Line (ADSL) or a satellite link (See Chapter 5 – Next Generation Telecommunications Networks).

Advanced Higher Bandwidth Service (1 Mbps to 2.5 Mbps, or higher) – this advance service level is suitable for very high quality videoconferencing. It also allows for the fast download of very large files, this type of connection could be suitable as a gateway for larger LANs. The service may have 'managed' properties such as static Internet Protocol (IP) address, firewalls and specialist filtering software. Customers would normally be medium to large business, including large schools and hospitals. This service would typically be delivered by either an ISDN service, a high grade Digital Subscriber Line (DSL) service, and advanced satellite system or a dedicated Asynchronous Transfer Mode (ATM) or Frame Relay link (See Chapter 5 – Next Generation Telecommunications Networks)

Why Wireless Broadband is important

Access to the Internet is available through the 64 Kbps telephone line using a dial-up modem with theoretical maximum data rates of 56 Kbps although never achieved in practice. Over recent years there has been an increased use of the Internet for commerce, medicine, government services, personal research and entertainment. Early web pages did not include the current large data files contained in most of today's web pages and therefore the need for large amounts of data to be transferred was not critical. Current and future web pages and web-based applications are much larger in terms of the data that needs to be downloaded and if a 64 Kbps connection is used, the time taken to open a web page is sometimes several minutes.

It is for this reason that faster ways of transferring data needed to be developed. Wireline technologies such as Integrated Services Digital Network (ISDN) and Asynchronous Digital Subscriber Line (ADSL) have been developed to provide for much greater data traffic on the existing telephone networks. The advantage to the user and the telecommunications carrier is that higher data transfer speeds are able to be obtained using the existing copper-wire telecommunications infrastructure and therefore cost less than installing high-speed cables to each home or business an alternative cabling technology.

The problem is that not every user will be able to utilise these new wireline technologies. There are three reasons for this. The first is that some users are connected to telephone switches and exchanges that do not have corresponding equipment. This is likely to be remedied with up-graded equipment at the

exchange. However, where there is a low population to connect to the service, telecommunications carriers may not decide to invest in this equipment as it is not a legislated requirement that they do so. Consequently no wireline broadband will be available.

The second reason is that some premises have an incompatible infrastructure that uses a “pair-gain” technology. This technology works with the local exchange and allows the telephone company to “gain” an additional telephone line so that there is a “pair” of lines on the one. This makes the use of Digital Subscriber Line technology impossible. Therefore the wireline broadband technologies will not work. Some 6 per cent of homes and businesses are affected.³

The third reason is that as a physical signal travels across a distance the initial intensity weakens. An example is the light from an electric torch (flashlight) appears bright when close to the eye but appears to dim as the distance between each increases. Similarly the signal from the exchange will decline (attenuate) unless a booster is included. With wireline broadband, the maximum distance from the exchange to the user is limited to 3.5 kms and the inclusion of a booster is not technically or economically practical. Users 3.5 kms way from an exchange will not be able to have broadband access and this affects 8 per cent of Australian wireline telecommunications users.⁴

Regulation of Australian Wireless Broadband

Wireless technologies use the radio frequency spectrum. Apart from a select range of frequency bands, all radio spectrum are controlled by the *Radiocommunications Act (1992)* and the *Telecommunications Act (1997)*. The first manages the use of the radio spectrum to ensure that no interference is caused to each user. In order to fund this management, users pay for a licence to use the band and are assured that other enterprises will not be able to use these frequencies. Therefore radio spectrum is limited and expensive.

For wireless broadband, certain frequencies will be more appropriate than others. Higher frequencies in the 38 to 40 GHz spectrum have wavelengths of 1 mm and are suited to line-of-sight, long distance communications. Therefore, wireless communications including broadband will depend upon regulation of the radio frequency spectrum.

The Federal Government in 2002 reviewed the situation regarding wireline and wireless broadband through a number of reports. The Department of Communications, Information Technology and the Arts issued *Australia's Broadband Connectivity*,⁵ the Parliament through the House of Representatives issued *Connecting Australia! Wireless Broadband*,⁶ and the Regional Telecommunications Inquiry issued *Connecting Regional Australia*.⁷ These reports provide recommendations for a review of broadband technologies and as this area is regulated, adoption of various technologies will depend upon government influence. *Connecting Australia! Wireless Broadband* is highly recommended and gives an in-depth overview of wireless broadband technologies as at June 2002.

