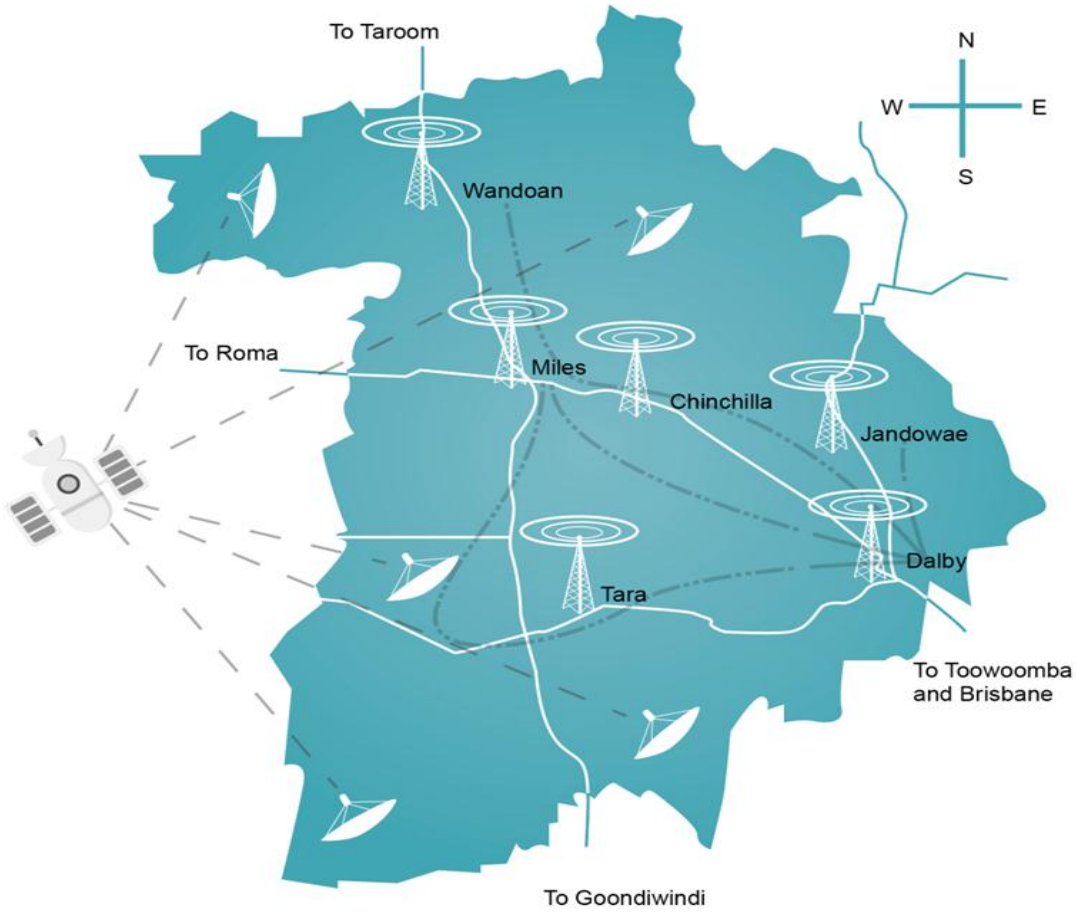
An Audit of Digital Infrastructure and Household Adoption and Use of Broadband Services: A Case Study of Western Downs Region



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Executive Summary

This report was commissioned by Western Downs Regional Council (WDRC) to conduct a detailed audit of the digital infrastructure and an assessment of household adoption and use of broadband internet services in Western Downs Region (WDR). This is the first phase of a number of projects undertaken by WDRC to develop a digital economy strategy that will strategically position the Western Downs Region (business, government and communities) in a digital future. The following key quotation from the general secretary of the International Telecommunications Union, Dr Hamadoun Touré highlights the importance that broadband networks will play in the future. "In the 21st century, affordable, ubiquitous broadband networks will be as critical to social and economic prosperity as networks like transport, water and power. Not only does broadband deliver benefits across every sector of society, but it also helps promote social and economic development.

