LEADWEST

Telecommunications in Melbourne's West

Eckermann & Associates

October 2008

Executive Summary

This report looks at telecommunications infrastructure in Melbourne's West and considers the adequacy of that infrastructure in terms of supporting the rising demand for high-speed broadband and continuing strong growth that is expected over coming years.

Telecommunications infrastructure has come to be just as vital a pillar of the socio-economic well-being of a community as other more visible infrastructure such as roads, railways, bridges, electricity, gas and water supply and sanitation. Broadband data access – both cabled and wireless – has emerged as being *especially* important. An increasing number of individual Australians are becoming dependent on it in many aspects of their daily lives. New businesses are proliferating in the growing global "information economy" and traditional businesses are reinventing themselves to take advantage of the opportunities that electronic communications presents. Communities that are deprived of adequate access will find themselves at increasing socio-economic and environmental disadvantage.

Despite its importance as the "new utility", the provision of telecommunications infrastructure and services has (for the most part) been left to free market forces since the commencement of deregulation in Australia in 1992. These forces have driven healthy investment in *some* areas of the market – notably in trunk routes and central business districts. However, in *other* areas – especially local access – progress has been slow and patchy.

A systematic look at the key broadband infrastructure in Melbourne's West as well as anecdotal evidence from individuals and businesses struggling to obtain quality access exposes limitations and "black spots" in the region. Without studying the entire city, it is difficult to judge to what extent the incidence of problems is abnormal and to what extent it is common to high growth areas at the urban fringes.

What does stand out, however, is the opportunity for telecommunications to be used in alleviating many of the demographic imbalances that currently exist in the West – for instance, in raising education levels, in improving the balance between population and employment opportunities and in reducing transport bottlenecks. These imbalances risk becoming more acute unless proactive measures are taken to ensure that infrastructure provision keeps pace with the region's growing population.

Local governments do not have direct responsibility for the provision of telecommunications, but they can influence the outcome in a number of ways. This report recommends that local governments embrace the goal of seeing telecommunications infrastructure and services in their jurisdictions put on a par with those available in inner urban areas of Melbourne. Towards achieving this goal, the report outlines two key areas of action.

The *first* area relates to the "National Broadband Network" – an initiative of the Australian Government that promises to deliver sweeping upgrades to Australia's telecommunications infrastructure. These upgrades could overcome many of the problems that are noted in this report. However, the initiative carries a number of risks, and it behoves LeadWest and its local government constituents to highlight areas of concern to the Government.

The *second* area relates to measures that can be taken at a local government level to influence the outcome. The report recommends two key actions:

- (depending on the outcome of the NBN process) mandating the provision of optical fibre provision as a condition of approval for all new land developments in the West; and
- looking for "niche" opportunities to improve the backbone connectivity between population centres in Melbourne's West and the CBD in conjunction with other infrastructure development projects that may be carried out.

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1. Introduction

1.1 Background to this Report

Melbourne's West is the fastest growing region of Melbourne and one of the fastest growing regions of Australia. At the same time, the rapid transformation of the Australian economy is eroding the West's traditional manufacturing industry base, whilst the concentration of the new service industry opportunities is in the Melbourne CBD and the Eastern suburbs.

Add to this the gross deficiency of the West's public infrastructure relative to that of the East, educational and health levels that are below those in the rest of Melbourne, and it is clear that the West faces a number of challenges.

At the same time, the West enjoys several advantages – particularly it's proximity to major centres of economic activity, and with virtually all Melbourne's rail, road and air transport connections to the rest of Australia running through it or being adjacent to it.

LeadWest has been formed to provide leadership to the West in addressing its challenges and capitalising on its advantages, to be a representative voice for the West (especially to State and Federal Governments) and ultimately to help the West realise its potential as a dynamic, enjoyable and fulfilling place in which to live, work and visit.

This report has been prepared by Eckermann & Associates in response to a brief from LeadWest to advise on the current status of telecommunications infrastructure and on developments that will be needed to support the socio-economic and environmental well-being of the West as a major growth area.

1.2 Why has Communications Infrastructure become so Important?

Telephony has long been regarded by many as an essential service. However, over the past 15 years, telecommunications has undergone a revolution that has elevated its importance to entirely new levels. In particular, three inter-related developments have transformed it forever from its historical origins as first-and-foremost a phone service:

(a) The Internet has come into widespread public use. In December 2007 the ABS reported[1] that there were more than 6 million of Australia's 8.5m households (over 70%) and almost 1 million businesses subscribing to Internet access. Such a large user base makes the Internet an extremely important channel of communication – and has spawned innovation in almost every aspect of business and social activity. Those without access to the Internet face significant socio-economic disadvantages and penalties in areas including (but certainly not limited to):

- communication with customers, friends and members of family – including enhanced forms of communications such as video conferencing and instant messaging;
- access to encyclopedic arrays of information on virtually any subject;
- the opportunity to exploit new forms of entertainment and leisure;
- support for education and skills development programs;
- as businesses, the opportunity to engineer new efficient ways of interacting with suppliers as well as customers and to reach much larger markets;

1 ABS Internet Activity Survey, December 2007 (referred elsewhere herein as "ABS 8146") – see http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8146.0Main+Features12006-07?OpenDocument.

- as citizens, the ability to access government services and transact many forms of business without travel, postage and other more costly, more time-consuming methods of interaction;
- growing potential to enhance health and lifestyle through electronic access to information, services and support;
- enablement of home-based businesses, or (in many industries) the potential to work from home at least some of the time;
- the opportunity to replace energy-inefficient activities with alternatives that have a much lower impact on a stressed environment.

(b) Data communication speeds have increased dramatically with the introduction of broadband technologies, allowing the rapid electronic transfer of multimedia resources including images, video and sound. Enhanced by multimedia, Internet sites have become much richer repositories for all sorts of information, with appealing interfaces to aid navigation and use. As noted in an OECD report, "broadband amplifies or accelerates the impacts of Internet activities on households and individuals"[2]. However the flip-side of this is also true, and the increasing use of multimedia has made access to many sites using slow dial-up connections at best frustratingly slow, and at worst totally impractical. High speed connectivity is becoming an essential requirement for efficient use of the Internet.

The "need for speed" is not something that will be satisfied with a one-time upgrade to any particular level of performance. Rather, as soon as a higher level of performance becomes widely available, applications emerge that exploit the capacity and it is usually not long before the new performance level is coming under pressure.

(c) Wireless technologies have emerged to allow users to access information whenever and wherever they need it, and to capture information where it is generated. The full impact of this is still gathering momentum, epitomised by the popularity of mobile phone handsets that support Internet access for email access, web-browsing and an emerging new generation of applications.

Much has been written about the way in which communications is transforming modern lifestyles. Rather than including a lengthy discourse on that subject, this report will assume that the reader generally understands and accepts the growing role that it plays.

However, the link with economic development merits special attention. Few people would debate the importance of infrastructure such as roads, rail, electricity and water to the development of a region. However, in a world where the information economy represents a growing proportion of global economic activity, telecommunications infrastructure has become an equally vital foundation for progress.

The Australian Industry Group and Deloitte summarised the clear message emerging from their latest survey[3] of the views of Australian business leaders as follows: *"the development and deployment of a high speed (national) broadband network is now seen as crucial in building the future competitiveness of both Australian companies and the Australian economy."*

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[2] "Broadband and ICT Access and Use by Households and Individuals", OECD DSTI/ICCP/IE(2007)4/FINAL, December 2007.

[3] "High Speed to Broadband: Measuring industry demand for a world class service", Australian Industry Group and Deloitte, October 2008. The reports is available at http://www.deloitte.com/dtt/cda/doc/content/High%20Speed%20to%20Broadband%281%29.pdf.

Other observations from this survey include:

- broadband is being used as a tool to drive the productive capacity and innovative behaviour of many Australian firms;
- Australia's competitors are alive to the economic importance of high speed broadband networks and are taking action accordingly;
- almost three quarters of all businesses (73.5%) indicated that they were likely to upgrade to high speed broadband if available;
- the desire for high speed broadband is highest among firms located in regional areas;
- a faster broadband network is likely to result in considerable increases in all areas of business activity for Australian firms;
- Internet access is seen as highly important to the business operations of 85.1% of respondents;
- 69.9% of firms surveyed indicated that they believe that internet provides their business with a 'strategic advantage'; and
- over 93% of companies indicated that the internet has had a positive impact on their efficiency/productivity.

In a recent report, the Victorian Government[4] discussed the role of broadband in local economic development, and noted the benefits it offers to the community in general and to business in particular. The report also acknowledges that there are "*critical gaps in the availability of services for businesses, let alone residents, in outer suburban LGAs of Melbourne*". This report certainly reinforces that view.

1.3 Content of this Report

Section 2 provides a brief overview of the demographic profile of Melbourne's West, and includes a summary of some past work done on telecommunications patterns in metropolitan Melbourne. Whilst this work is now dated, it includes indications that are consistent with infrastructure investment lagging in areas of high population growth.

Section 3 looks specifically at the telecommunications landscape in Melbourne's West. It can be shown by a consideration of the technology and infrastructure that the availability of broadband via Telstra's copper network is the single most critical area of differentiation in terms of the adequacy of a region's communications infrastructure and services. The section relies on a level of familiarity with key technical concepts and terminology. For those readers who lack this familiarity, Appendix A provides a high-level introduction and sets out the rationale for focusing on Telstra's copper.

Section 4 explores the options for securing better telecommunications outcomes in Melbourne's West. Because this report has been prepared at a time when the future of Australia's telecommunications infrastructure is the subject of a major upgrade plan, the first part of Section 4 concentrates on particular outcomes that LeadWest and its constituent local governments should seek as part of that upgrade process. The second part of the report looks at measures that fall within the control of the local governments themselves.

Section 5 proposes several recommendations for transforming the observations and conclusions of this report into a plan of action for securing better outcomes.

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4 "Local Economic Development in Outer Suburban Melbourne", Outer Suburban/Interface Services and Development Committee, September 2008 (see especially pages 353 and following). The report is available at http://www.parliament.vic.gov.au/osisdc/inquiries/economicdevelopment/report.htm.

1.4 Contact for More Information

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2. Profile of the West

The diagram below shows the location of the six local government areas (LGAs) that make up Melbourne's West. A latent strength of the region is its proximity to the Melbourne central business district (CBD) relative to many areas in the South/East of Melbourne's greater urban area.

2.1 Demographic Profile[5]

The table that follows shows population information for each of the West Melbourne LGAs and for the region as a whole. The region represents approximately 17% of Melbourne's population, has a growth rate approximately twice that of Victoria and higher than any other region of Melbourne. By 2030 it is expected that the population of the region will have grown by some 30% to 850,000. Wyndham and Melton have particularly high growth rates and a younger age profile than other LGAs in the region.

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5 Unless otherwise noted, information in this Section is derived from a report entitled "Metropolitan Melbourne – Victorian Government Departmental Region: Spend/Demand – Telecommunications in Regional and Rural Victoria", prepared in by ACIL Tasman in February 2007 for Multimedia Victoria (hereafter simply referenced as the "ACIL Tasman Report").

LGA	2005[6]			Area (square kms)	2007	
	Homes	Pop'n	Median. Age		Growth in prior 12m	Pop'n
Brimbank	56,476	175,979	34.3	123.3	0.9%	176,249
Hobsons Bay	32,331	83,194	37.0	112.5	0.8%	85,525
Maribyrnong	26,162	61,985	35.5	64.2	2.5%	67,825
Melton	24,766	76,131	30.5	47.4	5.8%	85,613
Moonee Valley	43,809	108,878	37.5	52.8	0.8%	112,481
Wyndham	38,960	115,532	32.0	44.3	6.2%	123,162
Total	**222,504**	**621,699**	**36.1**	**444.5**	**2.6%**	**650,855**

Table 2-1 Demographic Information
(Primary Source: Australian Bureau of Statistics)

Past work by LeadWest[7] has identified various key characteristics of the West:

(a) It is the most culturally diverse region in Melbourne, with over 90% of nationalities represented and 35% of families speaking a language other than English.

(b) Education levels are lower than for metro Melbourne – with low school retention rates and the lowest rate of tertiary qualified graduates.

(c) There is a significant and widening gap between population numbers and employment opportunities – making the West heavily dependent on inner Melbourne for jobs. The resultant high travel demand coupled with poor transport infrastructure contributes to congestion and detracts from social and environmental amenity.

(d) Compared to the State as a whole, employment in the advanced knowledge and service sectors is lower and employment in transport, production, clerical, sales and labouring sectors is higher. The region has 12.3% of the Victoria's manufacturing and transport jobs, but only 6.5% of the knowledge-based services jobs. The West delivers 14% of Victoria's gross manufacturing output.

(e) The overall unemployment rate of 5.5% is about 25% higher than the State and metropolitan rates. Unemployment in some areas exceeds 11% and the region has the highest rate of youth unemployment. Job growth in the region lags well behind population growth – despite having 12.5% of Victoria's population, the region has barely 8% of the State's jobs.

The Melbourne 2030 report sets a number of directions that will impact on the future development of the region including:

(f) Melbourne's sprawl will be limited by setting an urban growth boundary. Parts of Melton and Wyndham lie outside this boundary.

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6 2005 data is included in this table for alignment with other information extracted from the ACIL Tasman report. The 2005 data was originally sourced from the Australian Bureau of Statistics (ABS), but subsequently the ABS amended some of the figures. As a result, the growth rates shown for the 12 months to 30th June 2007 may seem anomalous when comparing the 2005 and 2007 populations.

7 "Western Agenda – A Strategic Action Plan for Melbourne's West Region – 2008-2011", LeadWest, May 2008 (hereafter simply referenced as "Western Agenda"). Only some of the most salient points – related to telecommunications – are included in this report, and readers are encouraged to read the Western Agenda for greater insight into the character, challenges and opportunities associated with Melbourne's West.

(g) Urban expansion will be concentrated into growth areas that are served by high-capacity public transport[8].

(h) Werribee (in the Wyndham LGA), Sydenham (in the Brimbank LGA) and Footscray (in the Maribyrnong LGA) have been designated as Transit Cities aimed at promoting higher density commercial and residential development.

(i) There is potential to:

- significantly develop the existing Agriculture & Food Technology Precinct at Werribee; and
- to develop a new major activity centre at Werribee West, serving as a hub for new suburbs.

The Western Region Employment and Industrial Development Strategy (WREIDS[9]) sets out a framework for sustainable economic development and employment growth in Melbourne's Western Region. All indicators point to continuing strong growth, with all of the infrastructural challenges that such growth brings.

2.2 Internet Access (2005)

The first three columns of the table below shows the number of Internet access services being provided using metro-equivalent[10] broadband, satellite and dialup technology. The rightmost column gives an estimate of the number of premises for which access to metro-equivalent broadband was not available – and estimates the unmet demand in such areas.

LGA	Metro-equivalent Broadband	Satellite	Dial-up	No Access to Metro-Equivalent Broadband	Unmet Demand for Metro-Equivalent Broadband
Brimbank	21,309	8	19,829	299	104
Hobsons Bay	31,190	0	12,161	13	5
Maribyrnong	10,953	0	9,811	10	4
Melton	9,406	41	9,725	1,593	587
Moonee Valley	19,272	0	17,357	18	7
Wyndham	15,961	4	14,737	156	58
Total	**108,091**	**53**	**83,620**	**2,089**	**765**

Table 2-2 Internet Access
(Source: ACIL Tasman Report)

8 LeadWest has also prepared a submission to the East-West Link Needs Assessment, seeking improvements to road transport infrastructure (in addition to public transport infrastructure).

9 "Western Region Employment & Industrial Development Strategy – Summary Report", Ratio Consultants Pty. Ltd. in association with National Institute of Economic & Industry Research, C.B. Richard Ellis, CSIRO Transport Futures, July 2007 – available at http://www.maribyrnong.vic.gov.au/Files/WREIDS_Final_Summary_Report.pdf

10 Metro-equivalent broadband is a generic term reflecting the standard of broadband access that is typically available in central urban areas, whether delivered over copper (DSL), coax cable (HFC) or wirelessly.

Some coverage "black spots" obviously exist in each LGA, particularly in Melton. Although the information in this table is now somewhat dated, enquiries undertaken in preparing this report indicate that there continue to be problem areas in the region – especially in Wyndham and Melton.

The ACIL Tasman report did not delve into the quality of metro-equivalent broadband connections – these can vary widely, by one or two orders of magnitude relative to the lowest entry-level broadband speeds. In addition, the more competition and choice that exists in the market, the better the prospects that users will be able to find an affordable plan that suits their usage patterns. These issues are discussed further in Section 3.2.2.

Table 2-2 combines residential and business use, and therefore it is not possible to infer uptake rates. However, in separate investigations, LeadWest has noted[11] that ***the number of people using computers and the Internet is around 15% below the metropolitan average***.

2.3 Telecommunications Expenditure (2005)

The ACIL Tasman report estimated a total annual telecommunications expenditure approaching $1 billion by users in Melbourne's West. A breakdown of this figure is provided in Table 2-3.

	Internet Access						
LGA	**Metro-equiv. B'band**	**Sat-ellite**	**Dial-up**	**Fixed Line Tel.**	**Mobile Tel.**	**Pay TV**	**Total[12]**
Brimbank	$30.11	$0.01	$7.69	$102.44	$74.79	$10.19	**$239.82**
Hobsons Bay	$20.95	$0.00	$4.85	$64.98	$43.51	$5.97	**$152.70**
Maribyrnong	$23.10	$0.00	$4.25	$64.02	$39.90	$4.92	**$156.68**
Melton	$11.84	$0.06	$3.71	$41.98	$23.19	$5.49	**$88.44**
Moonee Valley	$29.60	$0.00	$6.85	$90.10	$53.63	$8.34	**$199.30**
Wyndham	$20.95	$0.01	$5.61	$65.50	$50.44	$8.70	**$157.86**
Total	**$136.55**	**$0.08**	**$32.96**	**$429.02**	**$285.46**	**$43.61**	**$994.80**

Table 2-3 Telecommunications Expenditure
(Source: ACIL Tasman Report)

A substantial proportion of this would represent revenue to Telstra given its role as:

- the near-exclusive provider of telephony line rental;
- the dominant provider of retail telephony services and of wholesale telephony services to other carriers;
- a major provider of retail broadband services, and the provider of various wholesale services (ULL access etc) on which many other retail services are based;
- one of the major providers of mobile telephony services.

It is of interest to note that telephony revenues (fixed line, mobile and dial-up Internet access) were more than 5 times higher than broadband revenues (metro-equivalent and satellite), despite the growing importance of the latter! In particular, fixed line telephony expenditure dwarfs all other areas.

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[11] "Western Agenda", LeadWest, May 2008

[12] The total does not necessarily add up because of inclusion in the ACIL Tasman report of an "Other" category.

This is not a reflection on the relative importance of broadband and telephony services and nor is it unique to Melbourne' West. Historically the full costs of the Telstra's extensive network infrastructure have been recovered through telephony charges. Since deregulation, many new market entrants have deployed trunk capacity, and the resultant competition has led to significant reductions in long-distance telephony charges. However, with just a few exceptions, there has been little investment in local-access infrastructure, especially outside of CBD areas. As a result, line rental and local access charges have not been exposed to the same competitive pressures, and these remain relatively high despite the balance of user interest shifting towards broadband services.

Whilst the ACIL Tasman report does not offer projections for individual LGA's, it does give a view on the growth of telecommunications expenditure for metropolitan Melbourne as a whole – see Table 2-4 below:

Year	Internet Access			Fixed Line Tel.	Mobile Tel.	Pay TV	Total[13]
	Metro-equiv. B'band	Sat-ellite	Dial-up				
2006	$1,131	$0.74	$228.7	$3,227	$2,125	$253.9	**$7,607**
2007	$1,342	$0.95	$200.6	$3,123	$2,212	$273.4	**$7,870**
2008	$1,632	$1.08	$153.8	$3,034	$2,321	$296.1	**$8,243**
2009	$1,845	$1.15	$128.1	$2,944	$2,423	$319.6	**$8,561**
2010	$1,996	$1.17	$116.7	$2,854	$2,538	$342.8	**$8,857**
2011	$2,111	$1.16	$113.3	$2,763	$2,653	$365.6	**$9,137**

Table 2-4 Telecommunications Expenditure for Metropolitan Melbourne ($m)
(Source: ACIL Tasman Report)

The overall trend is for total telecommunications expenditure to grow with annual increases ranging from 3.2% to 4.7% and a total increase over the period of around 20%. However, the rate of change is not uniform across the different service streams, with decline in some service streams masking higher rates of growth in others. In particular:

- expenditure on fixed line telephony services (including dial-up Internet access) is projected to fall steadily; and
- expenditure on mobile phone services and metro-equivalent broadband is projected to rise steadily.

Furthermore, rates of change are not homogenous across the different LGAs. The ACIL Tasman report forecasts growth rates in expenditure that (relative to the 20% average across metropolitan Melbourne) are:

- around double in Melton and Wyndham;
- slightly higher in Maribyrnong; and
- slightly lower in the other three LGAs.

[13] The total does not necessarily add up because of inclusion in the ACIL Tasman report of an "Other" category.

2.4 More Recent Data from the Bureau of Statistics

The latest ABS report on household use of information technology[14] was released in December 2007. It does not include a detailed analysis by LGA, but it is expected that most of the general trends noted would also be evident in Melbourne's West.

Key findings included:

- Internet Access - steady growth has continued, with 64% of Australians now having Internet access from home and 73% now having access to a computer.
- Broadband Access - there has been continuing strong growth in broadband access, with 43% of all households now using broadband connectivity.

The ABS study notes some correlations between their observations and certain demographic profiles that may be more prevalent in Melbourne's West:

- home computer access, Internet access and broadband access are all lower amongst households with lower incomes;
- use of the Internet is significantly higher amongst people with higher levels of educational attainment and those who are employed;
- use of the Internet at work was highest amongst professional, administrative workers and managers and lowest amongst labourers, machinery operators and drivers;
- 53% of those sampled cited education and study, and 52% cited work or business-related purposes, as a reason for Internet use; and
- people aged 15-17 used the Internet on a daily basis than other age groups.