Broadband is considered to be an important part of a country's infrastructure, competitive advantage and a key driver of a nation's Gross Domestic Product. It is forecast that the next generation broadband technologies could produce economic

benefits of \$12 – 30 billion per annum over the next 25 years provided that broadband becomes as universally adopted as the telephone.⁸ While efforts have been directed towards the digital divide by providing equipment and training, another divide may be created where access to the Internet with reasonable data rates is not available in some areas.

Wireless broadband is also known on occasion as Fixed Wireless Access (FWA) and Wireless Local Loop (WLL). The Local Loop (LL) is the wireline telecommunications infrastructure that runs from the local exchange to the user and is also known as the 'last mile' that carriers had to provide. Some observers have felt that this does not place appropriate emphasis on the users' requirements and it should be called the 'first mile'.⁹ As discussed above, some users will not be able to obtain wireline broadband within the Local Loop so a wireless solution is employed.

Wireless broadband is able to provide an alternative method for data transmissions that overcomes the problems of wireline broadband access. It is important to remember that each technology has benefits and costs, opportunities and difficulties in implementation. Wireline broadband will be the preferred option for new developments but retro-fitting of buildings and rural areas may benefit the most from wireless broadband.

Technology Overview

Radio Spectrum

The physical radio spectrum is measured in hertz (Hz). Each Hz refers to the frequency of oscillations (cycles) that the electromagnetic field changes per second. The frequencies used for wireless communications are those above 30 million Hz and below 300 GHz.¹⁰

One Hz can carry around 1 bits per second (bps) . Therefore a signal at 1000 Hz (or 1 KHz) carries 1000 bps or 1 to 4 Kbps. Mobile telephones using the Global System for Mobiles (GSM) carry around 9.6 Kbps. The new Third Generation (3G) mobile telephones are likely to provide between 20 to 80 Kbps.¹¹ Wireline broadband technologies such as an Asynchronous Digital Subscriber Line (ADSL) have a performance of around 140 Kbps.

Radio signals at the lower end of the spectrum (less than 3.5 GHz) have a large wave pattern and are able to go around corners to the receiver and travel comparatively further. This makes this end of the spectrum rather useful but it is also licensed. By contrast, radio signals from 30 GHz and up are in the "1 mm" range as the radio wave is around that size and is often unlicensed. The distance that a signal is able to travel is not as far as the lower frequencies however these frequencies are able to carry greater amounts of data but the signal needs to be in line-of-sight. These frequencies are also affected by wet weather conditions.¹² For more information, see Box 8.2 – Choice of Frequency.

Point-to-multipoint wireless broadband

Broadband is defined as a single access line that is connected to a telecommunications network and is therefore comprised of a telecommunications carrier (point) providing an access line to a number of subscribers (multipoint). In

terms of the numbers of installations for wireless broadband access, this technology will be in more demand than point-to-point connections as these are larger, carrier oriented and less frequently commissioned.

BOX 8.2 – CHOICE OF FREQUENCY¹³

Different frequency bands in the radio frequency spectrum are regulated by a system of three licences.

Apparatus licences – authorise the operation of radiocommunications equipment for specific purposes, for example, land mobile, outpost, amateur, maritime or aeronautical communications and broadcasting. You pay a licence fee and the Australian Communications Authority (ACA) issues you with a licence to operate the equipment.

Class licences – are open, standing authorities that allow anyone to operate particular radiocommunications equipment provided the operation and the device meet the conditions of the licence. Class licences do not have to be applied for and no licence fees are payable. Under class licensing, users may operate various types of radiocommunications equipment including citizen band radios, mobile and cordless phones and a range of other low power devices, such as remote control garage door openers. The spectrum governed by these licences are considered 'public parks' where each person in the park needs to be sensitive to causing others radio interference.

Spectrum Licences – are a tradeable, technology-neutral (that is, the licence is not related to any particular technology, system or service) spectrum access right for a fixed non-renewable term. Instead of authorising the use of a specific device, spectrum licences authorise the use of spectrum-space and give licensees the freedom to deploy any device from any site within their spectrum, provided that use is compatible with the core conditions of the licence and the technical framework.