Currently there is no doubt that a digital divide exists between rural and regional Australia and urban Australia even though there has been a significant uptake in broadband internet in Australia in the last 10 years. It is well acknowledged fact that rural and regional Australia is grossly underserved in terms of high quality digital infrastructure which is taken as a given in many urban areas of Australia. This is despite WDR having a strong growing and diverse economy with the key industries of agriculture, mining and manufacturing contributing significantly to the GDP of the State of Queensland. The lack of adequate of digital infrastructure and in particular access to reliable high speed broadband internet (wired and wireless) is a significant impediment to the continued economic growth and improved quality of life of communities in WDR.

This report examines the fixed wired and wireless telecommunications which currently underpin digital infrastructure in WDR in terms of their current coverage and capability. The report reviews the proposed potential improvements in digital infrastructure (wired, wireless) from the future roll out of the NBN although at this point in time there is no firm timeline in place for the roll out of the NBN in WDR. This report reviews the digital services that can be delivered by the current digital infrastructure in WDR. The report also presents the key findings from 80 interviews of households and over 300 completed surveys of households regarding their adoption and use of broadband internet services in WDR.

WDR is large covering 38,039 sq kms with an estimated population of 32,872 people (as at 2012) largely concentrated in six localities (Dalby, Chinchilla, Miles, Jandowae, Wandoan and Tara) (Advance Western Downs 2013; Western Downs Regional Council 2012). Hence it is quite challenging to deliver digital infrastructure and in particular reliable high speed broadband to all of the people living in the WDR given the vastness and remoteness in some cases of the parts of WDR. This is currently exasperated by the large itinerate population of mining workers estimated to be in the range of 4000 to 8000 at any point in time living in mining camps across WDR.

Currently WDR is serviced by the public switched telephone network (PSTN) which is now basically a digital telecommunications network. The local loop or last mile from PSTN exchanges is a copper network which supports Asynchronous Digital Subscriber Line (ADSL/ADSL2+). This copper network underpins ADSL/ADSL2+ and fixed wired broadband internet access. While providing an extensive coverage of broadband internet access across the main population centres in WDRC ADSL/ADSL2+ broadband internet is problematic because of the current state of the copper network and the associated telephone exchanges. In many instances, smaller population centres in WDR, residents do not have access to ADSL/ADSL2+ or if they do the quality of service is poor and below acceptable levels in terms of download and upload speeds for broadband internet access.

Three main population centres of WDRC (Dalby, Chinchilla and Miles) are already serviced by at least two backbone fibre optic networks. So the opportunity exists to improve the capability of existing wired and wireless broadband internet by better utilising this fibre optic backbone network. However how this can be achieved is not clear and potentially problematic. If left to market forces it is unlikely that much can be achieved because of the lack of commercial incentives as the cost of connecting these population centres to a fibre optic backbone network is substantial. Similarly if there is government intervention how can this be best achieved through the involvement of federal, state and local governments?

WDRC is extensively covered by the mobile phone networks of Telstra and Optus and to a lesser extent Vodafone with 2G and 3G mobile phone network services available in all population centres and 4G mobile phone network services available in the major population centres, such as Dalby, Chinchilla and Miles. Other reasonable sized towns such as Tara and Jandowae also starting to get 4G mobile phone network services. However the reliability and quality of mobile phone network services across WDR is less than desirable in delivering an alternative means to access broadband internet due the number of black spots that exist in the transportation routes between towns in WDR.

Furthermore, given the rapid growth that WDR has experienced due to the mining boom with Coal Seam Gas exploration, the capacity of the mobile networks in place is struggling to cope with the data traffic in peak demand times. In main three population centres of Dalby, Chinchilla and Miles, it is a well-known fact among residents that accessing mobile broadband internet services and downloading and uploading data is problematic from 3 pm to 10 pm because the mobile phone networks in WDR do not have sufficient backbone capacity for data traffic during that time. In the less populated rural areas signal strength is a major problem in maintaining reliable connections to mobile phone networks and antennas and signal boosters are essential in order to maintain reliable good signal strength connections. Furthermore in rural areas many businesses are forced to purchase expensive satellite hardware and services in order to have access to reliable broadband internet services. Residents of WDR who do not have access to wired or wireless broadband internet services are able to access broadband internet delivered by NBN Co's interim satellite service. However access to satellite broadband internet is only available to residents who can demonstrate that they do not have access to ADSL/ADSL2+ or do not have access to mobile broadband internet. Moreover, this NBN Co interim Satellite broadband service is over-subscribed and unable to deliver high speed and reliable broadband services.