2.5 Summary

Melbourne's West is facing a unique set of challenges associated with the highest growth rate in the State. Various demographic indicators suggest a growing imbalance between the expanding population and the healthy socio-economic balance that one might expect in a sustainable community.

In the area of telecommunications, it is not immediately obvious whether infrastructural deficiencies are contributing to the problem or are merely a symptom of it.

However, it does seem reasonable to expect that eliminating "black spots" and putting telecommunication services on a par with the best that is available elsewhere would help to dismantle barriers and make positive socio-economic contribution in areas such as:

- facilitating skills development and raising below-average education levels;
- alleviating the imbalance between the residential population and the number of jobs in Melbourne's West – especially in knowledge-based industries which are currently under-represented in the region;
- supporting the growth of home-based businesses;
- reducing pressures on transport infrastructure (with consequential environmental benefits) by making it easier for employees in some industries to work a proportion of their time from home.

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[14] See ABS 8416.0

3. Current Status of Telecommunication in the West

In addition to a systemic look at telecommunications in the West, this Section contains a number of "boxed" case studies to illustrate anecdotally the sorts of difficulties that are being experienced, and the problems that this is causing to residents and businesses.

3.1 The Critical Elements

Appendix A provides an introductory overview of the technology that is used in the delivery of modern telecommunications services. Several key principles can be distilled from an analysis of the technology:

(a) Access to both free-to-air TV (via antenna) and Pay TV (via cable network or satellite dish) is essentially available everywhere.

(b) Conventional telephony services over Telstra's copper network are available *almost* everywhere – though this study identified some pockets (for example, in central Melton) where Telstra has not been able to connect customers to its network months after they have moved into their new premises. In such situations, Telstra typically offers an interim service delivered via its mobile telephony network and charged at standard land-line rates. This solution may be adequate for voice communications, but it is not suitable for fax or data communication.

Frozen out of Metro-Equivalent Broadband Access

One of the largest cold storage facilities in Melbourne is located at Laverton North in Melbourne's West. To the uninitiated an operation such as this may appear to be concerned with little more than big sheds and big trucks. However as with almost all businesses, nothing stands still and to remain competitive, it is imperative that the business continues to develop and keep pace with modern systems and technologies. In this regard access to broadband services has become an essential foundation for the Company's operations.

This business is only one of many in the area that is unable to access the level of broadband infrastructure that they need to achieve maximum productivity – or to support healthy growth that would create new employment opportunities. A group has been formed in an effort to try and secure remedial action and to ensure that future economic growth will not be impeded by uncertainty over the availability of broadband in developing commercial and industrial precincts.

(c) The standard of infrastructural support for data communications is more than anything else what will distinguish between well-served and under-served areas in Melbourne. This involves both cabled and wireless infrastructure.

(d) The adequacy of both core network infrastructure and access infrastructure needs to be considered. Any deficiencies in core network infrastructure will typically be capable of being remedied at a fraction of the cost relative to deficiencies in core network infrastructure.

(e) No matter what cabled or wireless access technology is used, the closer that optical fibre is taken to users, the higher the capacity that can be delivered. As an extension of this principle, optical fibre all the way to the user's premises gives the ultimate in performance and bandwidth "future proofing".

(f) Of the various cabled access technologies, HFC infrastructure is unlikely to be extended or upgraded, and no BPL technology has yet been deployed or is likely to be deployed in the near future. Fibre to the premises is currently limited to some greenfield areas

Without Decent Broadband, Land is not fit for Occupation

A small start up food processing & technology company operating in Derrimut produces a range of fresh tasting fruit preparations and juices. The key to the business is an innovative Australian first process known as high pressure processing that is used to pasteurise and preserve fruit products without the use of heat. The company is the first in the world to use the process.

The company currently exchanges a great deal of information with a company in Spain and, due to the lack of cabled broadband access, currently uses a wireless broadband service. However, relative to high-speed cabled broadband, performance is inferior and variable.

The inadequacies of the present wireless service are a source of daily frustration – and an embarrassment when hosting international visits. The company considers that land without adequate broadband access should not be represented as fit for commercial and industrial use.

and to the largest corporate customers. By elimination, ***copper is the most significant cabled infrastructural resource in Melbourne's West at present***.

(e) Wireless technologies (especially point-to-point links) can substitute for cabled access in some limited circumstances. For networks offering widespread coverage, wireless performance will be lower than might be obtained from good cabled connections, and more variable, depending on the number of active users at the time.

(g) Notwithstanding the inherent performance limitations, wireless access is becoming increasingly important as a complement to cabled access, supporting mobile and nomadic use.

3.2 Telstra's Copper Network

3.2.1 Infrastructure

As discussed in Appendix A, the performance potential of a copper circuit is a function of its length, condition and the gauge of copper used. Many features of the circuit that affect performance cannot be easily ascertained without physical inspection and testing. These include (for example) the degree to which is it is prone moisture ingress, the number of joints in the path, the quality of those joints and the possible existence of un-terminated "spurs" left in place during the course of the connection history of the circuit. Because of this, it is not possible to give an accurate formula for the performance that can be expected at different distances.

Nevertheless, as an indicative guide for circuits of 0.5 gauge copper in good condition, the following performance levels at different copper distances would be realistic:

- 1 km – 23 Mbps
- 2 kms – 16 Mbps
- 3 kms – 9 Mbps
- 4 kms – 4 Mbps
- 5 kms – 2 Mbps
- 6 kms – 1 Mbps

Because most copper circuits originate in a Telstra exchange, the quality of broadband access to any location in Melbourne's West will *in general* be a function of the distance of that location from the exchange to which the location is connected.

Sick of Sub-Standard Broadband

A General Practice Network (GPN) with a staff of approximately 15 services around 200 GPs in the municipalities of Wyndham and Hobsons Bay. The service is vitally dependent on electronic communication with allied health providers, Commonwealth and State organisations, Local Government and a multitude of service providers.

The GPN operated in a more central urban location for 9 years before resolving to move its operations to Wyndham as a major growth corridor of Melbourne's West.

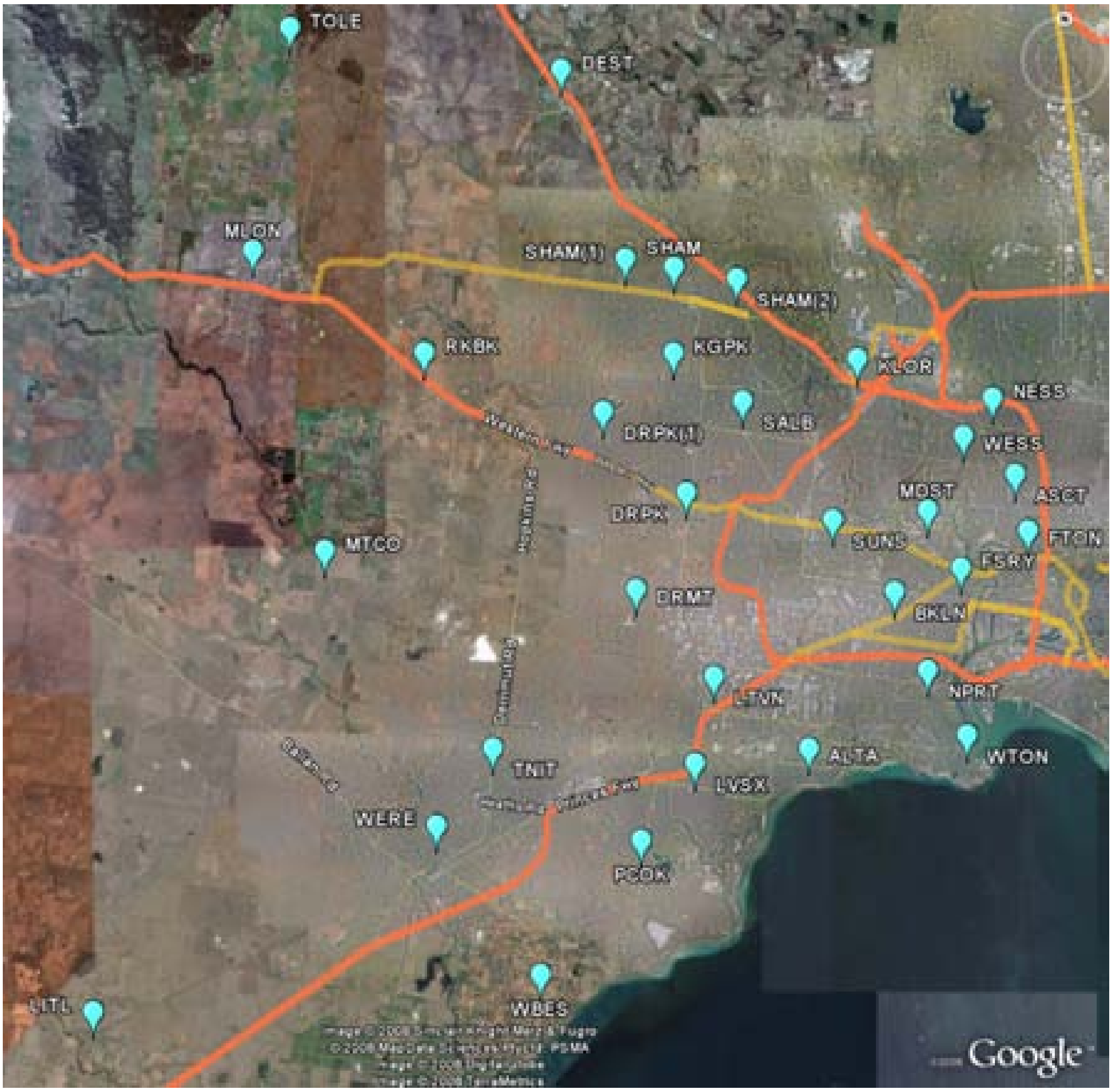
Upon locating a possible lease site in Hoppers Crossing, interrogation of the Telstra website indicated that ADSL and potentially ADSL2+ would be available. The business relocated in November 2007 and an application for broadband was made at the local Telstra shop.

No response had been received after five days, and on contacting Telstra, the business was informed that there were doubts about ADSL availability. Enquiries with other ISPs also suggested that there were problems, apparently due to the continued use of pair gain technology – and Telstra eventually confirmed that ADSL was not available.

Despite letters to Federal and State Ministers and the CEO of Telstra, no progress had been made by January 2008. Continuing on the interim low speed dial-up service was simply not viable, so the business eventually resorted to a wireless broadband service. The ongoing costs are twice that of a comparable ADSL service and the service required installation of a large antenna at an installation cost of around $1,000.

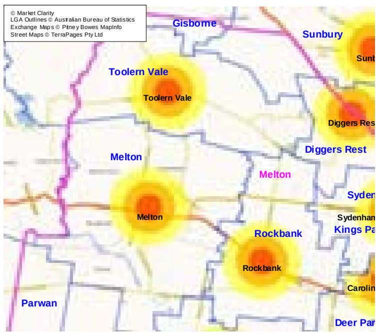
The business describes this as a disgraceful experience – finding problems with broadband access after having locked itself into a 3-year accommodation lease.

The map on the next page shows the location of the Telstra exchanges in Melbourne's West. Each is identified by a code (see Appendix B for translation and additional information regarding the location and status of the exchange). Note that some areas along the boundary of six target LGAs obtain service from exchanges which are located in surrounding LGAs. Such exchanges are not shown on the map.



In many cases, service is *not* provided from the geographically closest exchange. Rather, the coverage area is subdivided into exchange serving areas (ESA) and (with some exceptions noted below) all connections within the ESA are made back to the exchange in the "heart" of the ESA. It is the length of the copper path between the user and the relevant exchange that determines the ADSL performance potential.

To provide insight into the capabilities of Telstra's copper network, Market Clarity[15] has prepared a series of charts such as those shown in the thumbnail image on the right. Appendix C provides a separate chart for each LGA showing the LGA boundary (in magenta), the ESA boundaries (in blue) and exchange locations. A series of circles at 1, 2 and 3 kms are drawn around each exchange. Users within a 1 km radius could generally expect to get excellent ADSL2+ performance; within the 1-2 km band, performance should still be good; in the 2-3 km band it becomes questionable whether users

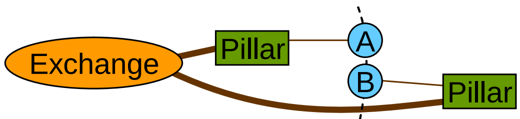


[15] See www.marketclarity.com.au.

would get the benefit of the higher performance ADSL2 and ADSL2+ standards. Outside of the 3km band, the copper distances will necessarily be longer than 3 kms and accordingly the performance improvements of the ADSL2 and ADSL2+ standards will definitely not be attainable.

Several notes of caution are needed in interpreting these charts:

(a) Direct inferences about the copper distance to any location in the service area cannot be drawn by simply measuring the distance "as the crow flies" from the exchange. Cables follow street and other alignments, resulting in tortuous paths that are invariably longer than the straight-line distance. A multiplier is sometimes used to convert from a direct distance to an estimated path length, but knowledge of the route is needed for any degree of accuracy – as can be shown from the diagram below where two adjacent properties A and B fall into different distribution areas and the copper paths are of significantly different length.



A & B are the same radial distance from the exchange

(b) Telstra's network is not wholly based on a fibre-to-the-exchange architecture. For about the past 15 years, most new areas have been developed with a FTTN architecture, where nodes are connected back to the exchange by optical fibre and/or copper. ADSL services may be being delivered from *some* of these nodes, in which case distance will in general not be a limiting factor. Telstra does not generally make information about its network architecture public, but local governments may be able to identify FTTN areas based on the era in which land was developed.

(c) The original exchange in some ESAs has been augmented with supplementary exchanges. This enables growth areas to be supported more efficiently by creating a concentration point that is in turn connected to the original exchange. Each property can be connected to one and only one exchange – but the details of how the ESA is subdivided into sub-areas is not published. Furthermore, the boundaries may be intricate with older pockets in a new sub-area remaining connected to the original exchange.

(d) Although the use of pair gain technology (see Appendix A.3.2 (b)) has been discontinued by Telstra, some of the case studies that were reviewed in the course of this project suggest that may not yet have been fully eliminated from the network.

(e) Users may be located close to an exchange, but the availability of ADSL2+ services may be limited because:

- no operators have deployed the necessary equipment in the exchanges;
- equipment has been installed, but it is fully loaded and there is no spare capacity to support additional users.

It is evident from the maps in Appendix C that:

- coverage is relatively good in Maribyrnong and Moonee Valley, with only a small proportion of the territory lying outside the 3 km circle;
- for Brimbank and Hobsons Bay the proportion of areas beyond 3kms direct distance increases; and
- at the fringes of urban growth in Melton and Wyndam, many areas lie quite some distance from the exchange.

More detailed information about the availability of services at particular locations can be obtained from the web sites of many ISPs (by providing a phone number) and from other sites[16] devoted to monitoring the availability of ADSL services.

3.2.2 Competition

The focus of the second series of charts is on the level of competition that prevails in the area. This can occur at a number of levels. At the lowest level, an ISP can simply buy a wholesale service from an infrastructure owner and repackage it. In this case, there is no scope for technical differentiation.

At the "highest" level, ISPs can acquire their own core network capacity to the Telstra exchange, deploy their own equipment in the exchange, rent raw copper capacity from Telstra and "construct" services with a high level of flexibility. In such situations, the services can be differentiated by:

- the capacity that the ISP uses to carry traffic from the exchange to their core network; this affects the "contention ratio" – that is, the degree to which multiple customers compete for capacity on the shared "backhaul" segment of their Internet connection;
- removing any artificial constraints imposed on the copper/DSL performance; the more innovative ISPs allow the line to operate at its maximum speed – which could be as high as 24 Mbps service for users close to the exchange;
- commercial terms such as monthly download quotas, over-quota policies and the like.

To provide an indication of the levels of competition, the charts use colour coding to show the number of fibre owners in an ESA, and different icons in the exchange location to show the number of carriers renting raw copper and operating their own DSLAMs. An overview of the entire region is shown below, with more detailed charts for each individual LGA being provided in Appendix D.

Based on information provided by Market Clarity, there are a total of eight different parties with optical fibre to one or more of the Telstra exchanges in Melbourne's West:

- NextGen
- Optus
- Pipe Networks
- Silk Telecom
- SP AusNet
- Telstra
- UEComm and
- VicTrack.

Learning the Limitations of Wireless Broadband

Limited internet access in Cairnlea is making learning difficult for an autistic boy. Justin Stapleton, 7, uses wireless broadband internet to see language and puzzle-based education sites. It is easier for him to use the internet, as people with autism have difficulty interacting with others. But his line often drops out, is slow, has a small download limit and is expensive.

Justin's father, Russell, is campaigning to upgrade internet access in Cairnlea to include the more reliable Asymmetric Digital Subscriber Line, known as ADSL. "I would just like to see us up to normal standard as far as the telecommunication technology goes," he said. "When I bought land in Cairnlea I expected the telecommunications infrastructure to be in place and to be top-class as the suburb was promoted as a family-friendly suburb of the future. How wrong I was."

VicUrban communication director Rose Gigliotti said internet access was not promised to residents. "ADSL was never part of the development package," he said. "We included access to the copper phone networks. Whatever telecommunications services provide through that network is up to them."

Telstra said there were no plans to provide ADSL to the areas of Cairnlea that were too far out to get access. Until Telstra was shown otherwise, it was seen as an unsound investment to upgrade the exchange. "Because it is a capital outlay for Telstra, we want to know there will be some return from the investment," Telstra spokesman Pat O'Beirne said.

VicUrban has no plans to discuss the issue with Telstra.

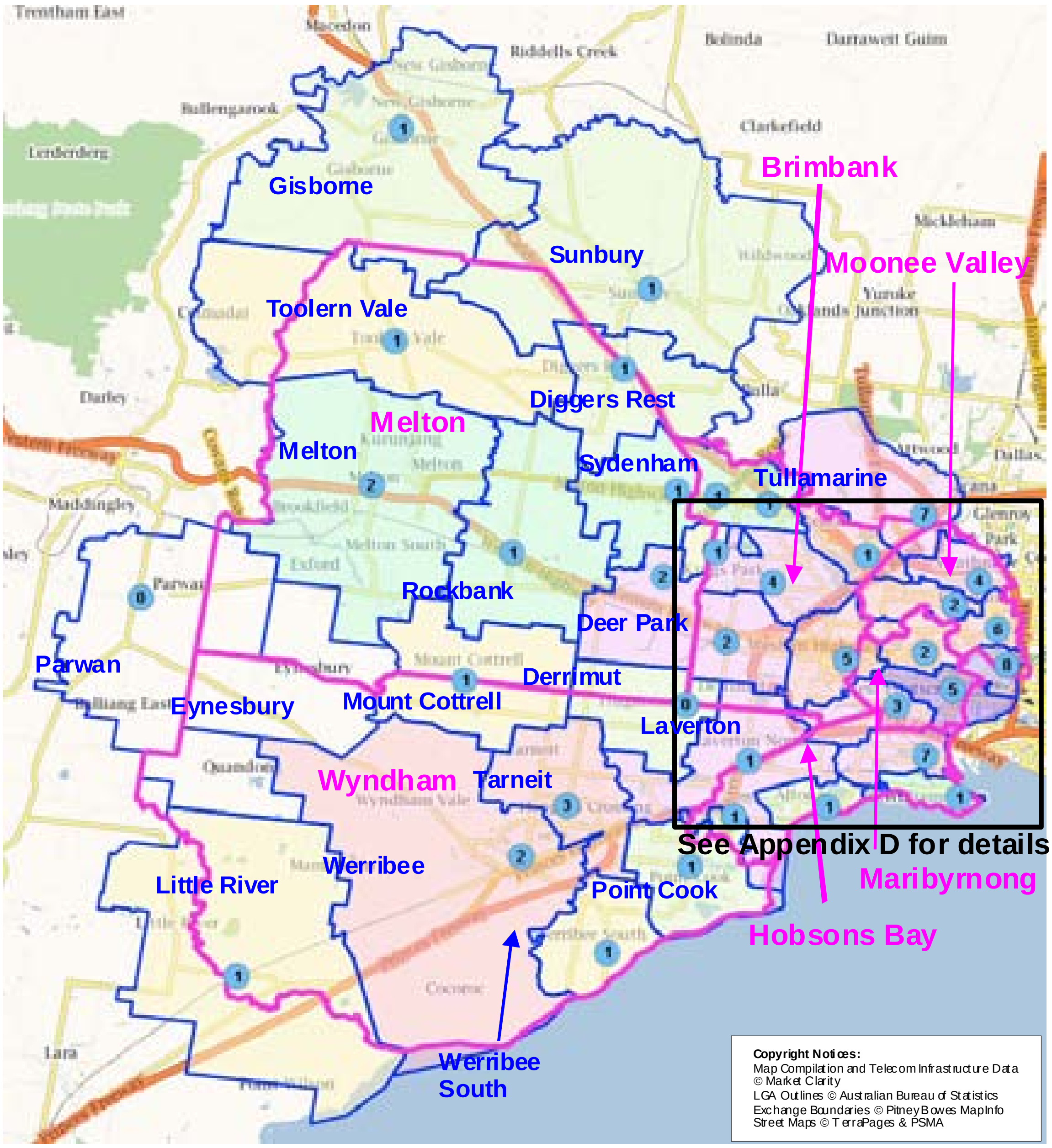
Brimbank councilor Ken Capar is pushing to have ADSL available to all of Cairnlea.

[16] See for example http://www.adsl2exchanges.com.au/providerexchanges.php?Location=VIC.

Market Clarity also identified ten different parties owning DSLAMs in one or more of the exchanges in Melbourne's West:

- AAPT
- Agile
- iiNet
- iPrimus
- Macquarie Telecom
- Netspace
- Nextep
- Optus
- Telstra and
- TPG.

Competition, consumer choice and value for money are likely to be strongest where there are multiple DSLAM owners *and* multiple providers of access fibre. An overview of the entire area is as shown below (see Appendix D for key to colour coding).



As might be expected, there is a stronger level of competition in the inner West. Operators interested in establishing a presence in the more central Telstra exchanges will tend to have a choice of multiple backhaul providers, and the resultant competition will help to lower costs. Similarly, end customers will tend to have broader array of ADSL providers from which to select a service, and with increased choice they are more likely to find a cost-effective package for their requirements.