Choosing the right frequency – The best frequency for a given application depends on many factors, including:

- The available band width and ambient noise, which affect achievable data rates.
- Whether the band is an Industrial Scientific and Medical (ISM) where co-channel interference may be random, unavoidable and difficult to localise.
- The nature of the environment. Waves above 15 GHz cannot be used in humid or rainy areas if long distance transmissions are required. These would be the best frequencies to use spatial separation to avoid co-channel interference. In general terms, waves above 1 GHz require strict line-of-sight in most terrain; however this could still be as far as 10 to 30 kms.
- The cost and availability of infrastructure such as repeater towers. Hilly terrain requires expensive infrastructure for all but the VHF and UHF frequencies.
- Cost and availability of the technology. High frequency systems (greater than 5 GHz) are generally more expensive.
- The cost of the spectrum should dedicated spectrum be required.

As this area is defined as a new and potentially well-adopted technological area, there is a range of available technologies that need to be proved reliable prior to mass adoption. It is important to remember that this report looks at technologies likely to be dominant in 2008. Current wireless broadband technologies may not be the preferred choice at that time.

Local Multipoint Distribution Service (LMDS)

This technology refers in a general sense to microwave data distribution systems operating at 10 GHz and above usually in the licensed 24 to 32 GHz band. This makes the technology a line-of-sight application with the need for high towers at the base station and suitable aerials for users. These antennas will need to be carefully aimed and require careful engineering. The useful distance for transmissions is limited to around 3 to 5 kms with data rates at around 1.5 Mbps and higher. This technology can be used for voice, data services, TV, and broadband Internet access.¹⁴

Multichannel Multipoint Distribution System (MMDS)

This technology is used to describe fixed microwave data distribution at licensed frequencies below 10 GHz but usually from 2.5 to 3 GHz. This technology has a wide coverage of 20 to 40 kms and is used for television transmissions and data transmissions such as access to the Internet. Installation is sometimes expensive with a site-survey usually required.¹⁵

Satellite

Satellites are able to provide wireless solutions throughout the entire globe and are expected to provide the majority of wireless broadband services. Radio waves are unimpeded travelling through a vacuum and are therefore able to maintain transmissions through space over longer distances than on earth. Geo-synchronous orbits are 36,000 kms above the earth and Low Earth Orbit (LEO) satellites travel between 200 and 3000 kms altitude. Operating in the 12 to 14 GHz range with one-way or two-links with data rates estimated to be between 200 kbps to 400 kbps. Satellite-base communications can carry a wide variety of communications services including television, voice, and data for Internet access¹⁶

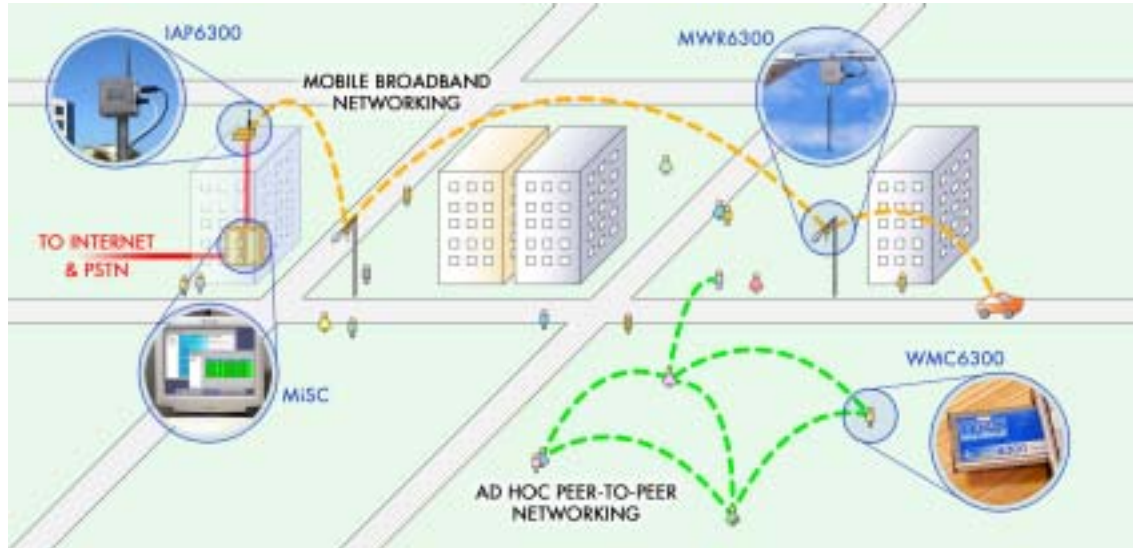
MeshNetworks and IEEE 802.11

The House of Representatives stated that “for both urban and regional Australia, the most exciting technology for wireless broadband is 802.11”¹⁷ (see Chapter 7 – Wireless Local Area Networks). The IEEE 802.11 technology provides for inexpensive equipment and is in the unlicensed spectrum of 2.4 GHz. Interestingly this technology allows for device mobility as well as access while travelling in a vehicle. The US company MeshNetworks has gained a commercial licence from ITT Industries who developed a prototype for the US Defence Advanced Project Research Agency (DARPA) and the US Federal Communications Commission has granted a licence to MeshNetworks for its proprietary product Mesh Enabled Architecture (MEA) and MeshLAN technologies.¹⁸ This approval from the US commission opens the way for implementation into Australia through the Australian Communications Authority.¹⁹