The roll out of the NBN in WDRC had been earmarked for completion in 2015. However the change of the Federal government and the recent NBN Strategic Review would indicate that the mix of broadband internet access technologies may change slightly in that the three main population centres of WDR may now receive Fibre to the Node (FTTN) instead of Fibre to the Premise (FTTP) while most of other areas except for the areas considered to be remote will receive Fixed Wireless broadband internet access. Currently there is no clear deadline for the rollout of the NBN in WDR although Coalition Federal Government has consistently indicated in the revised NBN roll out priority will be given to underserved areas. WDR as a rural and regional shire clearly falls into one of these underserved areas in terms of adequate access to broadband internet.

Digital Services being delivered by the current digital infrastructure in WDR have been considered in terms of information, communication, transaction and distribution virtual spaces. Increasingly information, communication, transactions and distribution of goods and services for private sector, government, health and education services are being delivered and/or managed digitally. However the current digital infrastructure in WDR imposes on

some constraints on the level of activity that can be undertaken in each of these digital virtual spaces. We believe that the impediments in current digital infrastructure available in WDR is seriously constraining the economic capital human capital and social capital that can be built with affordable access to high speed and reliable broadband internet.

Despite the impediments in digital infrastructure the uptake and use of broadband internet services by households in WDR is significant. For instance more than 75% of households have been using the Internet for more 5 years. Households are using broadband services frequently on a daily basis. Mobile broadband is most frequently used by households (60%) followed by ADSL (50%) and Satellite (10%). The most frequent location for household members accessing the Internet is home (98%), followed by work (59%) and on the move (47%). Most commonly used devices by households for accessing the Internet include: Laptop/netbook (80%), Smartphone (64%), Desktop computer (58%), and Tablets (55%). The 10 most common digital services used by households include email (97%), Information search (90%), Banking (78%), Facebook (71%), Shopping online (68%), Maps (62%), News (61%), Music (55%), Government services (47%) and Games (44%).

There would appear to be digital divide in the Western Downs Region as the availability, reliability and affordability of broadband services is dependent on the digital infrastructure available and highly variable across the region. Digital literacy would also appear to be an issue for some residents. The lack of high speed and reliable broadband services is a significant barrier to development of economic, human and social capital in the Western Downs Region.

Key recommendations of this report are:

- WDRC to include the development and utilisation of digital infrastructure as part of its short and long strategic planning by developing a digital economy strategy plan for the next 3 years;
- Building economic, human and social capital in WDR by ensuring adequate access to high speed and reliable broadband internet;
- Existing digital infrastructure (both wired and wireless) need to be better utilised and upgraded;
- Ensuring through consultation with the key stakeholders that the roll out of the NBN infrastructure in WDR addresses the shortcomings of the existing digital infrastructure;
- Develop a digital literacy plan for residents of WDR so all residents can make the transition and be active participants in a digital future.

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1 Existing Digital (Telecommunications) Infrastructure in WDR

This section provides a review of the existing telecommunications technologies that are available in varying degrees across the Western Downs Region.