3.3 Wireless Infrastructure

The wireless infrastructure on which both individuals and businesses rely most heavily is the mobile telephony network – for both telephony and increasingly for data access. There is a general expectation that access will be available throughout urban areas – and "black spots" can be a source of great frustration to users who live or work in an area of poor coverage.

Other networks are less established, and in general, their user communities are conditioned *not* to expect ubiquitous coverage. Naturally improvements in coverage are welcomed, but the absence of coverage in a particular area does not create the same problems as the absence of adequate mobile telephony coverage.

Each of the operators publishes coverage maps on their websites, or provides a facility for ascertaining whether coverage is provided at a particular location. In addition, a national database of all transmission sites[17] is maintained and can be searched to ascertain the location of sites in a particular area.

In general, coverage can be patchy at the fringes of urban expansion, with infrastructure often lagging behind the population growth. Anecdotal evidence from a number of the people consulted during this project indicates that there are problem areas in Melbourne's West, particularly in the Melton and Wyndham LGAs.

In contrast to the situation with cabled broadband (where there is heavy dependence on Telstra's copper), there are four mobile telephony networks. This provides a healthier level of competition and enables users who are not satisfied with coverage from one provider to explore alternatives. It also serves as a stimulus for the network operators to maintain adequate coverage in populated areas so that they do not lose customers to competitors.

Because of these dynamics, the situation in terms of wireless broadband coverage is not considered to be unduly problematic in Melbourne's West. However, to the extent that some users may be pushed into using wireless broadband due to the lack of access to availability of an ADSL service, loadings on the network may be abnormally high at times and this could exacerbate any performance problems.

Five Years of Frustration

A business on Old Geelong Road in Hoppers Crossing has been unable to access Telstra Broadband for at least the last 5 years.

The story is long and often convoluted. The company has applied to Telstra on numerous occasions to access this service. Many of these early requests came back negative on the basis that the business was too far away from the exchange. The company even sought to negotiate a new phone line from a different exchange specifically to access broadband, all to no avail.

Despite more recent technical developments that have extended the reach within which ADSL services are offered, the company is still unable to obtain a cabled broadband service, nor get a consistent explanation as to whether the problem relates to distance from the exchange, a lack of capacity at the exchange, or the use of pair gain technology. Requests for someone to visit the site and carry out tests have been unanswered.

The company needs interconnectivity between three key locations and spends over $20,000 per annum on telecommunications. ADSL is available at the other two locations, but the company has had to resort to a 3G wireless connection at Hoppers Crossing. This is very unsatisfactory for large data transfers.

The bulk of the company's telecommunications expenditure has been moved away from Telstra in protest at the lack of broadband in Hoppers Crossing – a problem which also afflicts other businesses in the area and impacts on efficiency and growth.

With the bulk of Australians now having access to broadband, the company is very frustrated that a significant business area such as Hoppers Crossing lacks essential telecommunication services.

[17] See http://www.rfnsa.com.au/nsa/index.cgi (use guest login).

3.4 Fibre Infrastructure

Various developers have started exploring the provision of fibre-to-the-home (FTTH) in greenfield developments as a means of differentiating the product that they deliver to land buyers.

Most efforts to date have centred on residential developments, with VicUrban's Aurora project being the first significant initiative (outside of some gated communities) in the Melbourne area. A case study on the Aurora project was published by Multimedia Victoria in 2006[18]. Since that time, a growing number of greenfield developments around Australia have incorporated FTTH plans.

There are many benefits flowing from these projects:

(a) Residents in the development are typically offered higher performance broadband services than are generally available in non-FTTH areas, and can be assured of access to further performance increases without the delays that others may face when cabling has to be upgraded.

(b) The FTTH areas serve as a catalyst for raising the public understanding of what is possible through advanced communication – in turn leading to pressure for better infrastructure more widely.

(c) The communities served with FTTH become islands of rich internal connectivity, typically with a substantial optical fibre backhaul link to the operator's core network in the CBD. Neighbouring areas may eventually benefit if services are extended beyond the boundaries of the estate.

Residential estates in Melbourne's West known to have been (or planned to be) developed with FTTH infrastructure include:

- Sanctuary Lakes (ClubLinks COM, PBN)
- Eynesbury (EDJV, Telstra)
- Valley Lake (VicUrban, IP Systems)
- Ashley Park (MFS, Telstra)
- Saltwater Coast, Point Cook (FKP, Telstra)
- Riverwalk, Werribee (VicUrban, TBD)

To date, developers have given less attention to providing advanced broadband infrastructure in commercial and industrial (C&I) areas – even though telecommunications is typically more critical to business users than it is to most residential users. It is likely that this is because very large users can pay the premiums involved in getting a high performance service brought to their building, and many of the smaller users are adequately supported by whatever residential-grade services are offered in their area.

However, as some of the case studies in this Section highlight, there are businesses in Melbourne's West that are suffering considerable disadvantage and much frustration because they cannot get the standard of broadband services that most urban Australians take for granted.

Sub-standard Internet Access is Hurting

A clothing design company has grown significantly since its establishment a couple of years ago and now has agents representing it throughout Australia. The company's principal line of business is importing motorbike clothing and accessories from overseas – with a high proportion of the business dependent on Internet connectivity.

The company has only recently been able to obtain an ADSL service in the precinct, but is still frustrated by poor response times and frequent drop outs. The company suspects this is an issue with the exchange not having sufficient ports to cover the expanding business community in this region. Previously the company operated through the wireless network, but this proved unreliable.

After being advised that ADSL would be introduced, the company applied for a connection. Enquiries about subsequent delays met with mixed responses – and regular feedback that the exchange could not yet service the area.

Informal discussions with other businesses in the same precinct have shown the company's experience is not an isolated incident. Business performance has been adversely impacted by the inadequacy of good internet access in the area.

[18] See http://www.mmv.vic.gov.au/Assets/24/1/aurora110906.pdf.

As awareness of the importance of telecommunications grows, some land developers have begun to explore options for providing their C&I estates with optical fibre infrastructure. Such projects are generally less advanced than the residential projects, but early precedents are likely to raise the expectations and demands of businesses looking at options for locating their operations. This in turn is likely to see FTTP come onto the agenda of a growing number of land developers in the coming years.

The C&I approaches currently being explored in various parts of Australia differ from typical residential approaches in a number of key ways:

(a) In residential areas, interest in services is relatively homogenous and lends itself to the use of standardised customer premises equipment that is capable of supporting telephony, video and data services. In contrast, C&I users have more diverse needs, and a "one size fits all" technical solution is less appropriate. As a result, the solution may be limited to passive optical fibre cabling, with whatever electronics is most appropriate to the customer's needs only being deployed when services are connected.

(b) C&I users typically have limited interest in video services, but often want equipment capable of supporting multiple phone lines and higher-speed data connections.

(c) The cost to the developer of a residential solution can be higher than for a C&I solution because of the need to include standardised customer premises equipment and to remove the barrier of high connection fees. In C&I areas, businesses are better able to meet non-trivial connection costs.

(d) To achieve economies of scale, many residential solutions use PON technologies where one fibre is split to support multiple customers. In C&I areas, it is more common for each building to have one or more dedicated fibres, and cabling architectures may be more sophisticated to provide a level of redundancy in the connection between the customer's premises and the telecommunications entry point to the precinct.

Lack of Broadband Infrastructure a "Showstopper"

A Kensington resident has informed the Wyndham Council that over the past couple of months he has been investigating the potential of moving his consulting business to Point Cook with a view to operating from home.

The business has been operating since 2005 and organises visits by Chinese business delegations to Australia. This requires constant communication with China and high speed Broadband is critical.

As a result of a recent article in the Werribee Banner the business has learned that it cannot be guaranteed broadband internet services in the Point Cook area. Its initial excitement of finding a new home and business location has dissipated.

This business has the potential to grow and in time expects to be in need of a commercial office and more staff.

Plans to relocate in the outer western region of Melbourne have been placed on hold until availability of the internet infrastructure needed to support and grow the business can be assured.

At this stage, there are no known C&I precincts being developed to incorporate a FTTP solution in Melbourne's West. However, given the need to redress the imbalance between population and employment opportunity, proactive initiatives by local governments to ensure that business precincts are well-served with advanced broadband services deserve attention.

3.5 Summary

Several conclusions can be drawn based on a consideration of the telecommunications infrastructure currently deployed in Melbourne's West and on other anecdotal information:

(a) A proportion of residents and businesses in Melbourne's West are struggling to obtain telecommunications services that are taken for granted in more central areas. Many of the problems encountered are evident in other new growth areas. Without doing a comprehensive survey of the whole city, it is difficult to prove that the West is uniquely disadvantaged. However, having the highest growth rate in the State, it is considered likely that a higher proportion of the population will be exposed to these problems.

(b) Based on socio economic data (under-representation of knowledge-based industries, imbalance of employment opportunities, typically lower education levels, broad multi-cultural population etc), the West may benefit disproportionately by increased investment in telecommunications infrastructure.

(c) If Melbourne is to exploit the opportunities to grow its population in the West (with all the advantages that growth relatively close to the CBD would bring), it must dismantle barriers to businesses choosing to locate in the region. Inferior telecommunications can be a major barrier – especially where a region has earned a reputation through the publishing of problem stories. The goal should not only be to put Melbourne's West on a par with other outer-urban areas, but to embrace strategies that will put the telecommunications services in key business and commercial areas on a par with those available in the CBD.

4. Opportunities for Improving the Telecommunications Environment in the West

This Section looks at the opportunity for improving the broadband outcome in Melbourne's West in two key areas.

The first relates to the expected deployment of National Broadband Network infrastructure over the coming 5-6 years. Although this is a national initiative being driven by the Australian Government, it is expected that the Government will remain receptive and responsive to the views put to it by interested parties. This report proposes a number of key principles that LeadWest and its local government constituents should support.

The second area of opportunity relates to initiatives that could be taken by the local governments that make up Melbourne's West.

4.1 The National Broadband Network (NBN)

4.1.1 The Process Currently Underway

As a key element of its plan for the future, the Rudd Government has committed to provide up to $4.7 billion and to consider necessary regulatory changes to facilitate the roll-out of a new open access, high-speed, fibre-based broadband network, providing downlink speeds of at least 12 megabits per second to 98 per cent of Australian homes and businesses. The network will represent the single largest investment in broadband infrastructure in Australia's history.

The party to build the National Broadband Network is being selected through a competitive assessment process. A Request for Tenders (RFT) was issued on 11th April 2008, and on 23rd May 2008 a prequalification process concluded with the establishment of a list of parties who had put up a $5m bond and thus become eligible to submit tenders. Whilst the Department of Broadband, Communications and the Digital Economy (DBCDE) has not officially disclosed details of prospective tenderers, the list is known to include Telstra, Optus, Terria[19] (a consortium of 10 significant telecommunications companies), Axia, Macquarie, TransACT and the Tasmanian Government.

The original due date for the lodgement of tenders was late July 2008, with the goal of a decision in October 2008. However, the lodgement deadline has now been extended by four months, and with the Christmas/New Year holiday period intervening, it would now be more realistic to expect an outcome towards the middle of 2009.

The process could result in the appointment of a single NBN Supplier – or potentially several NBN Suppliers, each with responsibility for one or more States and Territories. In any particular jurisdiction there will be only one NBN Supplier.

4.1.2 Potential Technical Approaches

It is ultimately a matter for tenderers to put forward solutions that they believe can best satisfy the objectives that are set out in the RFT. Under the strict non-disclosure provisions applying to the RFT process, details of bids other than the successful bid may never be fully disclosed.

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19 See www.terria.com.au.

For the reasons set out in Section A, the best technical solution would be based on a fibre-to-the-premises (FTTP) architecture. However, the cost of deploying new optical fibre cabling to 98% of Australian homes is so substantial that the Government's offer of a $4.7 billion co-funding would be reduced to being a relatively weak catalyst for industry-led investment.

Whilst there may be pockets of the market that can be provided with a FTTP outcome (for example, new estates), it is widely expected that the most likely outcome in most areas of Australia will be a wide-scale upgrade of Telstra's copper network from a fibre-to-the-exchange (FTTX) architecture to a fibre-to-the-node (FTTN) architecture. This approach delivers the performance benefits of shorter copper loops by replacing the "upper reaches" of the "tree and branch" copper network for a fraction of the cost of totally replacing the network.

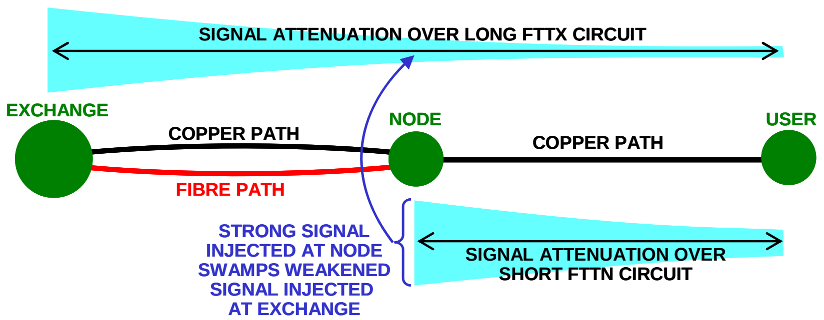
The depth to which optical fibre is taken in any such upgrade is also a matter for the various NBN tenderers. It is generally expected that copper distances would be reduced to no more than around 1 km in order to assure all users a good xDSL performance.

The number of users connected to any node within a 1 km distance will vary, depending on housing density. By way of an "order of magnitude" indication, based on around 300 premises served from each node, there would be around 2,500 nodes[20] required in Melbourne's West. Some of these nodes already exist (in the more recently developed areas) – but the number still represents a major increase relative to the 33 exchanges presently located in the region.

4.1.3 The Threat to Competition

Currently, a major part of the competition that prevails in the Australian market is based on operators locating their ADSL equipment in Telstra's exchanges and renting copper loops from Telstra at regulated prices. It is technically possible to introduce a FTTN architecture without dismantling the exchange-based infrastructure – deploying new optical fibre and nodes in parallel to existing copper.

However, if *any* broadband customers are connected by copper *through the node* all the way back to the exchange, the higher-performance ADSL standards that could otherwise be offered from the node can no longer be run at full capacity. This is because an ADSL signal sent from the exchange suffers loss in strength (attenuation) over distance and is weakened by the time it gets to the node. If full-strength signals were injected at the node onto copper pairs in the same cable, they would "swamp" the weakened signals coming from the exchange (see diagram opposite). Thus, *in general*, converting a traditional FTTX network to a FTTN network has to be an "all or nothing" approach if the benefits of shortened copper loop lengths are to be realised.



[20] This estimate allows some additional nodes to support commercial and industrial areas.

There are technical solutions to this dilemma. If different xDSL standards are used at the exchange and at the node (for example, ADSL and VDSL respectively), services from both origins may coexist so long as the power of any signal injected at the node in any frequency band that overlaps with that used from the exchange is reduced appropriately. Future technology advances may introduce dynamic power management to maximise performance in the absence of interfering signals.

Whilst such technical solutions may exist, they are unlikely to be attractive to the eventual NBN Supplier for commercial reasons. Having made a substantial investment in the FTTN upgrade, the Supplier will inevitably be reluctant to see their return on investment eroded by the continuance of competing FTTX-based services.

4.1.4 Key Issues to Pursue

The NBN remains the most promising option on the horizon for a wide scale upgrade to the telecommunications infrastructure in Melbourne's West. At this stage, the exact shape that such an upgrade might take remains unclear, and there remains potential for LeadWest and other interested parties to try and influence the outcome through the representations that they make through various channels to the Australian Government. The following positions are recommended:

(1) Seek an Early End to the Uncertainty

The NBN has been on the Australian telecommunications agenda since well before the most recent Federal election. Because of the very real risk that ADSL infrastructure installed in Telstra's exchanges could be stranded under a FTTN upgrade (see Section 4.1.3), carriers have become understandably reluctant to invest in new equipment whilst ever the future operational life of that equipment remains so uncertain.

The impact of the uncertainty extends beyond investment in ADSL equipment in Telstra exchanges. For example, there is a possibility that the NBN Supplier(s) could offer FTTH as the standard infrastructure in greenfield areas, installed at no cost to developers (the same basis on which standard copper infrastructure is normally provided by Telstra today).

Reasons why developers have good cause to contemplate such an outcome include:

- carriers around the world recognise and accept that optical fibre will displace copper at some point within the next few years; the gap in capital costs has largely disappeared;
- there is mounting evidence of worthwhile operational savings from those carriers who have made the change to optical fibre early;
- whilst copper provides a cheap, robust way of delivering telephony, the number of premises wanting only telephony is diminishing as broadband uptake continues to grow;
- for data and video services, optical fibre unlocks new performance levels and revenue opportunities for the operator;
- key equipment (in particular, the optical network units that must be installed at the customer's end of the fibre) is falling in price and can be expected to reach commodity pricing levels in coming years.

If Telstra were to incorporate such an offer into a successful NBN proposal, it is difficult to see how the burgeoning market of alternative FTTH suppliers could continue to grow their market share – and this could put their future at risk. Developers who have previously been willing to invest in differentiating their estates with FTTH infrastructure are now becoming cautious about making long-term commitments to pay for an outcome that may in the future be offered at no cost.

There has already been four months slippage in the NBN schedule. The process is complicated by the uncertain regulatory regime that will apply in the future, and clarification of this could see tenderers contending that they would have submitted a very different proposal had they known the rules in advance. Given so much is at stake, it is easy to imagine outcomes that might be legally challenged by losing tenderers. However, if the process drags on for too long, not only will the benefits of the NBN be delayed, but the country could well fall behind as the current investment hiatus is extended.

There also exists a possibility that the Government will determine that *no* proposals satisfactorily meet its requirements and accordingly bring the NBN process to a conclusion without selecting an NBN supplier. The loss of momentum suffered during the hiatus surrounding the NBN process would be regrettable, but at least such an outcome would free the industry to resume evolving under free market forces.

(2) Preserve Competition

Competition is a well-established driver of innovation, and Australian broadband uptake has flourished with ULL-based competition. The business case is for new operators to enter the market is generally attractive, with:

- a modest fixed cost to install equipment in a Telstra exchange;
- a regulated cost for acquiring copper access from the exchange to the customer, giving access to a market of many thousands of prospective customers with costs of access incurred only when a paying customer is secured;
- varying but generally healthy levels of competition for capacity from the exchange back to the operator's core network.

As outlined in Section 4.1.3, this framework for exchange-based competition could evaporate under the expected FTTN network upgrades. Furthermore, it is not easily replicated in the FTTN architecture.

Current regulatory provisions entitle operators to access Telstra's "raw" copper at the node, but the business case simply does not support the widespread use of this right by other carriers. By way of contrast to ULL-based competition from exchanges:

- it is not practical to provide space for multiple carriers in kerbside equipment cabinets, and alternative operators would typically need to deploy their own nodes (with complications such as powering) in order to access "last mile" copper under ULL provisions; this is neither an efficient nor elegant approach, and community opposition could well be expected to a proliferation of kerbside equipment cabinets;
- from a node, the operator gains access to a limited market of just a few hundred customers rather than the thousands of customers that are served from an exchange;
- the investment needed to provide a competitive market in backhaul from thousands of nodes is considerable and, coupled with the likelihood of low demand from operators wanting backhaul capacity from numerous nodes, is unlikely to ever make sense.

There has been much debate, not just in Australia but throughout the world, as to whether access networks should be treated as natural monopolies. Australia moved away from this view with its approach to deregulation in the early 1990's, hoping to stimulate facilities-based competition. Whilst there has been healthy investment in certain segments of the market (notably trunk capacity between the major population centres and in CBD areas where there is a concentration of high-value customers), building healthy infrastructure-based competition on a wide scale in local access networks has proven much more problematic.

The prospects for future access network investment on a wide scale are likely to be even bleaker if 98% of Australia is covered by a National Broadband Network capable of delivering (at least) 12 Mbps to every customer. As discussed above, ULL-based competition is likely to wither and the NBN Supplier(s) is likely to become entrenched in a natural monopoly position. It can be easily demonstrated that anyone deploying a new rival network need to capture significantly more than 50% of the market to achieve viability. Even if the challenger were to build a technologically superior network (such as FTTP), many users will not ascribe a premium to higher performance – and the prospects of taking such a large market share from an entrenched incumbent are minimal.

Notwithstanding this, it is likely that rival carriers will continue to pursue "cherry picking" strategies, targeting the most lucrative pockets of the market. Indeed, if the NBN Supplier offers homogenous pricing across the country, it is likely that challengers will attack the areas where a high concentration of valuable customers can be reached for a relatively small investment in infrastructure.

More generally however, it is a high priority that competition be protected through the regulatory regime that is introduced to support the NBN. There are different ways in which this might be accomplished.

One approach would be to vest ownership of the access network in a company that operates exclusively at the wholesale level, offering local connectivity at convenient points of access (such as existing exchanges) to all parties seeking access. The more rigorously the management of such a company is separated from any conflicting interests associated with the retail provision of services, the more likely the company will be able to deal with all access seekers on fair and equal terms.

If the NBN outcome does not feature such structural separation, it will become doubly important to implement mechanisms for monitoring and controlling the company's behaviour so that it does not exploit its natural monopoly to the detriment of user interests.

There is also a technical aspect to the preservation of competition. With ULL-based competition from the exchange, operators can manage the service they provide their users by their choice of ADSL equipment. In the FTTN scenario, access from convenient points of presence (such as exchanges) will not be via a raw cable, but rather over circuits that include optical fibre, copper *and active electronics* managed by a third party. The service characteristics will be defined by the technology that is adopted by the NBN Supplier(s), and opportunities for technical differentiation will be reduced.

This is particularly important for emerging new services such as IPTV – that is, the delivery of broadcast-quality video services over the cabled network. Such services are demanding in their use of bandwidth – requiring a constant multi-Mbps stream that is insulated from typically "bursty" Internet-access traffic that may be present over the same line at the same time. Despite the demands that services like IPTV impose on the network, it is not practical for the providers of such services to pay premium rates for the traffic and remain commercially viable.