The reason that this vendor’s products are important is that through the use of repeater stations (or wireless routers), the area of coverage for a Wireless Local Area Network can be increased beyond the limits of other current vendor offerings. This technology works in the unlicensed Industrial, Scientific and Medical (ISM) frequency and provides good coverage using the 2.4 GHz band.

The technology was originally developed for the US military to create instant networks in the field. A graphic describing the Meshnetworks system is shown in Figure 8.1 – Meshnetworks Wireless Broadband

Figure 8.1 – Meshnetworks Wireless Broadband



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Ultrawideband (UWB)

The technology works in the 3.1 GHz spectrum and above and signals are spread over 3 GHz of spectrum thereby attracting the name “ultra-wide”. Ultrawideband transmits a number of signals across a number of frequencies in timed, very short (10 to 40 million) pulses per second with the receiver collecting the in-sync signals to form a message.²⁰ This technology provides for a low cost and low power option with high data rates. The technology was developed by Time Domain²¹ and has received approval from the US Federal Communications Commission for commercialisation but with some technical limits, especially the distance that signals are allowed to travel (that is, less than 10 m). The limits are placed on the technology because the signal crosses over a very wide band of frequencies that can cause interference in the licensed spectrum.²²

Mobile Telephony

The cellular mobile telephone networks are able to provide for voice and data transmissions albeit at a reduced rate to wireline or wireless broadband. The newer mobile networks are using a range of transmission methods to increase data rates but this technology will remain expensive for applications other than voice. There are reports of individuals utilising the mobile network for downloading data from a server that has compressed electronic communications (such as email) and this greatly reduces the time spent on air.²³ This option may not suit many users and may be limited to specific commercial applications and enthusiasts within the time period of this project.

Summary

For the purposes of this examination, mobile telephony is to be excluded as this wireless access is the slowest and is in the domain of telecommunications carriers exclusively. This technology will remain within the telecommunications industry and not be shared with other industries. However, the other technologies described may not be carrier dependent and will require the development of infrastructure in mainly regional, rural and remote areas of Australia. Additionally, the focus of wireline broadband is to primarily provide access to the Internet and by its nature is not mobile.

The technologies outlined above should not be viewed as competing but as technologies that can be combined to produce a site-specific solution for broadband access. For example, a satellite link located centrally within a small town with a Multichannel Multipoint Distribution Service out to a WLAN for access by users. These systems may be provided by a telecommunications carrier for a fee or through a community-owned network. The Australian Communications Authority announced on 20 September 2002 that a single site Wireless Local Area Network does not require a carrier license and this allows for a range of private installations to be developed freely.²⁴

IMPLICATIONS FOR THE SHARED TECHNOLOGY INDUSTRIES

Automotive

Limited application for these technologies apart from mobile telephony. MeshNetworks WLAN does provide for vehicle access as does 3G mobile telephony. Daimler Chrysler has tested a vehicle with the European Universal Mobile Telecommunications System (UMTS) that is specifically designed for vehicles.²⁵ Automobile users may adopt petrol-station based WLANs for access to the Internet or rely upon downloading compressed data via the 3G mobile telephony systems.

Building and Construction

Limited impact on this sector as access points and antennas will be added-on to buildings rather than used within the building structure.

Electrical

This area is likely to become involved in site-surveys and connection testing. Development of the access point (that is the main transmitter) will most likely remain with telecommunications due to the high degree of installation engineering. Issues similar to those arising in the Wireless Local Area Network (See Chapter 7 – Wireless Local Area Networks) will arise as well as combined high-level operations and commissioning with telecommunications engineers.

Electronics

Limited impact of these technologies in this area.

Information Technology

Limited impact of these technologies in this area.

Telecommunications

High level of involvement with this industry as these technologies fit squarely within the Public Switched Telephone Network (PSTN). A high degree of problem solving and interference issues will arise before this technology becomes routine.

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