Table 1 A snapshot of existing telecommunication technologies available in WDR

									NBN			
Locality	**Pop**	**2011 Census Count**	**2012 ERP Est**	**PSTN**	**ADSL**	**ADSL2+**	**3G**	**4G**	**Fibre**	**Fixed Wireless**	**Satellite**	**Other Radio Services**
Dalby	16000	10861	11320	Y	Y	Y	Y	Y	Y	N	Y	Y
Bell	300	274	290	Y	Y	N	Y	N	N	N	Y	Y
Kaimkillenbun	100	101	110	Y	N	N	Y	N	N	N	Y	Y
Macalister	15	-	-	Y	N	N	Y	N	N	N	Y	Y
Chinchilla	7200	4780	4980	Y	Y	Y	Y	Y	Y	N	Y	Y
Brigalow	40	33	40	Y	N	N	Y	N	N	N	Y	Y
Kogan	40	34	40	Y	N	N	Y	N	N	N	Y	Y
Miles	1450	1170	1220	Y	Y	Y	Y	Y	Y	N	Y	Y
Condamine	135	168	180	Y	Y	Y	Y	N	N	N	Y	Y
Dulacca	120	79	90	Y	N	N	Y	N	N	N	Y	Y
Drillham	70	17	20	Y	N	N	Y	N	N	N	Y	Y
Tara	1100	855	900	Y	Y	Y	Y	N	N	N	Y	Y
Meandarra	250	114	120	Y	Y	Y	Y	N	N	N	Y	Y
Moonie	40	-	-	Y	N	N	Y	N	N	N	Y	Y
Glenmorgan	20	24	30	Y	N	N	Y	N	N	N	Y	Y
Jandowae	1000	746	780	Y	Y	Y	Y	N	N	N	Y	Y
Warra	120	72	80	Y	N	N	Y	N	N	N	Y	Y
Jimbour	40	-	-	Y	N	N	Y	N	N	N	Y	Y
Wandoan	400	330	350	Y	Y	Y	Y	N	N	N	Y	Y
Gulugaba	10	-	-	Y	N	N	N	N	N	N	Y	Y
				All	9	5	19	3		0	20	20

Note: Satellite Broadband Internet is only available in remote areas and other areas where wired and wireless broadband are not available. Proprietary radio networks have potential broad coverage of WDRC if the infrastructure is in place.

Table 1 shows that four telecommunications technologies have a broad coverage across WDR. These are PSTN, ADSL/ADSL2+, 3G/4G Mobile Networks and Satellite (note 2G is assumed where there is 3G/4G mobile network coverage). These telecommunications technologies form the basis of the existing telecommunications or digital infrastructure in WDR. It should also be noted that there is substantial coverage of WDR by proprietary mobile (radio) networks which are owned by mining companies such as Queensland Gas Company (QGC, a subsidiary of BG Group)(QGC 2013) and government entities such as Ergon and Queensland Rail. There are also at least two fibre optic backbone networks running through the three major population centres of Dalby, Chinchilla and Miles. These existing telecommunications technologies which form the basis of WDR's digital infrastructure are now evaluated in detail.

1.1 Wired - Public switched telephone service (PSTN)

Public switched telephone service also known as Plain old telephone service (POTS) is the voice-grade telephone service that is based on Analogue signal transmission that was common before the advent of advanced forms of telephony such as Integrated Services Digital Network (ISDN), cellular telephone systems, and voice over Internet Protocol (VoIP) (Wikipedia 2013a). It remains the basic form of residential and small business service connection to the telephone network in many parts of the world. The term reflects a technology that has been available since the introduction of the public telephone system in the late 19th century, in a form mostly unchanged despite the introduction of Touch-Tone dialling, digital telephone exchanges and fibre-optic communication into the public switched telephone network (PSTN).

The technology of PSTN is characterized by several aspects:

- Bi-directional (full duplex) communications.
- Frequency range of the human voice (voiceband) of 300 to 3400 Hz.
- Signalling using call-progress tones, such as dial tone and ringing signal.
- Subscriber dialling;
- Operator services, such as directory assistance, long distance calling, and conference calling assistance;
- Standards-compliant analog telephone interface including BORSCHT functions

In Australia, the pair of wires from the central switch office to a subscriber's home is called a subscriber loop. It is powered by direct current (DC), typically at a nominal voltage of 48V, supplied by a large bank of batteries in the central office facilities, resulting in continuation of service during most commercial power outages.

Many calling features became available to telephone subscribers after computerization of telephone exchanges during the 1970s and 1980s. The services include voicemail, Caller ID, call waiting, speed dialling, Conference calls (three-way calling), Enhanced 911, and Centrex services.

The communication circuits of the PSTN continue to be modernized by advances in digital communications; however, other than improving sound quality, these changes have been mainly transparent to customers. In most cases, the function of the local loop presented to the customer for connection to telephone equipment is practically unchanged and remains compatible with pulse dialing telephones. However, it should also be noted that there has been a significant drop in the revenues of telecommunications companies from home phone fixed lines as many consumers are now opting to using mobile phones as their primary communication device (Whalley 2013). Similarly there is also pressure from the Telcos to move their customers to mobile phone network services.