At a technical level, therefore, the NBN must be engineered to provide efficient support for emerging new classes of traffic at potentially differentiated prices.

(3) Recognise FTTP as the "End Game"

It would be naïve to think that the pressure for higher speeds will be satisfied once and for all by a network capable of delivering 12 Mbps to each user. New applications demanding higher speeds are constantly emerging and can be expected to come into common use in the future.

An example of one of the drivers for higher bandwidth is video streams – used not just for entertainment, but also in applications such as teleconferencing, education, aged care and security surveillance and the like. Today, video streams are usually not delivered to users in real time – rather, they are downloaded (as part of a web page or as a movie file) and viewed only when sufficient content has accumulated on the local device. However, applications such as IPTV and video conferencing rely on real-time transfer – that is, a constant stream that is only relevant if received and viewed within a fraction of a second of being generated at the other end of the line.

Today, most users of real-time applications have little option but to accept small, low-resolution streams at low frame rates – typically operating at speeds in the range 100-400 kbps. To raise the quality to that of standard-definition TV (SDTV), speeds of 2-6 Mbps would be needed – and to achieve high-definition TV (HDTV) quality, speeds of 4-12 Mbps would be needed. With so many Australian homes now equipped with HDTV-capable equipment, and it is unrealistic to expect that users will forever be satisfied with today's flickering "talking head" experience in applications such as video-conferencing. Furthermore, as environmental pressures intensify, it is reasonable to expect that the use of applications such as video-conferencing will become more common as an environmentally-friendly alternative to travel.

Anyone who has experienced high-end corporate video conferencing[21] will appreciate the difference that high quality, low-latency video brings to the dynamics of human interaction over telecommunication networks. The biggest barrier to widespread use of this technology today is simply the lack of affordable bandwidth.

Furthermore, HDTV certainly does not mark the end of progress in terms of video resolution. Already there are standards that pack 4x and 16x the number of picture elements (pixels) onto a screen. There is little reason to doubt that these will be enthusiastically adopted when prices start falling to consumer levels – and this will fuel the demand for further bandwidth increases.

It is not only "demand side" considerations that lead one to expect the need for speeds well in excess of the 12 Mbps (minimum) stipulated for the NBN. On the "supply side", a growing number of countries[22] are already pursuing strategies for deploying optical fibre all the way to the user. As discussed in Appendix A, this is the ultimate solution to the demand for higher speeds. Upgrades in electronics may still be required from time to time, but the cabling is capable of supporting arbitrarily high speeds.

The proliferation of FTTP in international markets will inevitably spawn applications that exploit the additional bandwidth offered. The form that these applications take may not always be predictable, but a variant of Parkinson's Law would suggest that applications will evolve to utilise the bandwidth that is made available to them.

To enjoy the same level of social, economic and environmental benefits that broadband can deliver, it is realistic to anticipate the need for a further upgrade of Australia's network infrastructure to take optical fibre all the way to the user. The same public pressures that have culminated in putting broadband onto the political agenda will resurface, next time with a call for an all-optical upgrade. This may come sooner rather than later – by the time that the NBN upgrade is due to be completed (2014), Australia will be lagging behind many other countries in terms of its national telecommunications infrastructure.

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[21] See for example, Cisco's telepresence solution (http://www.cisco.com/en/US/products/ps8333/index.html) with explanation and demonstration at http://www.youtube.com/watch?v=KInYEpDn7bI.

[22] For example, at an OECD Forum in Norway in April 2008, the Japanese representative

Given this, it is important that any FTTN upgrade be approached in a way that lays the foundations for an efficient further upgrade to FTTP in the future. In particular, the optical fibre cables connecting a node to the core network should contain sufficient cores to support future all-optical connections to all users supported from that node.

(4) Take Optical Fibre Deeper in Commercial & Industrial Areas

For many residential users, the assured access to network connections at speeds of 12 Mbps or higher will represent a substantial and welcome improvement over their current levels of service. However, many small and medium business enterprises are also reliant upon the same network infrastructure that is used to support residential users. Their need for bandwidth may be much higher than the average residential user – but in contrast to large corporations, they generally do not have the budgets to justify the high expense of obtaining all-optical connections. For some such business users, a residential-grade connection is likely to be very marginal.

It is easy to understand the need for higher capacity if one considers a small business employing (say) 10 staff in an information-centric business. The traffic generated from10 desks during business hours is likely to be (at least) equivalent to the traffic generated by 10 homes.

As outlined in Section A, the key to performance lies in taking optical fibre as close as possible to the user. It may not yet be viable to take optical fibre all the way to users in commercial and industrial areas under the NBN upgrade – but higher capacity could be provided if it is taken closer to the user than in residential areas. For example, if optical fibre is taken to within 300m of the user in a fibre-to-the-kerb (FTTK) architecture, speeds in the range 50-100 Mbps should be attainable over the final copper link. The approach requires some additional nodes and accordingly is more expensive, but the increase is relatively modest.

The suitability of Melbourne's West as a base for information-centric businesses will be improved if the NBN upgrade is engineered to deliver higher performance in commercial and industrial areas.

(5) Seek a FTTP outcome in Greenfield Areas

By the time that the NBN upgrade is due to be completed in 2014 (assuming the deployment phase runs to schedule), some 900,000 new homes are likely to be built in Australia, as well as many new commercial and industrial areas. With its high growth rates, a healthy share of this will occur within the urban growth boundary of Melbourne's West.

As outlined in (1) above, many carriers already believe that optical fibre is a more cost-effective option than copper in new areas. Accordingly, it is possible that the NBN Supplier(s) will offer FTTP as standard in greenfield areas – effectively "future proofing" these properties against future growth in bandwidth demand.

LeadWest and its constituent local governments are encouraged to support the Australian Government in seeking such an outcome from the process. It would be very unfortunate if new areas were provisioned with less "future proof" FTTN infrastructure when the cost of FTTP represents such a small (if any) premium. Rather than becoming the best-serviced areas for individuals and businesses to take up residence, the areas would be added to the national list of areas requiring future upgrade – probably sooner rather than later.

As an extension of (2) above, if FTTP is offered as part of the NBN outcome, it is important to scrutinise the terms and ensure that appropriate provision is made for open access so that the benefits of competition are preserved.

4.2 Matters of Local Government Jurisdiction

The NBN upgrade represents such a major uncertainty on the horizon that it is difficult to make other decisions until an outcome is announced. Nevertheless, there are strategies that can be adopted at a Local Government level towards securing better telecommunications outcomes in Melbourne's West.

4.2.1 Mandating Minimum Standards in New Developments

Little can be done to compel the telecommunications industry to enhance or upgrade existing infrastructure. However, in greenfield areas local governments have the power to set conditions on the granting of development approvals, and there are a number of levels at which policies could be set to achieve better telecommunications outcomes.

The potential policies listed in this section are "progressive" – that is, each one builds on the previous but takes it further towards the ultimate goal of providing a "future proof" telecommunications environment utilising optical fibre.

Several further considerations apply to any market intervention in greenfield areas through the implementation of local government policies:

(a) Improved telecommunication services rely on having better telecommunications infrastructure. It is to be expected that the cost of providing this infrastructure will flow through to the price of developed land. Local governments need to be mindful of affordability issues – and maintain a balance between short-term affordability and any long-term value that might be derived from superior telecommunications.

(b) Bearing in mind (a), policies adopted by a single local government in isolation will tend to create a minor distortion in the market. Within limits, both developers and land buyers may shift their preference to nearby areas where land costs are not loaded with any premiums for telecommunications infrastructure. The ideal outcome would be for any interventionist policies to be discussed through a body such as the Australian Local Government Association (ALGA) and adopted on the widest possible scale.

(c) Land in greenfield areas is typically sold and occupied over an extended period, and this adds to the challenge for any operator trying to establish a viable business case for investment.

(1) Mandating Pit-and-Pipe Networks

The Melbourne 2030 plan suggests that consideration will be given to measures including a Broadband Planning Code to ensure that ducting for broadband services is provided in all new major subdivisions and developments (initiative 4.5.1). The provision of such ducting has the potential to avoid prohibitive costs associated with retrofitting underground cabling at a future point in time.

The origins of this initiative can be traced to the City of Whittlesea which for some years has had a policy[23] in effect requiring developers to install underground ducting suitable for accommodating advanced broadband infrastructure (also known as a pit-and-pipe network). Under the policy, developers have the option of ceding ownership back to the City, or taking on the responsibility for delivering the City's telecommunications objectives with respect to that infrastructure. These objectives involve:

- securing the installation of advanced broadband infrastructure with the capacity to meet rising demand for bandwidth well into the future;

[23] See http://www.dse.vic.gov.au/planningschemes/whittlesea/ordinance/22_13_wsea.pdf and http://www.whittlesea.vic.gov.au/content/content.asp?cid=468&tid=468&tpid=468&sid=&spid=&cnid=2268.

- arranging for the availability of telephony, data and video services over the network infrastructure; and
- providing an open access framework for competition to assure long-term innovation in pricing and services.

This policy has been in effect long enough to make some observations about its impact:

(a) The policy initially attracted considerable developer opposition. The level of resistance may have since declined somewhat as a growing number of developers have become convinced of the merits of including FTTH in their estates and embarked voluntarily upon plans for doing so.

Opposition to the policy was based on the fact that fulfilling the requirement imposed an additional development expense but did not *per se* translate into an asset that *most* land buyers would accept as justifying a higher land price. Neighbouring developments in other jurisdictions were not faced with this cost, and as such, enjoyed a marginal advantage in the form of a lower cost of land development.

To exacerbate the situation, developers are typically not parties to joint trenching arrangements under which Telstra and other utilities typically install their conduits in a shared trench. As a result, most developers in the Whittlesea area dug a separate trench, adding to the cost of complying with the policy requirement. Compliance could potentially be achieved more cost-effectively if developers were to subcontract the provision of a spare communications conduit to a utility who was a party to a joint trenching agreement.

(b) With a few exceptions (notably the VicUrban Aurora project), the pit-and-pipe infrastructure has lain empty in the ground for several years. Efforts by the Wired Development Consortium (convened under the auspices of the Municipal Association of Victoria and led by the City of Whittlesea) to attract carriers to deploy cabling through the pit-and-pipe infrastructure and install electronics to support service delivery were unsuccessful. It can be demonstrated that the cost of deploying a full network in competition with an entrenched incumbent represents an extremely challenging business proposition: Any new market entrant would need to capture well in excess of 50% of the market in order to achieve commercial viability.

It is possible that as the base of homes passed by pit-and-pipe infrastructure grows, the point may be reached where a carrier sees merit in investing the substantial amounts required to converting the asset into an operational network – using the technical superiority of FTTP infrastructure to take market share from an incumbent operating and older, less-capable network. However, there are no indications that this point will be reached in the near future.

(c) In addition, it is highly likely that any defects in the infrastructure (such as blocked or broken conduits) would only be found at a future point in time when an operator had decided to deploy network infrastructure. The cost of remedying problems at such a late stage could be very high.

(d) Where Telstra deploys its normal copper infrastructure in an estate, a separate pit and pipe network (including lead-in conduit) will be provided to every home. In the event that Telstra upgrades its copper network to an optical fibre network at some future point in time, it is likely that the separate pit-and-pipe infrastructure deployed under such a policy might *never* be used.

(e) For local governments, introducing any policy raises the question of compliance checking. Most do not currently have staff with the experience to review plans and confirm their adequacy and to confirm that the required infrastructure has been provided to an appropriate standard.

Compliance monitoring could in large measure be delegated by accepting certificates (from suitably qualified and authorised companies) confirming that:

- plans complied with the policy; and
- (later) that the infrastructure had been installed and was constructed to a professional standard.

(f) Ownership of the infrastructure needs to be effectively managed. Under The City of Whittlesea's approach, ownership is ceded to the City if the developer does not undertake to deliver the City's strategy objectives. Effective management imposes responsibilities such as:

- maintaining records of the location of all infrastructure;
- registering infrastructure with "Dial-before-you-dig" to reduce the risk of it being damaged once installed;
- arranging for the repair of any infrastructure that is accidentally damaged;
- developing strategies for permitting access to the infrastructure; and
- supporting such strategies with appropriate access agreements.

(g) To maximise the value of the infrastructure, a level of planning and coordination is needed to address issues that transcend the boundaries of particular estates. Services will typically be reticulated to service areas from a "point of entry" or gateway facility in much the same way that phone exchanges serve as gateway facility to all the homes connected by copper in an exchange serving area.

Once such a major point of presence has been established, it is cost-effective to use it to support as many homes as possible in neighbouring areas. This may create the need for "transit conduits" that are not intended to accommodate final distribution cabling, but rather are cabling runs from a gateway facility to a service area that may be some distance away. A local government instigator of a mandatory pit-and-pipe policy is likely to find itself drawn into issues of this nature over time.

An indicative cost implementing this policy should be less than $500 per residential lot, though if developers chose to deploy the conduits in a separate trench, the costs could be increased by a further $500 per residential lot.

(2) Mandating Conduits, Lead-ins and Equipment Space

One of the barriers to future use of the infrastructure discussed in (1) above is the comparatively high cost of completing physical access from the pit-and-pipe network in the street into the user's premises. This requires retrofitting a lead-in conduit from the nearest pit and installing a location for the equipment that is needed to terminate the optical network (known as an Optical Network Unit or ONU).

ONUs are commonly installed in metal enclosures on an external wall of the building, thus allowing the operator access for the purposes of checking the integrity of the network without requiring entry to the customer's premises. As with the enclosures used to house electricity meters, the box is typically sunk into the wall, potentially requiring expensive changes to brickwork and external finishes in a retrofit situation. Similarly, the lead-in between the nearest pit and this cabinet may run through established garden areas, adding to the cost and disruption of future connection.

This impediment to future use could be eliminated if the policy was extended to require installation of a lead-in conduit and an equipment enclosure to accommodate a (future) ONU when the building was constructed. In essence, this would create an "empty shell" suitable for accommodating a future advanced broadband network.

As with the pit-and-pipe infrastructure itself, there is a risk that when any passive infrastructure of this nature is not used, it will be found to be damaged or defective if and when the time comes to put it to use. The best way to minimise this risk would be to use a combination of:

- awareness programs, education and training – especially within the building industry where many trades people are not aware of the requirements of advanced telecommunication networks;
- requiring work to be done by suitably qualified trades people;
- undertaking inspections as part of the requirement for gaining a certificate of occupancy.

Requiring the installation of a lead-in conduit and a powered equipment enclosure would indicatively add around $1000 per lot to the cost of the pit-and-pipe infrastructure.

There are no known examples of this policy being applied in Australia. Clearly the policy would further lower the costs of entry (relative to the policy described under (1) above) for an operator interested in deploying new infrastructure. However, there is no guarantee that an operator would ever find a positive business case for entering the market in competition with an entrenched incumbent.

(3) Mandating FTTP

This is the most far-reaching policy that could be adopted in relation to greenfield areas. In its simplest form, the policy would state that development approval would not be granted unless there was a plan for ensuring the deployment of FTTP infrastructure.

At the present time, it is not Telstra's practice to deploy rival copper infrastructure in any *residential* estate that incorporates FTTP infrastructure. Similarly, if Telstra deploys network infrastructure in a residential estate, no other carrier will typically be willing to deploy a rival network. Unless this situation changes, any party appointed to deploy FTTP infrastructure in a greenfield residential area would have a natural monopoly on the provision of last-mile access.

The situation with respect to infrastructure duplication is not as clear cut in commercial and industrial precincts. At the small and medium enterprise level, modest telecommunications spending is usually insufficient to attract facilities-based competition. However, large enterprises often have the buying power to attract a carrier to bring infrastructure to their premises.

This policy would overcome most of the objections that might be raised to the preceding two policies. In particular:

- it avoids an outcome where the cost of pit-and-pipe infrastructure is incurred, but no benefits flow to land buyers because no carrier is willing to build a network and offer services;
- it avoids the duplication of infrastructure in areas where that is not efficient or commercially sustainable;
- any damaged or defective infrastructure would be exposed at the time of building completion, when an operator installed network equipment;
- land buyers would be assured of immediate access to advanced broadband services;
- the deployment of a "future proof" optical fibre solution will obviate the need for expensive upgrade or replacement for the life of the cabling.

However, this level of policy also adds the highest cost to land development. In residential areas, the cost of FTTP infrastructure typically ranges from $1,500 to $3,500 per lot. Because this policy would at the "stroke of a pen" create a much larger market for FTTP deployment than currently exists, it is likely that average costs would fall due to improved economies of scale. However, it is difficult to estimate the extent of such cost reductions.

4.2.2 Seizing Opportunities

In separate reports, LeadWest has identified the need for improvements in road and rail infrastructure to support growth in Melbourne's West. When major upgrades are undertaken, there may be opportunities to deploy communications conduits along routes, laying the foundations for future improvements in connectivity in the region.

Opportunities of this nature need to be considered on a case-by-case basis. It would be rare that in any one road or rail project a path would be created between two "high value" end points. It is much more likely that the resultant asset will at best provide segments of a route and retrofitting of "missing links" will ultimately be needed to create a complete fibre route. Nevertheless, the greater the proportion of a route which can be provided as a low-cost by-product of other major infrastructure development projects the lower the overall cost to build the link.

The value of such links is particularly important in terms of establishing a more competitive array of backhaul options in those outer Western areas where there is currently very limited competition (see Section 3). An open access regime for "last mile" access may deliver few benefits if there is not a healthy layer of infrastructure allowing service providers to extend their service into an area.

In contrast to the approaches set out in Sections 4.1 (especially) and 4.2, accumulating lengths of conduit access may not have an immediate or direct impact on end-users. Rather, it is likely to improve the longer-term supply of inter-connectivity options between particular locations in Melbourne's West and the CBD. As such, it can be of longer-term benefit to:

- land developers and operators wanting to establish new FTTH communities;
- carriers wanting backhaul alternatives to Telstra exchanges at which they can obtain local access via Telstra's copper; and
- carriers wanting to compete for the business of commercial and industrial customers needing high speed connectivity.

Exploiting any sensible opportunities that exist will require an investment by the local government(s) through whose land new road/rail infrastructure passes. The costs are not huge (indicatively $50,000 per kilometre or less) – but it would need to be recognised that the resultant asset may lie idle for a period before any carrier seeks to deploy cabling and thereby create a productive asset.

In any projects for which assistance is sought under the Government's Infrastructure Australia funding program, it would be desirable in the development of budgets to include an allowance for any communication infrastructure that might be deployed cost-effectively at the same time.

5. Recommendations

The goal to which local governments in Melbourne's West should aspire is to see telecommunications infrastructure and services improved to a level that puts them on a par with what is available in the inner-urban areas of Melbourne.

The following actions by LeadWest (representing the local governments in Melbourne's West) are recommended towards achieving this goal:

1. Write to the Minister for Broadband Communications and the Digital Economy summarising the areas of concern set out in Section 4.1 and requesting that the Minister takes these concerns into consideration in the course of deciding an outcome from the current process to select a National Broadband Network Supplier (or Suppliers). It would be appropriate to append a copy of this report by way of additional background information.
2. Engage with the Australian Local Government Association (ALGA) to request that *the adoption of homogenous planning policies and guidelines to mandate a fibre-to-the-premises outcome in all new urban greenfield developments throughout Australia* be put on the agenda for consideration by the Association's membership. If the ALGA declines to act on the request, the Municipal Association of Victoria (MAV) could be approached to look at the issue on a State basis.
3. Coordinate discussions amongst the constituent local governments to consider the policy embodied in recommendation (2) above in order capture the maximum benefits of telecommunications opportunities in greenfield areas in Melbourne's West.
4. Review all major (non-telecommunications) infrastructure projects that are being contemplated in Melbourne's West to identify any marginal telecommunications opportunities that might be cost-effectively incorporated – especially where these may improve the availability of competitive backhaul capacity.

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Appendices

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A. Telecommunications Technology

This Appendix provides a general overview of the telecommunications infrastructure and technology to support discussion in the body of the report. Readers who are reasonably fluent with the key concepts and nomenclature need not bother reading this Appendix.

A.1 Starting from a Services Perspective

The various telecommunications services that are available are commonly classified as telephony, video and data. By considering each of these in turn, it can be shown that the most appropriate focus for this report is on the technology and infrastructure for supporting data services.

Access to fixed-line telephony is for all practical purposes ubiquitous, supported by the Universal Services Obligation (USO) that is currently carried by Telstra. Mobile telephony in Australia is now all-digital and relies upon wireless coverage of networks that are essentially data networks (see below). There are few critical weaknesses in terms of support for these services in most urban areas.

Video services can be subdivided into free-to-air television, Pay TV services and demand-based services. Free-to-air television is available throughout Melbourne's West, possibly requiring good external antennae in some areas. Subscription TV services are also available throughout the region by satellite delivery and, in some more established areas, also over the "Pay TV" networks that were deployed by Telstra and/or Optus in the mid-1990s. Demand-based services (such as video on demand) are typically delivered either as facet of Pay TV services (relying on features in the set-top-box), or as a broadband data service (see below).

For completeness, it is necessary to note that video services can also be delivered over data networks – notably in the form of Internet Protocol TV (IPTV) to a set-top-box, personal computer or mobile phone handset as the access device. Similarly, telephony services can be delivered over data networks – notably in the form of Voice over Internet Protocol (VoIP). As with demand-based video services, the delivery infrastructure is essentially the same as used for data communications.

Thus one of the key considerations in terms of the adequacy of telecommunications infrastructure is the quality of support that is available for data services. Because of their very different and complementary characteristics, both cabled and wireless networks need to be considered.

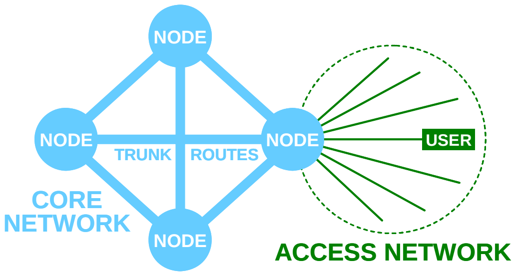
Until about 15 years ago, data services were most commonly supported as an extension of the telephony network. At the low end of the market, users relied primarily on dial-up modem connections, the speed of which varied considerably depending on the quality of the user's line and their distance from the Telstra exchange. Higher performance services (such as ISDN and Frame Relay) were available, but the costs involved (both installation and ongoing charges) put these out of reach of most residential and small business users.