PSTN is telecommunications infrastructure which has been in place for a long time and its coverage of populated areas in WDRC is complete. Most if not all households and businesses would have a fixed line telephone connection although this could be changing with the increased coverage of mobile phone – cellular networks and reduced costs associated with mobile phone services. Given that PSTN and in particular the last mile of copper from telephone exchanges underpins ADSL/ADSL2+ services it is likely that the PSTN copper network is going to be around for some time yet.

One of the big questions in regards to the population centres of WDR is how well will the existing copper network be able to support Fibre to the Node (FTTN) as an option for delivery of high speed broadband in the larger population centres in WDR given the current state of the copper network in rural and regional Australia (Ross 2103). However there have been some interesting developments in new technologies which can potentially deliver high speed broadband. G.Fast utilises Fibre to the Distribution Point (FTTDP) (Brown 2013) and the copper network to deliver high speed broadband at speeds only previously thought possible with Fibre to the Premise (FTTP). Getting more out of existing telecommunications infrastructure is one of the cornerstones of the Coalition's revised NBN strategy (NBN CO 2103).

1.2 Dial up internet access via PSTN

Dial up internet access is potentially available to anyone with access to the PSTN and an Internet service provider supporting dial up internet access. Wikipedia defines dial up internet access as follows. Dial-up Internet access is a form of Internet access that uses the facilities of the PSTN to establish a dialled connection to an Internet service provider (ISP) via telephone lines (Wikipedia 2013f). Dial-up access uses a modem and a phone call placed over the public switched telephone network (PSTN) to connect to a pool of modems operated by an ISP. The modem converts a computer's digital signal into an analog signal that travels over a phone line's local loop until it reaches a telephone company's switching facilities or central office (CO) where it is switched to another phone line that connects to another modem at the remote end of the connection (Dean 2010).

Dial-up connections to the Internet require no infrastructure other than the telephone network and the modems and servers needed to make and answer the calls (Wikipedia 2013f). Where telephone access is widely available, dial-up remains useful and it was once often the only choice available for rural or remote areas, where broadband installations are not prevalent due to low population density, and high infrastructure cost. Dial-up access may also be an alternative for users on limited budgets, as it is offered free by some ISPs, though broadband is increasingly available at lower prices due to market competition. In WDR it is likely that very few if any households or businesses would still be using Dial-up internet access as some form of ADSL/ADSL2+ is available in the six localities and surrounding towns and the populated areas of WDR are also extensively covered by 3G and 4G mobile broadband networks.

Operating on a single channel, a dial-up connection monopolizes the phone line and is one of the slowest methods of accessing the Internet. Typically, dial-up connections do not exceed a speed of 56 kbit/s, as they are primarily made using modems that operate at a maximum data rate of 56 kbit/s downstream (towards the end user) and 34 or 48 kbit/s upstream (Woodford 2013). Dial-up internet access is considered to be narrow band. In contrast, ADSL broadband works in a completely different way. Instead of treating a phone line as a single, narrow pipe between a computer and the ISP's computer, as a dialup internet connection does, ADSL divides the line into many different channels. Information can travel in parallel streams down these channels. It's like dividing a highway into several lanes: lots more traffic can go down it in parallel than down a single-lane road. This is why ADSL broadband is so much faster than dialup internet access. Even a slow ADSL broadband line, working at 512Kbps, is about nine times faster than the best dialup connection, while a moderately fast ADSL broadband line, working at around 8MBps (megabits per second), can be over 100 times quicker (Woodford

2013). The most commonly used wired broadband technology at this point in time is ADSL/ADSL2+.

However it is possible to achieve faster download speeds with Dial-up internet access through the use of bonding which is known as multilinking. Multilink dial-up provides increased bandwidth by bonding two or more dial-up connections together and treating them as a single data channel (Jones 2013). It requires two or more modems, phone lines, and dial-up accounts, as well as an ISP that supports multilinking. Any line and data charges are also doubled in using multilinking. This inverse multiplexing option was briefly popular with some high-end users before ADSL and other broadband technologies such as 3G Mobile Broadband became widely available (MaxiumumPC 2009). A recent report by ABS indicated that in the last 10 years Dial-up internet access has been replaced as the dominant technology for accessing the Internet by 3G Mobile Broadband and ADSL/ADSL2+ with 3G and 4G Mobile Broadband now becoming the dominant broadband internet access technology. In 2013 Dial-up only accounted for 2% of Internet access connections as reported by Australian ISPs (ABS 2013).