With the advent of competition in the Australian telecommunications market and with the surge of interest in broadband, new methods of data access have been established and pricing for commodity services has fallen to levels that most users now find affordable.

Having said this, the quality of access varies considerably across Australia, and users in areas that are not well serviced find themselves at a growing disadvantage.

A.2 Core and Access Networks

In any discussion of broadband networks, it is useful to distinguish between core and access networks. Core networks comprise nodes that are interconnected by high capacity communication links, often in a "mesh" structure so that the failure of any one link does not isolate a node. The nodes may be phone exchanges or other points where the traffic from multiple users is aggregated.



In contrast, access networks refer to the infrastructure that is used to connect individual users to the nearest nodal point in a core network. Links in an access network may be thought of simplistically as point-to-point connections between the user and the node. In practice the traffic from multiple users is often aggregated onto shared media as it converges on the node.

A.2.1 Investment in Core Network Infrastructure

In general, there has been a healthy level of investment in high-speed capacity *between* the major population centres such as capital cities. *Within* the capital cities, investment in capacity between the major aggregations points (in particular, to Telstra exchanges) is less predictable. There is usually an abundance of interest in reaching aggregation points that serve large, high-spending user communities. Telstra's outer-urban exchanges (which support predominantly residential user bases) are by comparison less attractive.

Optical fibre provides enormous capacity – thousands of times higher than today's commodity broadband speeds – and signals suffer very low loss over distance. As a result, it is invariably the medium of choice for core network links. Where centres are connected by optical fibre, upgrading capacity is typically as simple as upgrading the equipment at each end of the fibre. High capacity wireless links may be used in situations where it is not practical to reach an aggregation point using optical fibre.

At any point in time there will always be scattered bottlenecks in core network capacity – where either the infrastructure isn't adequate, or where the absence of competition and monopoly pricing is an impediment to usage. Nevertheless, the cost of increasing capacity on trunk routes is relatively low compared to the cost of upgrading access networks.

Changing patterns of usage will inevitably put more pressure on core networks (including international links) in the future. In particular, as speed limits are lifted in access networks and the volumes of information transmitted grow (for example, with the increasing exchange of very large video files) it is predictable that more links will become congested and need upgrading. One approach to managing this is to introduce differentiated levels of service, so that users wanting to be assured of consistent, high performance can do so by paying a premium. There is a good parallel with road networks – users wanting to reduce their trip times can opt to use toll roads that avoid the variable congestion levels that occurs on the public road network.

A.2.2 Investment in Cabled Access Networks

Since de-regulation, there has also been healthy investment in access network capacity *in CBD areas*, attracted by the comparatively high communication spend of large corporate and government users and high population densities. However investment in cabled access network infrastructure *outside of* CBD areas has been much more limited and sporadic.

The most significant developments include:

- The Optus hybrid fibre coax (HFC) network, passing around 2.2m homes, mainly in Sydney, Melbourne and Brisbane;
- The Telstra HFC network, passing around 2.5m homes mainly in Sydney, Melbourne and Brisbane; because of the substantial overlap in the "footprints" of the Telstra and Optus HFC rollouts, the total number of Australian homes that has access to one of both of the Telstra and Optus HFC networks is around 2.7m homes only;
- TransACT's fibre-to-the-kerb (FTTK) network, passing some 65,000 homes in Canberra and Neighborhood Cable's HFC network, passing some 90,000 homes in Ballarat, Mildura and Geelong; Neighborhood Cable was recently acquired by TransACT;
- A growing number of greenfield estates that are being developed with advanced fibre-to-the-home (FTTH) broadband cabling; whilst these are proliferating, the locations are scattered and (given the pace of land development) it will take some years before any sort of critical mass is achieved.

One other important development in access networks that is worth highlighting has been the deployment of ADSL (and more recently, its ADSL2 and 2+ derivatives) in Telstra exchanges following declaration of the unconditioned local loop (ULL) in 1999. This has not yet involved any significant upgrades to the national cabling infrastructure – only the installation of different technology to drive the copper in Telstra's network. However, it is particularly noteworthy since for many people broadband is synonymous with ADSL.

Today a lot of Australians are already operating at or near the limits of performance that can be achieved over existing infrastructure. Major performance gains cannot be unlocked simply by deploying more modern electronics – it requires fundamental re-engineering of network cabling and/or equipment sites to achieve meaningful advances.

A.3 Cabled Access Infrastructure

A.3.1 Optical Fibre

With the exception of large corporate entities and some recent greenfield developments, it is currently rare for optical fibre to be taken all the way to the end-user in access networks. In the case of greenfield developments, fibre-to-the-premises (FTTP) has started appearing in both residential and commercial/industrial developments over the past few years – but it is still not the norm.

Fibre all the way to the user offers the ultimate in performance. It can be deployed in any of three common topologies:

- point-to-multipoint – commonly referred to as a passive optical network (or PON) – where the light directed down one fibre from the aggregation point is "split" using a fused glass junction point to reach multiple users; despite the fact that multiple users (typically 32) in a PON network share a common optical signal, electronics at either end of the fibre segregate the signals and each user sees only what is intended for them;
- point-to-point (P2P), where each user is connected back to an aggregation point by a dedicated optical fibre path; this approach involves deploying more fibre cores but gives increased flexibility since each individual user can be provisioned with a service quite independently of all other users;

- ring – commonly used for larger corporate customers who want the security of two quite separate light paths between them and the upstream aggregation point; if one path is cut, service can be maintained over the surviving path.

Fibre can be "driven" by various different electronics. At the mass consumer end of the spectrum, the most cost-competitive approaches are designed for PON topologies – typically sharing 1 Gbps[24] symmetric[25] capacity amongst all the users on the PON. Even in periods of saturation demand, each user on such a PON system can in theory sustain communication rates of 32 Mbps in each direction – much higher than the very best ADSL speeds. An individual user can achieve burst speeds approaching the full capacity of the PON (1 Gbps) if the operator has not imposed artificial limits and no other users are active on the PON at the time.

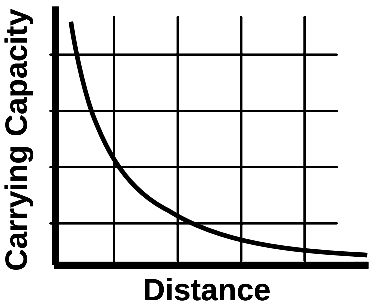
With P2P and ring topologies, the fibre can be operated at virtually whatever speed is required by the user. Common speeds include 100 Mbps, 1 Gbps and 10 Gbps – in each case, not shared with any other users.

Residential solutions (fibre-to-the-home or FTTH) typically utilise several wavelengths on the optical fibre – allowing both data and video services to be delivered.

In situations where optical fibre is *not* taken all the way to the user, the performance of the access link depends on the alternative medium that is used between the point where the optical fibre terminates and the end-user. The following Sections A.3.2 through A.3.4 consider the major cabling options that are available.

A.3.2 Copper (Historical Origins in Telephony Networks)

Where copper is used for the final link to the user, the technology used to drive broadband performance is known generically as digital subscriber line (DSL) technology – often denoted as xDSL where "x" can take on a range of values. The most common DSL technology is ADSL and its derivatives, ADSL2 and ADSL2+.



With all xDSL technology, the performance that can be achieved is a function of the length, gauge and condition of the copper cable. ADSL (asymmetric DSL) – one of the first xDSL variants to gain widespread recognition as a broadband technology – is optimised for the typical cabling distances of up to several kilometres that incumbent telephone companies (telcos) must traverse to reach customers connected to their exchanges. The performance limit of ADSL is 8 Mbps (downstream) – but this is only achievable at distances below about 3 kilometres. DSL variants that are designed for higher performance at shorter loop length include ADSL2+ (an evolution of ADSL that uses more efficient encoding and additional spectrum to achieve downstream speeds of up to 24 Mbps) and VDSL (where V stands for "very-high-speed" and speeds of up to 100 Mbps symmetrical can be achieved).

Some other noteworthy members of the DSL family are:

- HDSL (where H stands for "high bit rate") – this technology uses two good-quality copper pairs to achieve symmetric speeds of 1.5 Mbps or 2 Mbps at distances up to around 3 kms. HDSL has largely been eclipsed by SDSL.

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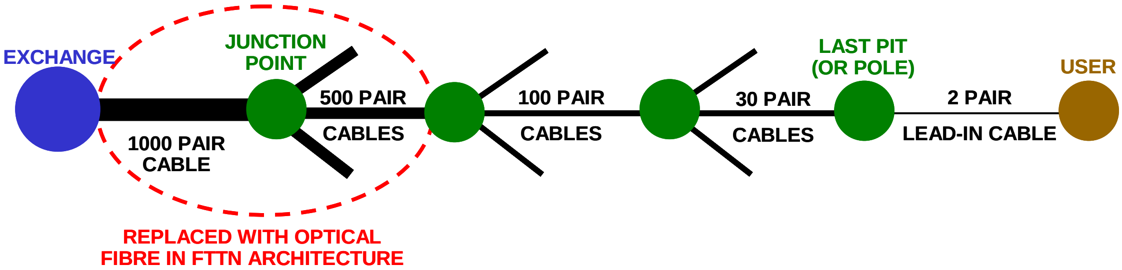
24 Network speeds are measured in bits-per-second (bps), with the most common measures being a kilo-bit-per-second (abbreviated to kbps, or 1024 bps), a mega-bit-per-second (Mbps, operating at 1024 kbps) a giga-bit-per-second (Gbps, operating at 1024 Mbps) and a tera-bit-per-second (Tbps, operating at 1024 Gbps).

25 Symmetric communication links are simply links where the speed is the same in both the upstream and downstream directions.

- SDSL (where S stands for "symmetric") – this technology uses a single copper pair to achieve *symmetric* speeds up to 2.3 Mbps at distances up to around 3 kms.

Copper-based networks are often described as having a "tree and branch" topology. Although each customer is normally connected by a dedicated pair of copper wires, those pairs begin at the exchange in cables that may contain 500 or more pairs. Such cables are cross-connected to multiple smaller cables at each of potentially several junction points (see picture of typical junction point on right) as the circuit gets closer to the user. The final cable that connects a small serving area often contains only 30 pairs or less.



In this sort of network, the cost of replacing cables goes up the closer the cable gets to the end user. However, by replacing the "upper reaches" of the copper cabling with optical fibre, telcos can effectively shorten the length of the copper cable by which a customer is connected and thereby achieve higher performance levels. xDSL equipment is still needed at each end of the copper loop – but rather than the "upstream" end of the loop being located in an exchange, it is located in an outdoor enclosure.

The most common upgrade reflecting this approach is from a fibre-to-the-exchange (FTTX) architecture to a fibre-to-the-node (FTTN) approach – where the node would normally be a kerbside equipment cabinet (such as pictured to the left) located less than a kilometre from the user. At this distance, a node may typically serve around 200-500 residential users. When copper distances are reduced in this manner, ADSL2+ or VDSL technology can be used to deliver consistently higher performance than is possible in a FTTX architecture.

An approach that takes optical fibre even deeper into the network is fibre-to-the-kerb (FTTK) – where the nodes are typically located 300 metres or less from the users. At this distance, the latest VDSL technology is capable of speeds up to 100 Mbps symmetric. This is the architecture that TransACT adopted for its Canberra deployment (see picture of TransACT pole-mounted node to the right). The equipment currently driving TransACT's copper pre-dates modern VDSL standards and is limited to 51 Mbps downstream and 1.6 Mbps upstream.

The vast majority of Australians are connected to Telstra's copper network, and many of these users currently rely on ADSL (or one of its variants) for their broadband service. The lowest "entry level" ADSL speed that is offered is 256 kbps (downstream) and 64 kbps (upstream) – usually denoted as a 256/64 kbps service. However, many ISPs offer higher performance options such as 512/128 kbps, 512 kbps symmetric, 1024/256 kbps and so on.

The maximum speed that is attainable on a copper cable is a function not only of the line length, but also the gauge (thickness) and condition of the copper. An indication of what is possible can be obtained from databases that describe the route and length of any particular line – but the performance potential can really only be definitively known when a service is activated by placing the modem technology on each end of a line. Even then, performance may vary in some conditions (for example, in wet weather when moisture ingress into cables degrades performance or when a high level of activity across multiple DSL services in the same cable leads to interference).

ADSL2+ is offered by some Internet ISPs, but users will only experience better-than-ADSL performance levels if the actual cable length by which they are connected to the exchange is less than about 2.5 kms in length.

All modern ADSL technology is adaptive and will automatically settle at the highest speeds that can be reliably maintained over a given copper line. However, some network operators artificially restrict the speeds offered over their lines, usually as an incentive to encourage users wanting higher performance to migrate to a more expensive access plan.

A FTTN-like architecture is already in use in Telstra's network – and has been the norm in new housing estates for well over a decade. In addition to an optical fibre connection between the node and the exchange, there is commonly also a copper cable. Customers who want an ADSL service are connected via a copper circuit all the way to the exchange.

There are various reasons why ADSL may not be available in a particular area:

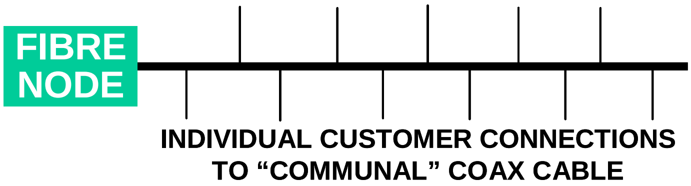
(a) The area may simply be too far from the exchanges to support xDSL services.

(b) The area may be served by Telstra nodes that are fitted with "pair gain" technology, designed to "squeeze" two telephony circuits into the capacity normally allocated to an individual circuit. This technique has no appreciable impact on voice services, but effectively halves the capacity that can be achieved on dial-up modem circuits. Instead of a peak of 56 kbps, users connected by pair gain circuits can typically only achieve around 28 kbps. Furthermore pair gain technology is incompatible with any form of xDSL service. Telstra used pair gain technology widely for a period, but is understood to have discontinued the practice as demand for broadband has grown. In addition, remedial action has been taken in areas previously afflicted with pair gain technology to provide customers wanting broadband with a copper path all the way to the exchange. It is not known whether any pockets of pair gain technology still exist in Telstra's network.

(c) Carriers operate under different policies for provisioning equipment in response to customer demand. xDSL support is not installed on a line-by-line basis. Rather, the carrier needs to install a relatively expensive "line card" that will typically support 16-64 customers; similarly, the racks into which line cards are installed can only accommodate a certain number of line cards before an entire new and relatively expensive rack is required. Some carriers will wait until demand exceeds a certain threshold before installing new line cards or racks. This practice can lead to potentially lengthy delays for service installation.

A.3.3 Coax Cable (Historical Origins in Cable TV Networks)

The origins of "hybrid fibre coax" (HFC) technology go back to early days of television when it was common practice in the United States to install a master (or community) antenna in a prime location selected for good reception of the broadcast signal. Coax cabling was used to reticulate the signal from this antenna to individual users, giving rise to the "CATV" (Community Antenna Television) acronym. It is ideal for broadcast television because all users share a common signal – in contrast to the architecture of a copper network where each user is connected on a dedicated pair of copper wires.



As CATV networks spread and connected more and more users, amplifiers were introduced to periodically boost the radio frequency (RF) signals that carried television services over longer runs. Unfortunately, the coax cable acts as a good antenna for collecting electro-magnetic interference (or "noise") from a wide range of sources – and amplifiers boost this noise as well as the signal. Accordingly there are limits to how many times a signal can be amplified and still remain usable.

To overcome this, optical fibre (with its low loss and strong immunity to RF noise) was introduced to carry a high quality optical signal through the upper reaches of the network to a node (see example in picture to the left) where it was converted from an optical to an electrical signal and thence reticulated over coax cabling. The resultant HFC networks have become the standard for Cable TV operators.

With the rise of public interest in Internet access from the mid-90's, HFC operators seized the opportunity to re-purpose some of the frequencies previously allocated for television distribution to carry data instead. Since everybody on a HFC network receives the same signal, a special type of modem was needed to filter out individual information from the communal flow. The Data Over Cable System Interface Specification (DOCSIS) standard for cable modems emerged to address this requirement. This standard has now evolved over several generations to underpin broadband data services on HFC networks throughout the world.

The shared nature of the final connection to the user (and hence the bandwidth available on that medium) gives rise to one of the key differentiating characteristics of a HFC network. When there are only a few active users on a coax segment, performance can be "sparkling". However, in busy periods, contention for the available bandwidth rises and performance degrades.

The extent to which this is a problem is determined by the depth to which optical fibre is taken in a HFC network, and the resultant level of sharing. Traditional coax networks were commonly engineered with between 500 and 5,000 customers on a common coax segment. At such high levels of sharing, broadband performance would typically be quite limited and very variable. More modern HFC architectures take fibre deeper, resulting in smaller serving areas, much lower levels of sharing and hence more consistent and better performance.

Both the Telstra and Optus HFC deployments had ground to a halt by 1997, and neither company has shown any appetite for further investment in this technology. The coverage that presently exists in Melbourne's West is therefore unlikely to be extended, and its capacity is unlikely to be upgraded by re-engineering the networks to a smaller cell-size architecture.

A.3.4 Powerlines (Historical Origins in Electricity Industry)

Broadband over Power Lines (BPL) is a relatively new technology that has generated considerable recent interest. Modem chipsets are used to send/receive a broadband signal over the same cabling that is used to reticulate electricity.

The technology is used in two comparatively different ways. As a form of *in-building* communication, end-users able to purchase modems that essentially bridge an Ethernet service from one power outlet to another. More sophisticated configurations can be used to reticulate a broadband signal throughout larger buildings – such as apartment blocks. This type of use is not especially relevant to the consideration of regional telecommunications infrastructure.

BPL can also be used as an *access* technology – using electricity supply wiring as the means for delivering a service into the home. It is in this context that it has generated much interest – the ability to access customers without the massive costs involved in deploying new wiring has natural appeal, particularly amongst utilities who may be interested in new revenue opportunities outside of the regulated returns in their traditional businesses.

From an architectural perspective, BPL is similar to HFC in that a shared signal is reticulated to a community of users – in this case, over power lines rather than a coax cable segment. The signal "injection" point (see example on power pole in diagram on the right) is most commonly located at the low voltage (LV) transformer, since transformers naturally inhibit the propagation of signals upstream and into adjacent "cells". For optimum performance, optical fibre would be used to carry the signal to the BPL injection point – and thus BPL could also be described as a fibre-to-the-transformer (FTTT) architecture. However, other means of signal delivery (including BPL over the medium voltage feeder lines) are available if the performance objectives are not especially high.

The number of customers connected to a LV transformer varies from one or two (in rural areas) to as many as 500 (in urban areas). Typically, the average in urban areas is between 50 and 100 residential customers. The degree of signal sharing in a BPL network depends on how many users in an LV cell actually subscribe to the service. As with HFC networks, performance can be very impressive when there are very few active users.

The capacity of the signal is the other key parameter that determines the performance that can be given to individual users. At this stage, BPL is not yet a standards-based technology. Whilst efforts are underway through the Institute of Electrical and Electronics Engineers (IEEE), it is likely to be some time before standards and interoperability become a reality. In the interim, there are three vendor groups vying to have their technology embraced as the foundation for standards.

The BPL technology favoured in Australia and Europe[26] is often cited as a 200 Mbps chipset. However, this is a measure of raw performance at the physical layer rather than the practical throughput that can be achieved. In optimum conditions, the technology can deliver about 85 Mbps throughput – but in real-world conditions, the signal commonly needs to be regenerated[27] in order to traverse the long distances that are found in a 240V electricity network. Simplistically, the amount of capacity that is available to the community in a LV cell can be divided by n+1 where n is the number of times the signal needs to be regenerated. For most practical purposes, therefore, it is more realistic to expect capacity of 20-50 Mbps shared amongst all of the users in an Australian LV cell.

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[26] This technology is based on a chipset from the Spanish company DS2.

[27] Regeneration can be accomplished by frequency division multiplexing (FDM – that is, using separate frequencies, one to receive and another to retransmit), or by time division multiplexing (TDM – that is, receiving for a period before requesting the transmitter to pause whilst the information received is relayed).

BPL has somewhat greater potential in the USA's 110V power environment. Lower voltages mean shorter reach, and as a result, LV cells in urban USA typically comprise only 5-10 homes. The need for signal regeneration is also eliminated with short LV distances, and the low levels of sharing mean that a more credible broadband service can be delivered to each user.

As a broadband access technology, BPL faces some significant challenges before it is likely to have a material impact on the Australian broadband landscape:

(a) the obvious parties to own and operate a BPL network are the electricity utilities – but they tend to be cautious about diversifying into new areas; recently, Tasmania's Aurora Energy scrapped its exploration of BPL technology, despite several years' investment in successful trials; this appears to be first and foremost a case of the utility returning to "core business";

(b) until standards are well established, the use of in-home BPL products will typically generate interference to and conflict with any BPL access technologies that are in use in the same neighbourhood; many potential network operators are cautious about embracing a technology before standards are settled and interoperability is assured;

(c) in aerial deployments, interference levels are of concern to the ham radio community and protocols for avoiding the contended frequencies have yet to be established in Australia;

(d) the amount of capacity that is available can underpin a good service, but only at low uptake levels; beyond around 15-20% uptake, performance would be degraded in periods of high activity and users would typically find an xDSL-based service more attractive in terms of consistent performance; unless technology breakthroughs allow LV cells to be subdivided into smaller isolated cells each capable of receiving a full-strength BPL signal, high levels of sharing will limit the potential for BPL to become a mainstream access technology.

There is no BPL infrastructure deployed in Melbourne's West at the moment, and it seems unlikely that any will be deployed in the foreseeable future.

BPL may find a natural home in supporting emerging new communication requirements of the utilities themselves. Today's electricity supply networks are largely "dumb" networks, with utilities having little or no visibility into what happens beyond their major zone substations. This stands in contrast to modern telecommunications networks where every active element is monitored and information and communications technology (ICT) is deeply embedded in the network.

Electricity grids can be modernised and new levels of efficiency achieved by monitoring all the active elements in the grid – in particular, every low voltage transformer and every supply meter. Such monitoring relies on a communications fabric, and BPL offers abundant capacity in a form that is naturally aligned with the architecture of the grid. Growing global pressure on greenhouse gas emissions could see utilities embracing Smart Grid technology in the future. If this leads to BPL being deployed, there may be potential for surplus capacity to be used for general broadband services.

A.4 Wireless Infrastructure

A.4.1 Point-to-Point and Point-to-Multipoint Wireless Technologies

There are many different forms of wireless infrastructure, but they can be classified as either point-to-point (P2P) or point-to-multipoint (P2MP).

P2P wireless technology uses a narrow, focused beam to concentrate the signal strength on a single target receiver – as such, it is often used as an alternative to a cabled connection. P2P links can operate over distances up to about 50 kms and *generally* rely on there being a clear line-of-sight (LOS) between the two end points. Some technologies will operate with near line-of-sight (NLOS), relying on signals reflecting off obstacles to traverse the link. However, the capacity of NLOS links is reduced. Maximum capacity depends on many factors including the power and frequency at which the link is operated. However, a consistent principle is that as distance is reduced, the potential for higher capacity increases. As a guide and "pivot point", technology to deliver speeds of 100 Mbps over LOS distances up to about 20 kms is readily available.

In contrast, P2MP technologies use much wider beams to establish coverage over an area, supporting simultaneous connection of many users. Signal "beams" can be omni-directional (covering 360^{O} around the transmitter), or shaped – commonly giving coverage of 60^{O} or 120^{O} "sectors". In the latter case, total coverage is established by using several antennae from the one transmission tower, each covering one sector. Because signals have a finite reach, coverage of a large area depends on deploying multiple transmission towers in a cellular structure.

The most significant feature of P2MP technologies from a performance standpoint is the sharing of signal capacity amongst all users in the coverage area. In areas of high user density, small cell sizes are needed to support adequate capacity to each user. In areas of low user density, larger cell sizes (limited primarily by the reach of the wireless technology) can be used to achieve coverage without the cost of a large number of transmission towers.

Multiple P2MP wireless technologies are in use in Australia, often coexisting in the same geographic area but differing in characteristics such as:

- operating frequency;
- maximum reach;
- types of devices available for communicating on the network;
- total (aggregate) capacity that can be supported by the signal; and
- support for mobility within and between cells.

From an infrastructure perspective, P2MP networks are more significant that P2P wireless links. An individual or business can generally deploy a wireless link wherever it is needed and offers a cost-effective alternative to cabled connectivity. Infrastructure is only deployed on an "as and when needed" basis.

In contrast, P2MP networks are intended for more widespread use, with coverage often being one of the most important considerations in the choice of network.

Although broadband access can be delivered by wireless networks, it should be noted that a wireless connection generally offers an inferior level of performance relative to a good cabled connection for two reasons:

- higher peak performance rates can be achieved when the signal is guided to its destination with "surgical accuracy" via the cabled medium; and
- because wireless signal beams are shared, the capacity available to an individual user can vary widely depending on the number of active users at the time.

Offsetting the performance disadvantage, P2MP wireless networks offer a key advantage that is simply not replicable on a cabled connection – the ability to support mobile or nomadic access. As lifestyles and businesses rely more and more on network access, the use of wireless technology will continue to proliferate – sometimes as an alternative to a cabled connection, but increasingly as an adjunct to it when users are away from their normal home or office location.

A.3.2 The Mobile Telephony Networks

The mobile telephony networks operated by Telstra, Optus, Vodafone and Hutchison provide coverage across most of Australia's populated areas as well as major highways. Given the high proportion of Australians that are equipped with handsets, the mobile networks are by far the most important consumer wireless networks in the country.

These networks were originally deployed to support mobile voice communications, but the technology has since evolved considerably to support data communications at increasingly higher speeds, hand-in-hand with the evolution of mobile phones that support functions like email and web-browsing.

In order to understand the capabilities available at any location, it is useful to be aware of the successive generations of mobile telephony technology:

1G: Designed to support analog telephony with no data capabilities. This is now obsolete and no longer operates in Australia.

2G: Characterised by the digital encoding of voice streams – with the key standard in Australia being GSM (Global System for Mobile communications).

2.5G: Added a service for data communications – with GPRS (General Packet Radio Service) as the key standard. GPRS facilitates "always on" connections, where usage is charged by volume (rather than time) – though in Australia, some operators charged for usage in blocks of time. GPRS typically delivers speeds of only 53 kbps – comparable to a dial-up modem only.

3G: Boosted data transmission speeds, typically to between 348 kbps (or comparable to an entry-level broadband connection) and 2 Mbps. 3G devices typically fall back seamlessly to GPRS performance when moving out of a 3G coverage area.

3.5G: Further raises speeds – using key standards such as HSDPA (High Speed Download Packet Access), HSUPA (U=uplink) and HSPA. 3.5G systems typically offer speeds in the range from 1.8-14.4 Mbps.

4G: This next generation of technology is unlikely to be deployed in Australia for several years, but is expected to support further peak-speed increases into the 10-30 Mbps range.

Mobile telephony (2G) tends today to be regarded as an essential service. Urban coverage in Australia is generally good, with few "black spots". As usage increases in an area (for example, through urban sprawl or other demographic changes) it is periodically necessary to upgrade capacity by deploying additional transmission towers and reconfiguring the coverage area into smaller cells. This can arouse concerns amongst residents over the impact on visual amenity or the risks to health that they perceive may come from exposure to electro-magnetic emissions.[28]

Demand for access to broadband data services (3G and 3.5G – referred in this report simply as 3G) services is growing strongly. Modern mobile phone handsets typically support features that rely on 3G connectivity to allow users access to their email and a range of Internet-based services. There is clearly a virtuous circle of growth where the proliferation of sophisticated handsets is stimulating the development of new applications (for example, news, finance, entertainment services optimised for handset access) which in turn is attracting more users to upgrade to the latest handsets – in turn fuelling demand for more coverage and capacity.

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[28] It should be noted that all mobile telephony transmission towers are subject to radiation safety standards, and no link between such towers and adverse health effects has yet been established.

Use of the mobile telephony networks purely for broadband data access is also growing. All network operators offer wireless broadband modems that will connect a notebook computer to their 3G service via a USB port or other interface. A growing number of people rely on this service for access to email and other Internet-based services from notebook computers when travelling. Other networks may offer higher speed connection, but the extent of coverage is often the crucial consideration.

3G network operators have also begun promoting wireless plans as an alternative to cabled broadband services. The plans that they offer typically have a much higher data allowance than plans promoted for handset access – no telephony, but several gigabytes of data compared to the tens or hundreds of megabytes included in handset plans. As noted in Section A.4.1, the performance of these services is typically more variable than with a cabled service.

Each of the four mobile telephony network operators provides coverage maps – either showing coverage of an entire region, or allowing coverage to be determined at a user-nominated location. The lack of 3G coverage could reasonably be regarded as a distinct impediment to efficient business practices and modern lifestyles. It will be noted that coverage on the growth fringes is typically less consistent than in well-established and heavily populated areas.

Prices within the mobile phone industry tend to be set nationally, and *in general* each operator will therefore tend to have a competitive array of service offerings. However, individual usage patterns vary widely, and maximum choice will be available where all four operators provide coverage in an area.

A.3.3 Wireless Broadband Networks

In contrast with the mobile telephony networks (see Section A.3.2), wireless broadband networks have been designed first and foremost to support broadband access rather than mobile telephony services.

The two wireless broadband operators offering coverage in more than just one location in Australia are UnWired and iBurst. Both operators commenced operation using proprietary technologies – this means that the modems required to connect to their networks will not work on any other network. However, UnWired intends to migrate its operation to the WiMax (IEEE 802.16) standard as it becomes better established.

Coverage of the iBurst network is available on the company's web site[29]. Whilst Melbourne's West appears to be reasonably well served it is worth noting in relation to the six LGA areas of interest that:

- there are some scattered "black spots" not covered by the signals;
- in general, performance drops down to a lower level in areas of marginal signal strength and this would include much of the growth fringe.

The ultimate holding company of the iBurst network (Commander Communications) was placed in receivership in August 2008. The future of the network remains highly uncertain unless the receivers accept an offer from a party wanting to take over the network.

UnWired declined to provide a coverage map, but claimed that its network provides coverage of the Melbourne CBD and surrounding areas, representing in total approximately 35% of Melbourne's population. UnWired's web site allows specific addresses to be checked and generates some limited maps – some spot checks using this facility suggested coverage West of Footscray was limited and patchy.

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[29] See http://www.iburst.com.au/indexManage.php?file=/uploaded/Melbourne.gif.

UnWired's plan to adopt the standardised WiMax as the core technology for its network is potentially significant. Most notebook computers today incorporate Intel's Centrino technology for in-built WiFi support (see Section A.3.5 following). The next generation of this technology (Centrino 2) will feature WiMax support – potentially much more valuable to mobile and nomadic users because of the longer reach and large coverage areas.

As new notebook computers come onto the market with inbuilt WiMax support, the market for WiMax connectivity will grow and could see UnWired (or other operators) finding a good business case for expanding their coverage. This in turn would see a strengthening of WiMax as a competitor to the 3G networks for users wanting good performance over a wide coverage area.

A.3.4 Satellite

Satellite technology represents the "ultimate" in wireless coverage, with the signal being delivered to the user via satellite positioned in geostationary orbit at an altitude of 36,000 kms. The signal beam can be shaped to cover an area as large as the entire Australian continent.

There are two key disadvantages to satellite-based broadband:

(a) The distance that the signal must travel from an earth station up to the satellite and then back down to the user will be 72,000 kms or longer, depending on how distant the transmitting earth station and the user are from the nearest point immediately "below" the satellite. Even though RF waves travel at the speed of light, this distance means a delay (or latency) of at least a quarter of a second over and above any other delays in the end-to-end communications path. As a result, satellite-based services are ill-suited to real-time applications such as VoIP and video-conferencing.

(b) Although a satellite may deliver many tens or even hundreds of Mbps of broadband capacity, the large serving areas mean potentially high levels of sharing – and thus the capacity available to an individual user can be both limited and highly variable.

For these reasons, satellite is likely to remain the broadband access technology of last resort, used principally in remote areas where it is simply not feasible to bring cabled technologies within reach of the user.

A.3.5 WiFi Networks

Inbuilt WiFi (IEEE 802.11) support has been common in notebook computers for the past 5 years, and this has made it popular for users wanting network connectivity without the restrictions imposed by cabling.

WiFi trades long reach for high performance. The nominal reach of a standard WiFi base station is just 100m – though signals can propagate over substantially longer distances in ideal conditions or if transmission power is raised. However, where 3G and WiMax performance is typically below 10 Mbps, with WiFi speeds of many tens of Mbps are possible. Furthermore, because of the short reach, the capacity of a signal is normally shared amongst a much smaller, private community of users – such as the members of a household.

A large number of homes and businesses install WiFi base stations in their premises to allow users to maintain network connectivity whilst roaming within their building or to obviate the need for retrofitting cabling. WiFi base stations can be purchased as standalone items or as an optional feature of other equipment such as a broadband modem – in either case a costs that are generally below $100.

Because signals are not neatly contained within buildings, it is common to be able to see multiple WiFi signals in urban locations. All of these signals operate within the same general frequency band (2.4-2.48 GHz) – but that band is only sufficiently wide to support three completely non-interfering signals. Accordingly, as the number of signals increases, so does the interference between different signals, degrading the level of performance provided. Furthermore, other appliances – such as microwave ovens, many cordless phones and Bluetooth headsets – all operate in the same band and add to interference levels.

Despite its short reach, WiFi does have some relevance to regional telecommunications infrastructure. Many businesses – often coffee shops and the like – host WiFi "hot spots" where their customers can access the Internet to download email or for other purposes. This service may be offered free (as an inducement to utilise the products and services of the host business) or on a commercial basis under charging models such as:

- subscription to a service;
- making a phone call and obtaining an access code by SMS message, with usage then charged to the phone account; or
- buying a "scratchy" card that contains an access code that will work for a limited period of connectivity.

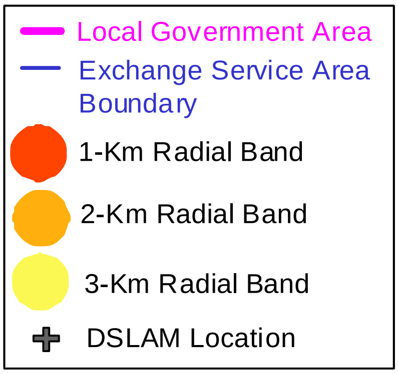
B. Location of Telstra Exchanges

The location of Telstra exchanges serving Melbourne's West as shown in this Appendix is sourced primarily from www.adsl2exchanges.com.au with some minor corrections and additions. Each exchange is referenced by a code, and these are colour coded using information from http://telstrawholesale.com/products/data/adsl-reports-plans.htm to indicate whether the exchange is enabled for ADSL (orange) or ADSL2+ (green).

Code	Exchange	Location
ALTA	Altona	53 Blyth Street, Altona 3018
ASCT	Ascot	315 Ascot Vale Road, Moonee Ponds 3039
BKLN	Brooklyn	433 Geelong Road, West Footscray 3011
DRPK(1)	Caroline Springs	4 Caroline Springs Boulevard Caroline Springs 3023
DRPK	Deer Park	23-25 Station Road, Deer Park 3023
DRMT	Derrimut	883 Palmers Road Truganina 3029
DEST	Diggers Rest	37-39 Calder Hwy, Diggers Rest 3427
FTON	Flemington	25 Eastwood Street, Flemington 3031
FSRY	Footscray	82 Napier Street, Footscray 3011
KLOR	Keilor	Cnr Ely Street & Exchange Close, Keilor East 3033
KGPK	Kings Park	37 Flint Crescent, Delahey 3037
LTVN	Laverton	167 Cherry Lane, Laverton North, 3026
LVSX	Laverton South	103 Merton Street, Laverton 3028
LITL	Little River	Lot 36, River Street, Little River 3211
MDST	Maidstone	75 Rosamond Road, Maidstone 3012
MLON	Melton	58 Barries Road, Melton 3337
MTCO	Mount Cottrell	1627 Boundary Road, Mount Cottrell 3024
NPRT	Newport	88 Hall Street, Newport 3015
NESS	North Essendon	218 Woodland Street, Essendon North 3041
PCOK	Point Cook	39 Point Cook Road, Werribee 3030
RKBK	Rockbank	1147-1151 Leakes Road, Rockbank 3335
SUNS	Sunshine	101-107 Devonshire Road, Sunshine 3020
SHAM	Sydenham	500 Melton Hwy, Sydenham 3037
SHAM(1)	Sydenham New	38 Bedingham Drive, Hillside 3037
SALB	St. Albans	1 Victoria Crescent, St. Albans 3021
TNIT	Tarneit	200-208 Derrimut Road, Tarneit 3029
SHAM(2)	Taylors Lakes	24 Verona Drive, Keilor Lodge 3036
TOLE	Toolern Vale	1552-1556 Coimadai Diggers Rest Rd, Toolern Vale 3337
WTON	Williamstown	2 Cole Street, Williamstown 3016
WERE	Werribee	55 Market Road, Werribee 3030
WBES	Werribee South	849 Duncans Road, Werribee South 3030
WESS	West Essendon	311 Buckley Street, Essendon West 3040

C. Copper Distances

The charts included in this Appendix have been prepared by Market Clarity and use a common legend as shown on the right.



The charts should be interpreted in the light of the explanatory notes ***and qualifications*** set out in Section 3.2.1 and are intended only to give a broad indication of distances from the exchange.

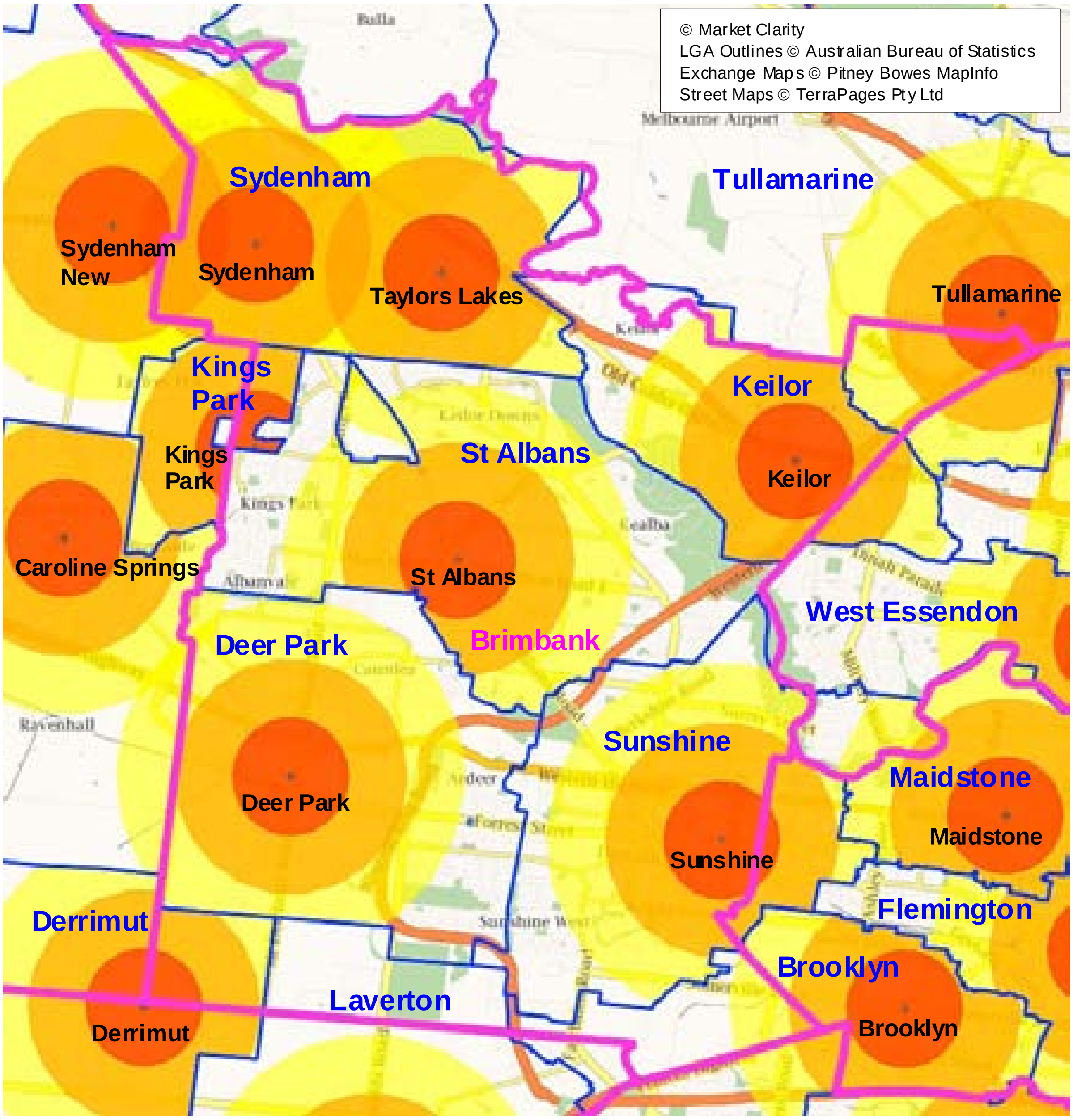
Many ISPs also include an advisory service on their web to inform prospective customers of the availability of an ADSL service based on their phone number.

Some offer more sophisticated facilities for advising prospective customers of the level of ADSL performance they may be able to achieve. As an example, see TPG's web site at http://www.tpg.com.au/maps/ - at the bottom of the map, select Victoria then double-click on any of the blue icons (which represent exchanges at which TPG have their own DSLAMs located) to view the quality of coverage surrounding the exchange.

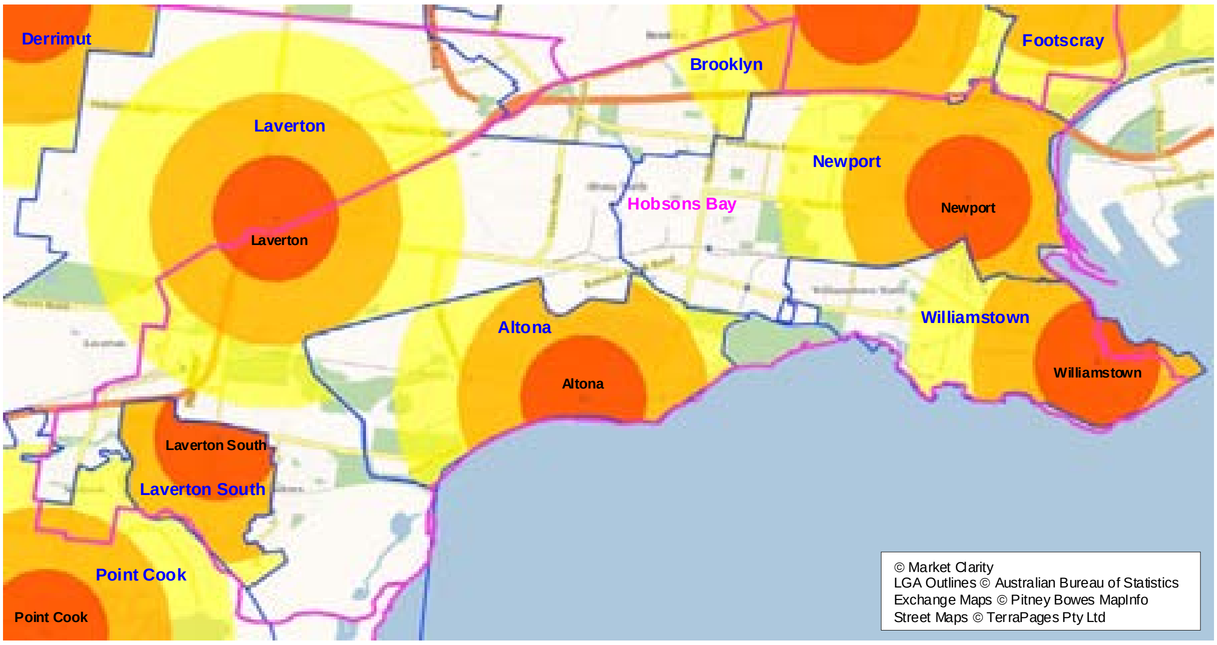
The site http://www.adsl2exchanges.com.au/detailedsummarystart.php identifies the exchange to which a location is connected and reports on the line-of-sight distance, the estimated copper distance and the maximum ADSL performance that might typically be expected.

Many ISPs also publish the list of exchanges in which they have DSLAM equipment located. As discussed in Section 3.2.1, having their own equipment (as opposed to reselling a service provided by someone else) gives additional flexibility in terms of the packages that can be offered.

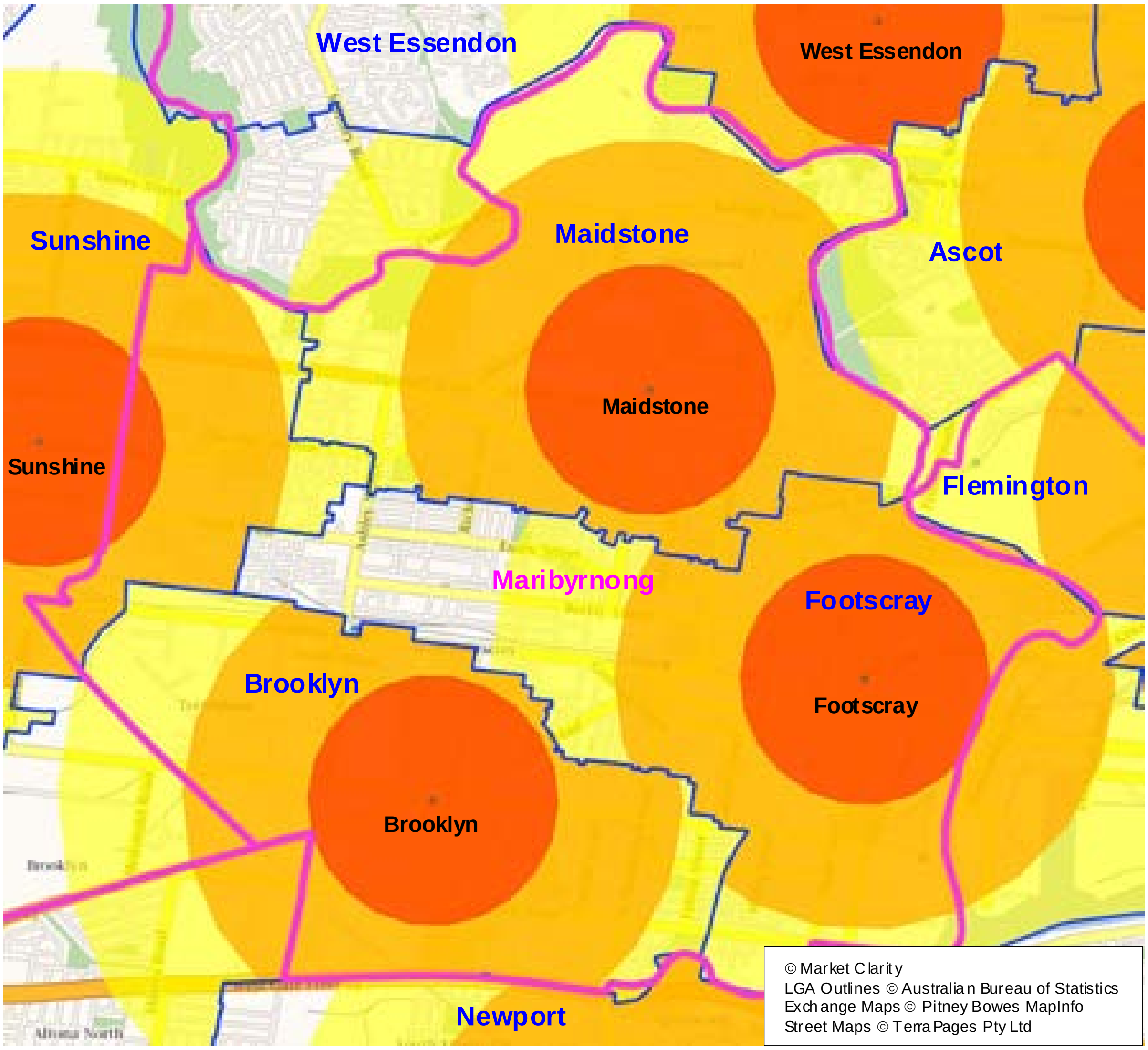
C.1 Brimbank


© Market Clarity
LGA Outlines © Australian Bureau of Statistics
Exchange Maps © Pitney Bowes MapInfo
Street Maps © TerraPages Pty Ltd
Sydenham
Tullamarine
Sydenham New
Sydenham
Taylors Lakes
Tullamarine
Kings Park
Keilor
Kings Park
St Albans
Keilor
Caroline Springs
St Albans
West Essendon
Deer Park
Brimbank
Sunshine
Deer Park
Maidstone
Maidstone
Sunshine
Flemington
Derrimut
Brooklyn
Laverton
Derrimut
Brooklyn

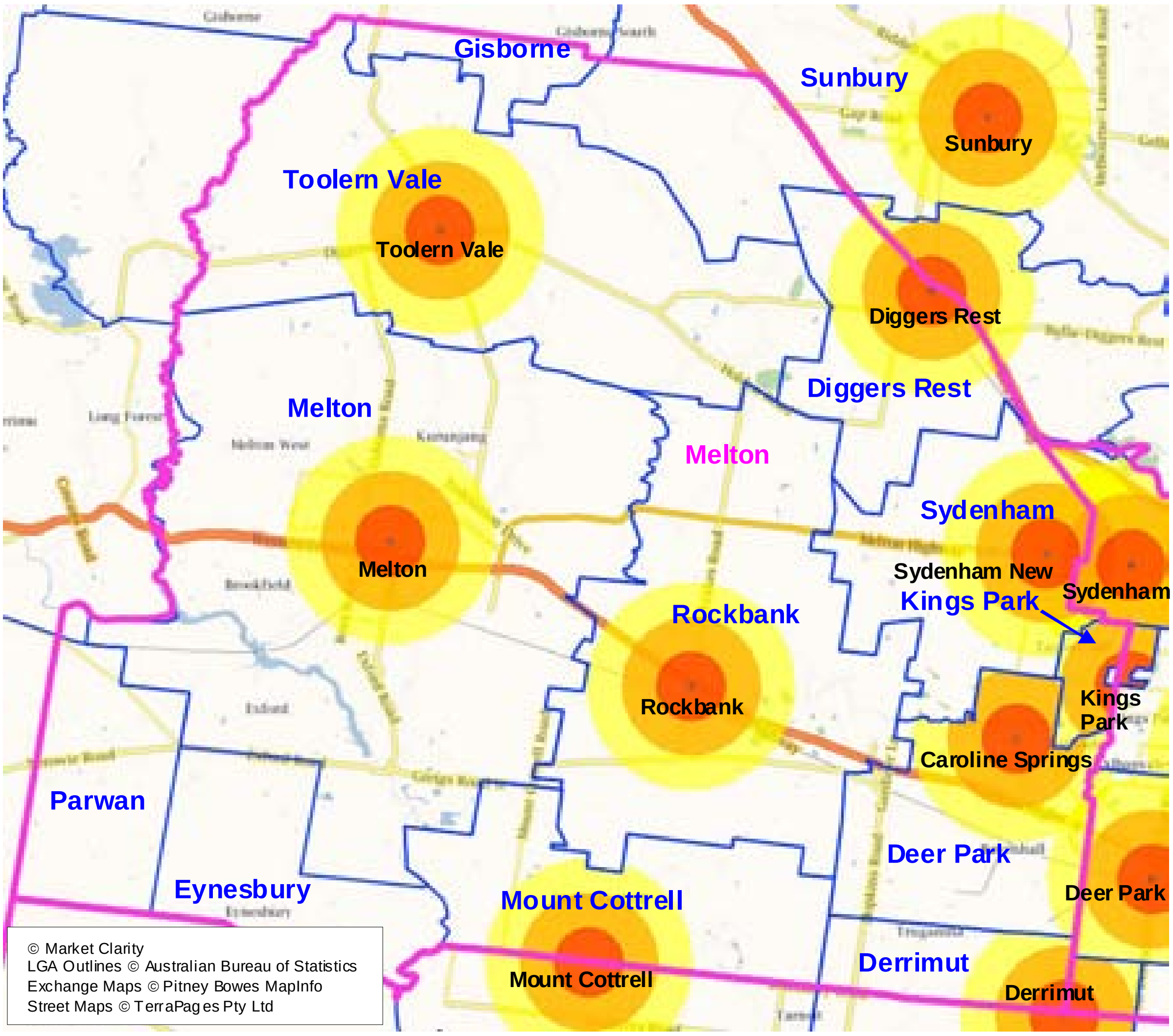
C.2 Hobsons Bay



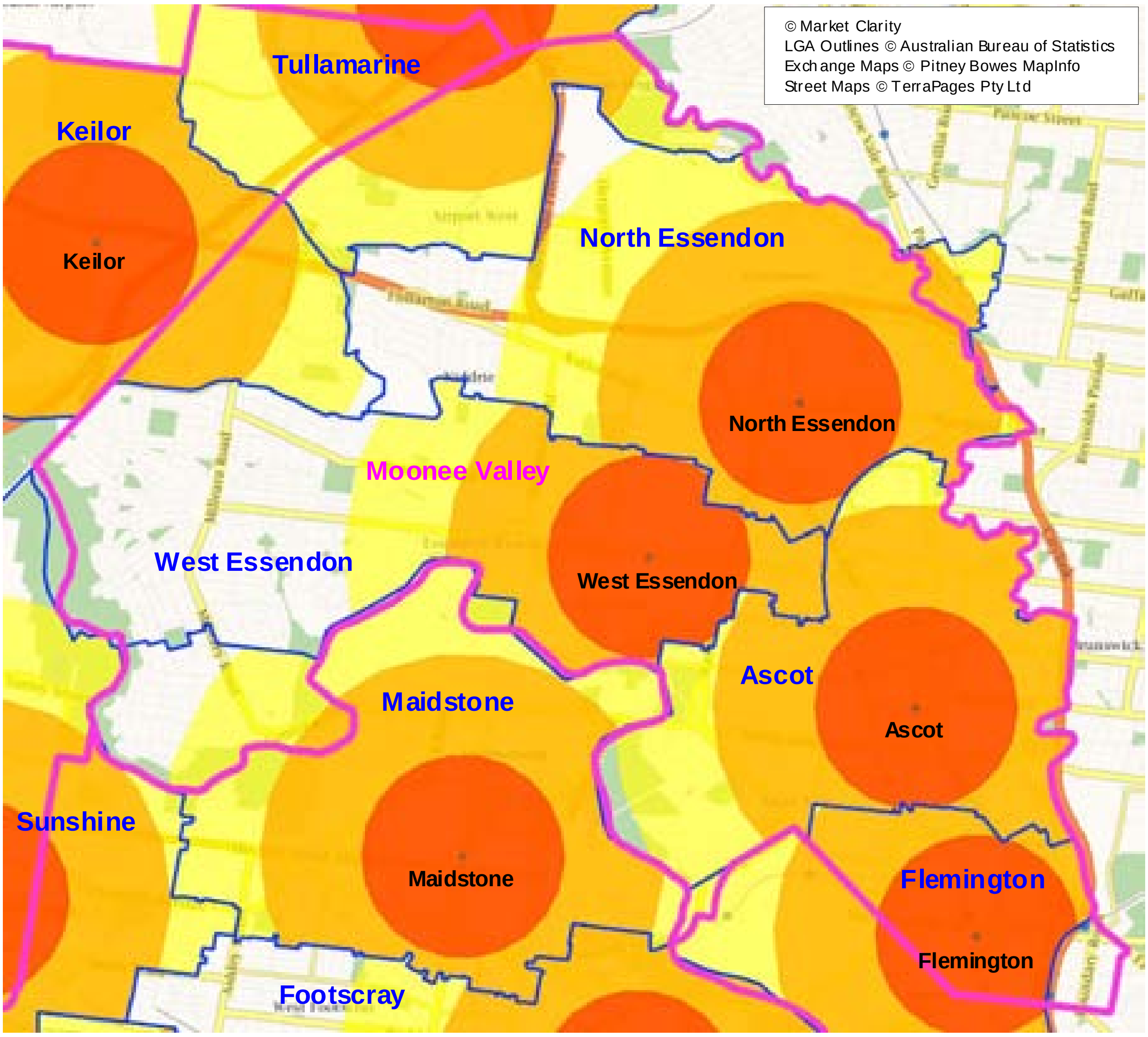
C.3 Maribyrnong



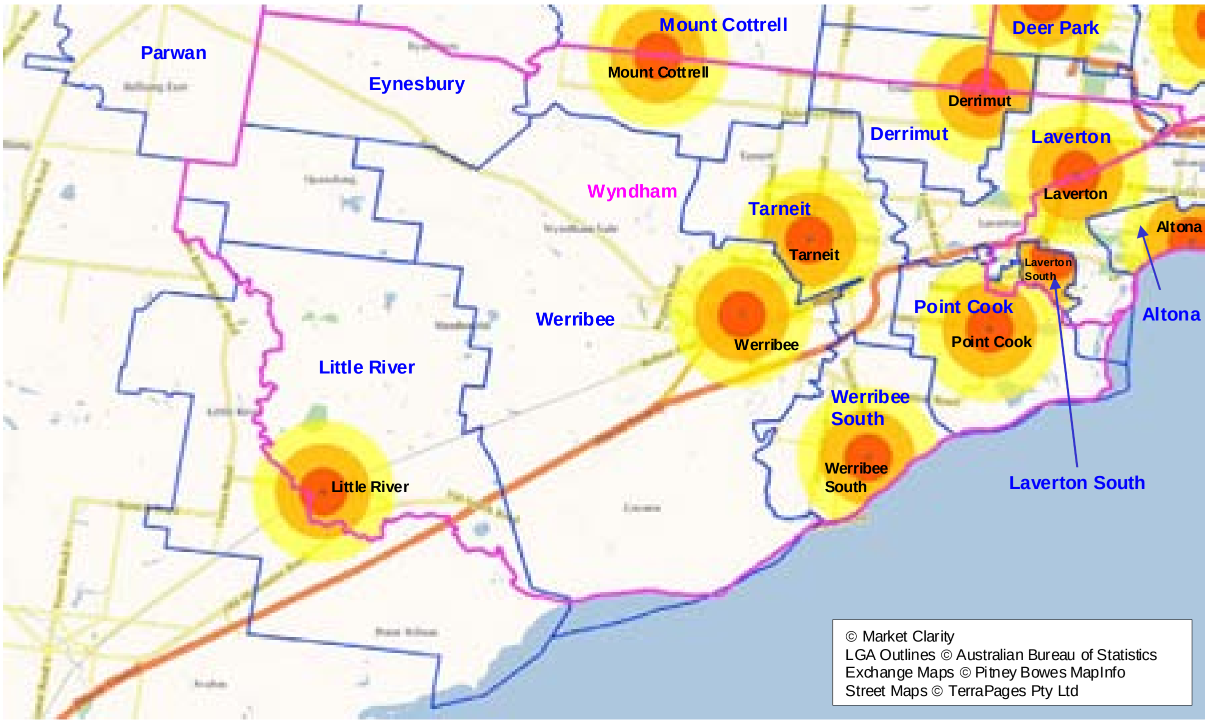
C.4 Melton


Gisborne
Sunbury
Sunbury
Toolern Vale
Toolern Vale
Diggers Rest
Diggers Rest
Melton
Melton
Melton
Sydenham
Sydenham New
Sydenham
Kings Park
Rockbank
Rockbank
Kings Park
Caroline Springs
Parwan
Deer Park
Deer Park
Eynesbury
Mount Cottrell
Mount Cottrell
Derrimut
Derrimut
© Market Clarity
LGA Outlines © Australian Bureau of Statistics
Exchange Maps © Pitney Bowes MapInfo
Street Maps © TerraPages Pty Ltd

C.5 Moonee Valley

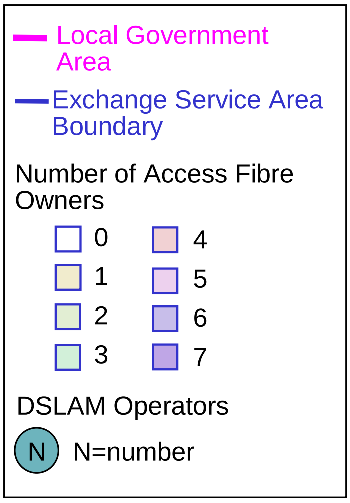


C.6 Wyndham



Market Clarity is not aware of any DSLAMs in the Eynesbury or Parwan ESAs.

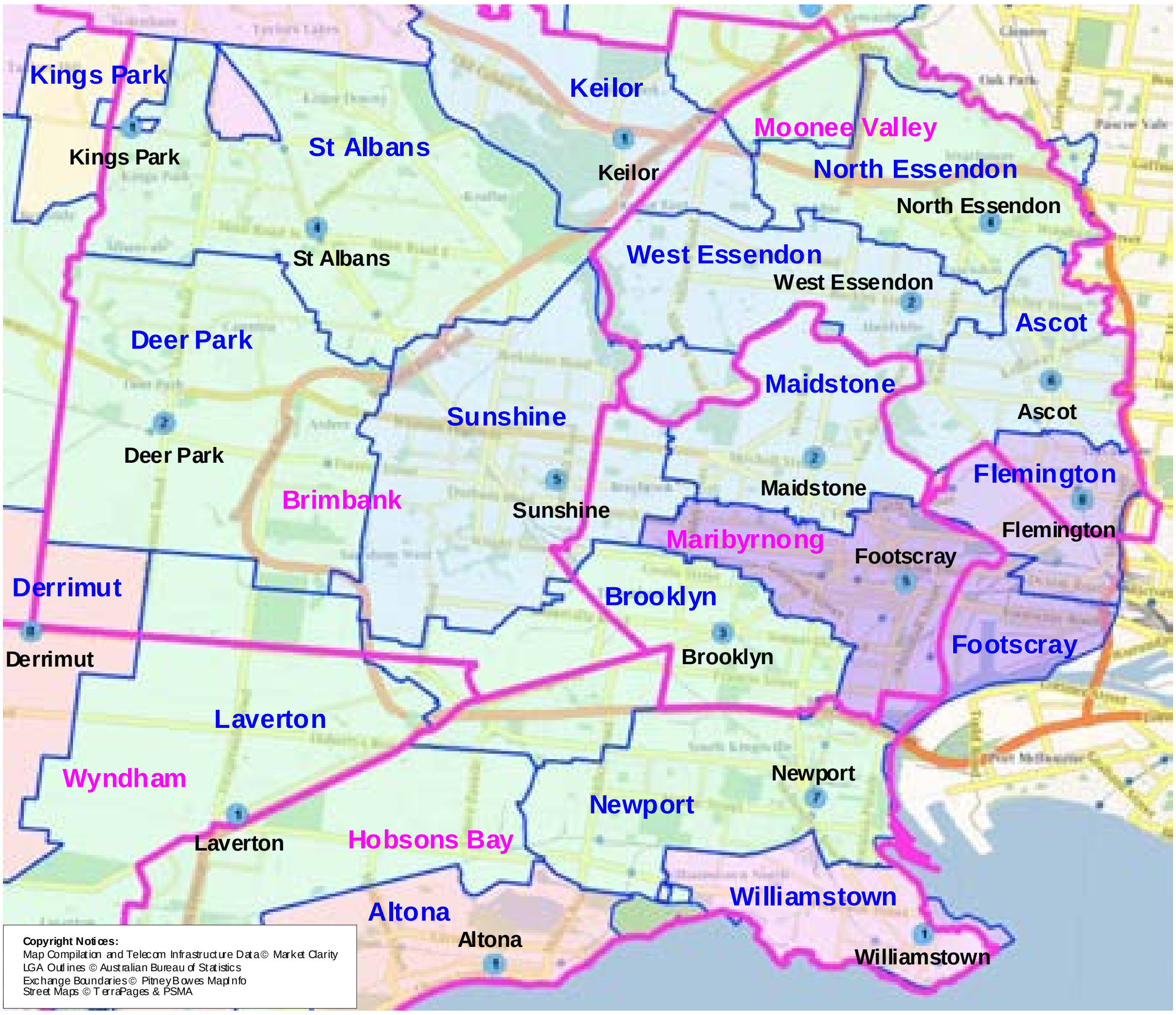
D. Competition Levels



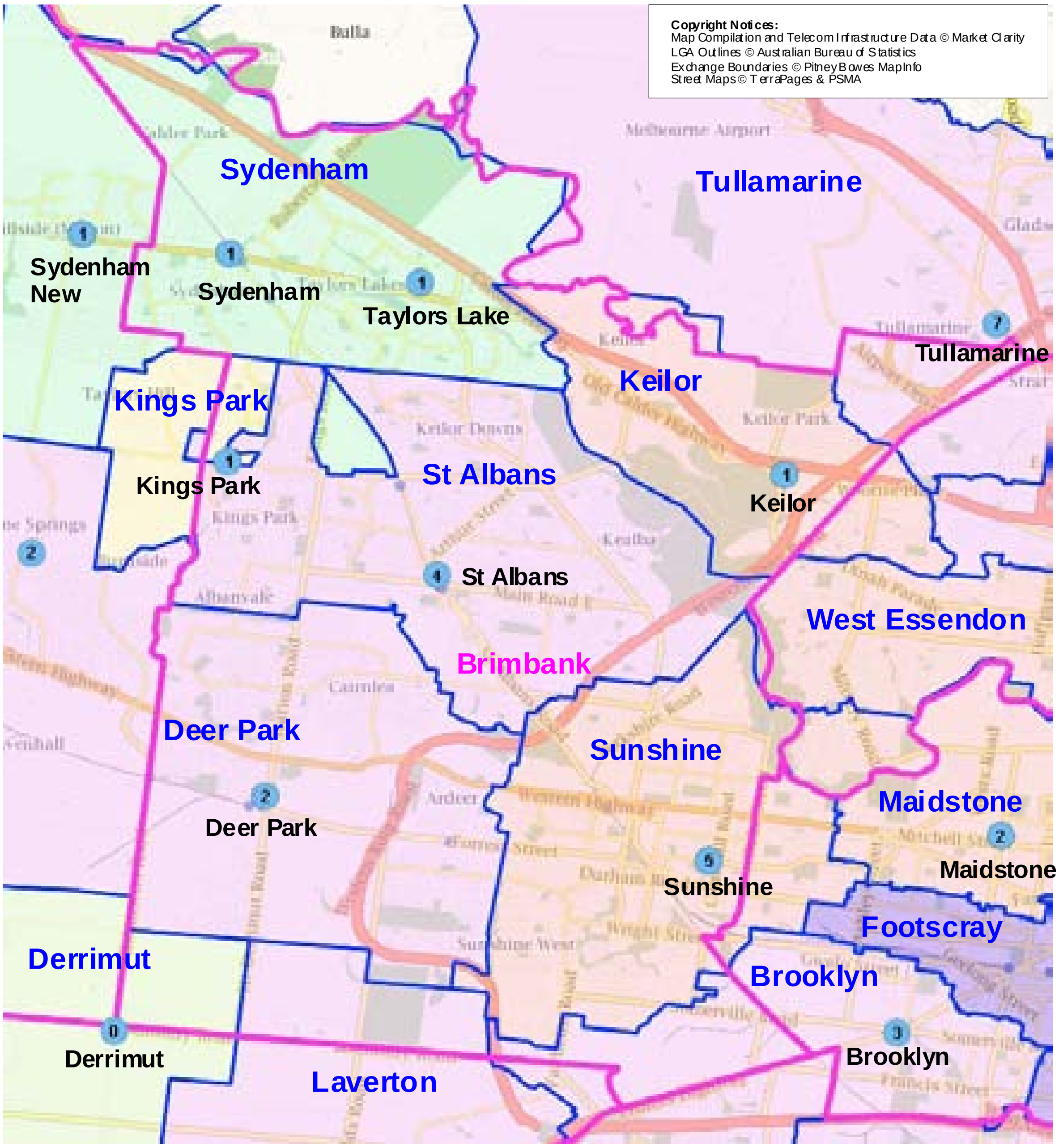
All charts included in this Appendix have been prepared by Market Clarity and use a common legend as shown on the right.

The charts should be interpreted in the light of the explanatory notes and qualifications set out in Section 3.2.2

Charts for each of the LGAs follow in Appendices D.1 through D.6. In addition, a summary of the central West Melbourne area (incorporating multiple LGAs) is provided below.



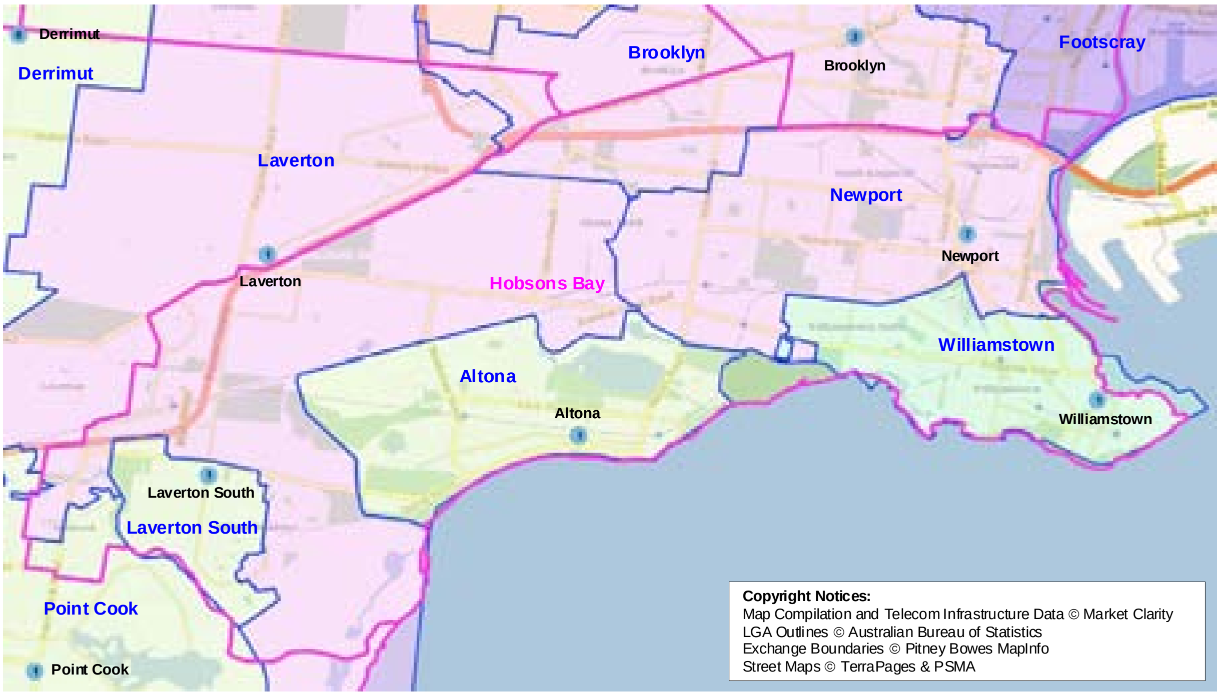
D.1 Brimbank



For the avoidance of doubt as to the interpretation of colours, the number of fibre owners in each of the ESAs on this chart is as follows:

- Brooklyn [5]
- Deer Park [5]
- Derrimut [2]
- Footscray [7]
- Kings Park [1]
- Keilor [4]
- Laverton [5]
- Maidstone [4]
- St Albans [5]
- Sunshine [4]
- Sydenham [3]
- Tullamarine [5]
- West Essendon [4]

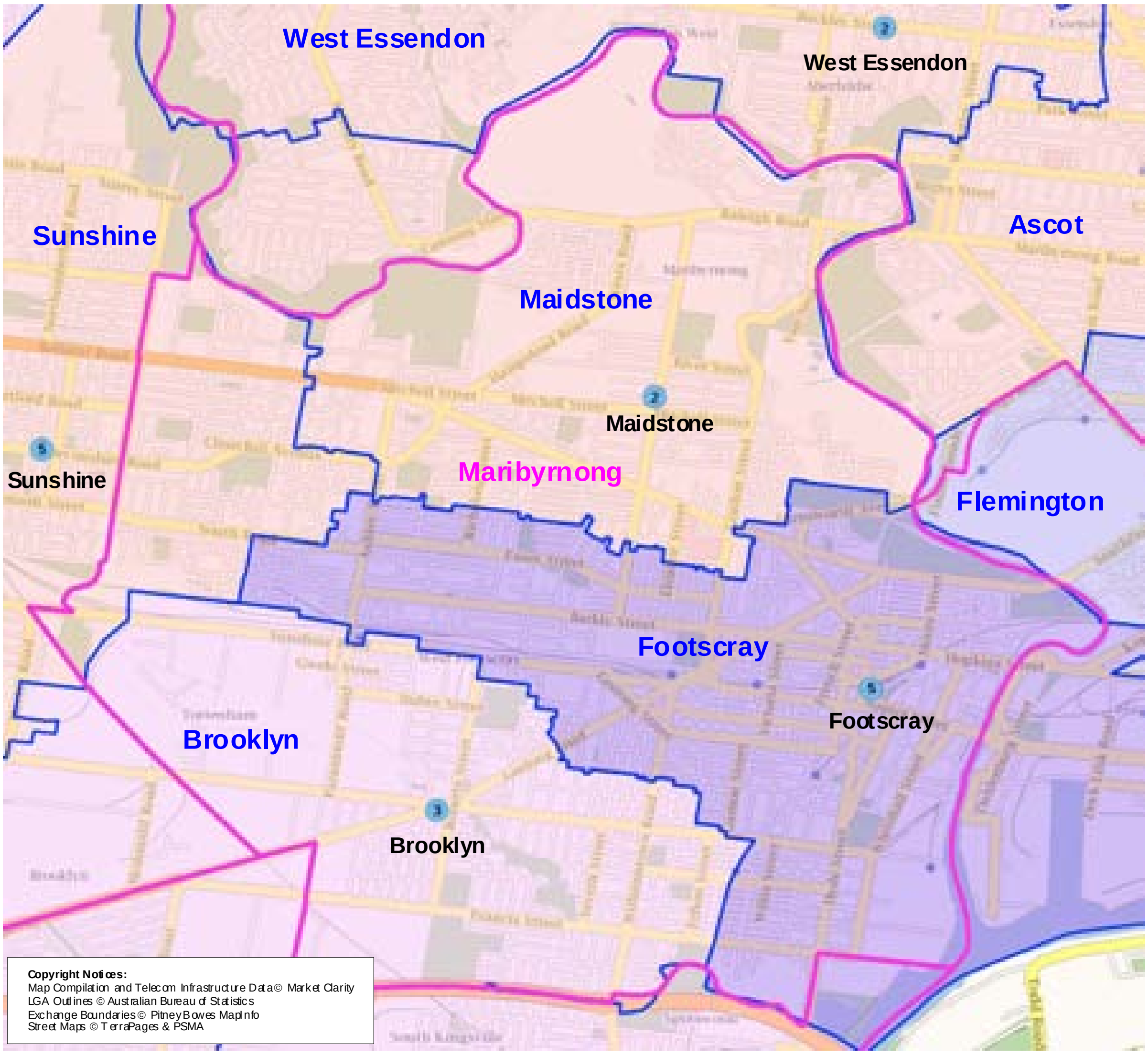
D.2 Hobsons Bay



For the avoidance of doubt as to the interpretation of colours, the number of fibre owners in each of the ESAs on this chart is as follows:

- Altona [2]
- Brooklyn [5]
- Derrimut [2]
- Footscray [7]
- Laverton [5]
- Laverton South [2]
- Newport [5]
- Point Cook [2]
- Williamstown [3]

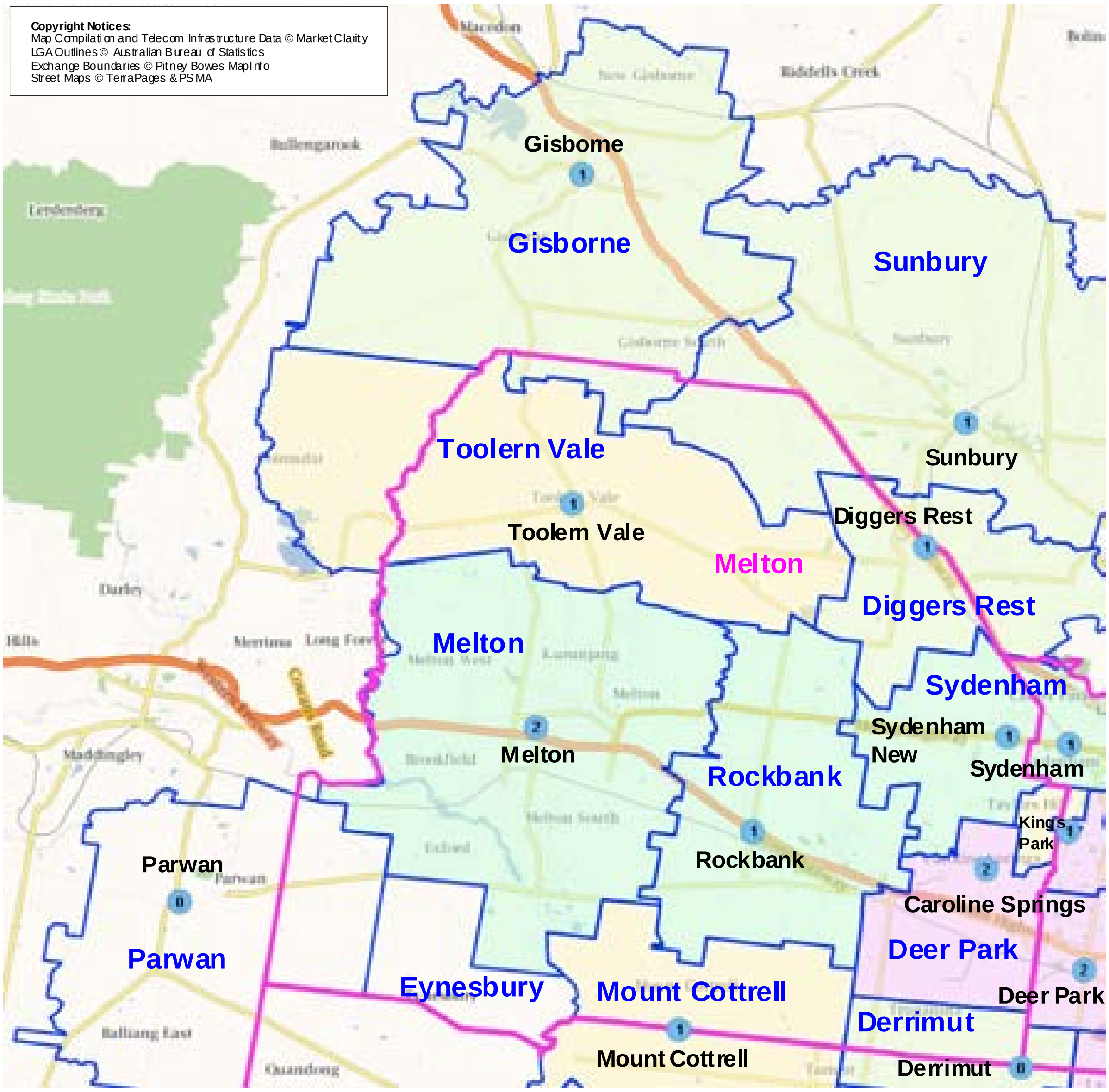
D.3 Maribyrnong



For the avoidance of doubt as to the interpretation of colours, the number of fibre owners in each of the ESAs on this chart is as follows:

- Ascot [4]
- Brooklyn [5]
- Flemington [6]
- Footscray [7]
- Maidstone [4]
- Sunshine [4]
- West Essendon [4]

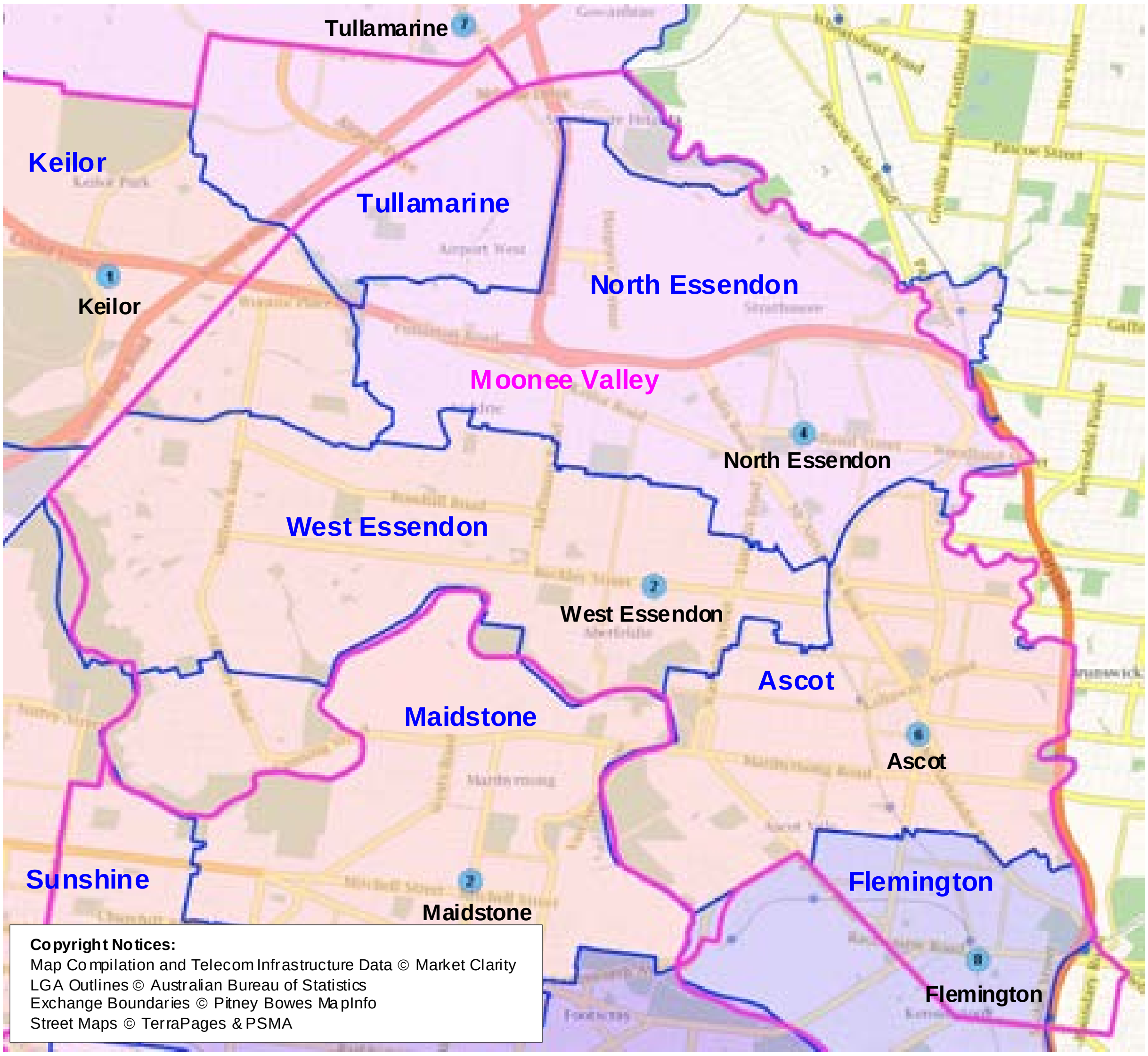
D.4 Melton



For the avoidance of doubt as to the interpretation of colours, the number of fibre owners in each of the ESAs on this chart is as follows:

- Deer Park [5]
- Derrimut [2]
- Eynesbury [0]
- Diggers Rest [2]
- Gisborne [2]
- Melton [3]
- Mount Cottrell [1]
- Parwan [0]
- Rockbank [3]
- Sunbury [2]
- Sydenham [3]
- Toolern Vale [1]

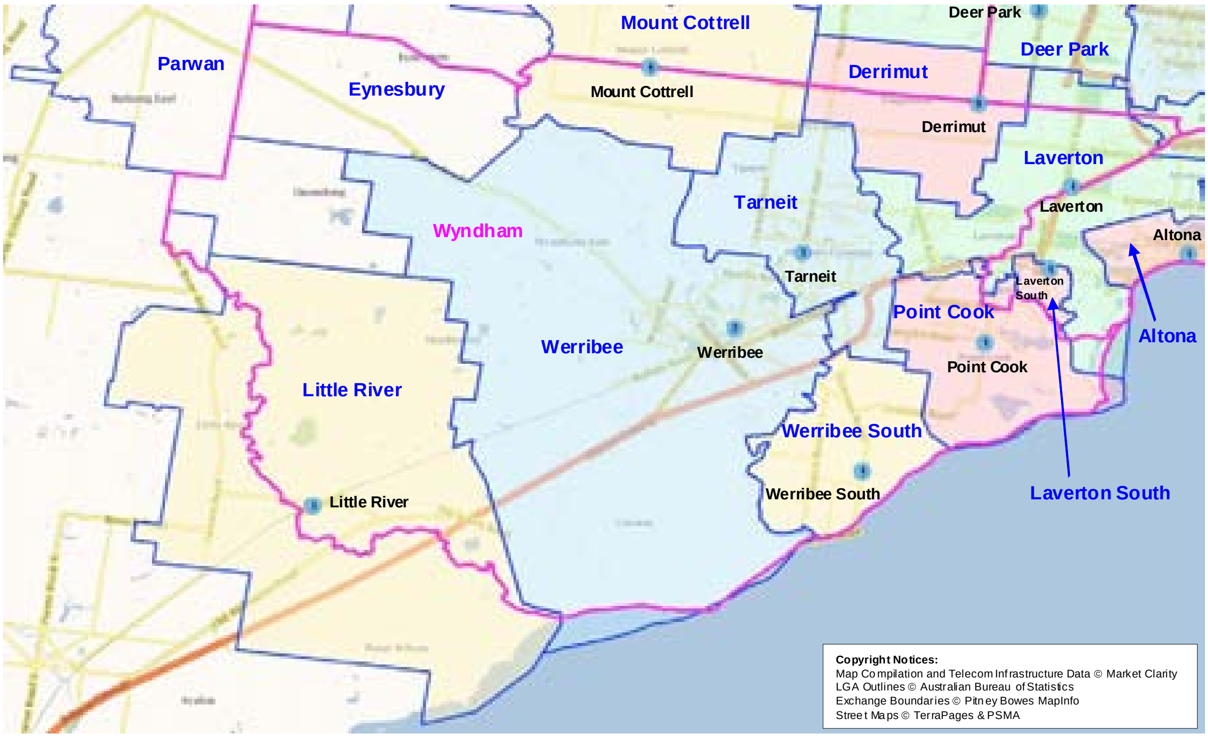
D.5 Mooney Valley



For the avoidance of doubt as to the interpretation of colours, the number of fibre owners in each of the ESAs on this chart is as follows:

- Ascot [4]
- Flemington [6]
- Footscray [7]
- Keilor [4]
- Maidstone [4]
- North Essendon [5]
- Sunshine [4]
- Tullamarine [5]
- West Essendon [4]

D.6 Wyndham



For the avoidance of doubt as to the interpretation of colours, the number of fibre owners in each of the ESAs on this chart is as follows:

- Altona [2]
- Deer Park [5]
- Derrimut [2]
- Eynesbury [0]
- Laverton [5]
- Mount Cottrell [1]
- Laverton South [2]
- Little River [1]
- Parwan [0]
- Point Cook [2]
- Tarneit [4]
- Werribee [4]
- Werribee South [1]