1.3 Wired Asynchronous digital subscriber line (ADSL), (ADSL2+)

Asymmetric digital subscriber line (ADSL) is a type of digital subscriber line (DSL) technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voiceband modem can provide (Wikipedia 2013c). It does this by utilizing frequencies that are not used by a voice telephone call. Figure 1 shows how ADSL/ADSL2+ utilises the frequency spectrum on the copper network not used by voice data. A larger frequency spectrum is available for download of data in comparison to the upload of data, hence with this broadband technology higher speeds are achievable for download of data. A splitter, or DSL filter, allows a single telephone connection to be used for both ADSL service and voice calls at the same time. ADSL can only be distributed over short distances from the telephone exchange (the last mile), typically less than 4 kilometres (2 mi), (ANSI T1.413-1998 1998) but has been shown to work for distances exceeding 8 kilometres (5 mi) if the originally laid wire gauge allows for further distribution.

At the telephone exchange the line generally terminates at a digital subscriber line access multiplexer (DSLAM) where another frequency splitter separates the voice band signal for the conventional phone network. Data carried by ADSL are routed over the telephone company's data network and eventually reach a conventional Internet Protocol network.

ADSL differs from the less common symmetric digital subscriber line (SDSL). Bandwidth (and bit rate) is greater toward the customer premises (known as downstream) than the reverse (known as upstream). This is why broadband internet service as known as asymmetric (ADSL). Providers usually market ADSL as a service that provides Internet access in a relatively passive mode: able to use the higher speed direction for the download from the Internet but not needing to run servers that would require high speed in the other direction.

There are both technical and marketing reasons why ADSL is in many places the most common type of broadband service offered to home users. On the technical side, there is likely to be more crosstalk from other circuits at the DSLAM end (where the wires from many local loops are close to each other) than at the customer premises. Thus the upload signal is weakest at the noisiest part of the local loop, while the download signal is strongest at the noisiest part of the local loop. It therefore makes technical sense to have the DSLAM transmit at a higher bit rate than does the ADSL modem at the customer end. Since the

typical home user in fact prefers a higher download speed, the telephone companies chose to make a virtue out of necessity, hence ADSL.

Currently, most ADSL communication is full-duplex. Full-duplex ADSL communication is usually achieved on a wire pair by either frequency-division duplex (FDD), echo-cancelling duplex (ECD), or time-division duplex (TDD). FDD uses two separate frequency bands, referred to as the upstream and downstream bands. The upstream band is used for communication from the end user to the telephone exchange. The downstream band is used for communicating from the telephone exchange to the end user.

Figure 1 Frequency spectrums utilised by PSTN and ADSL on copper network/local loop

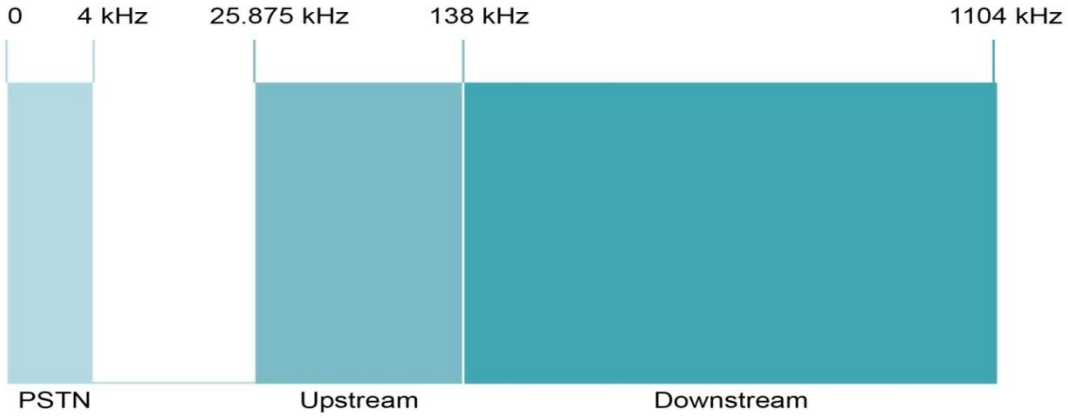
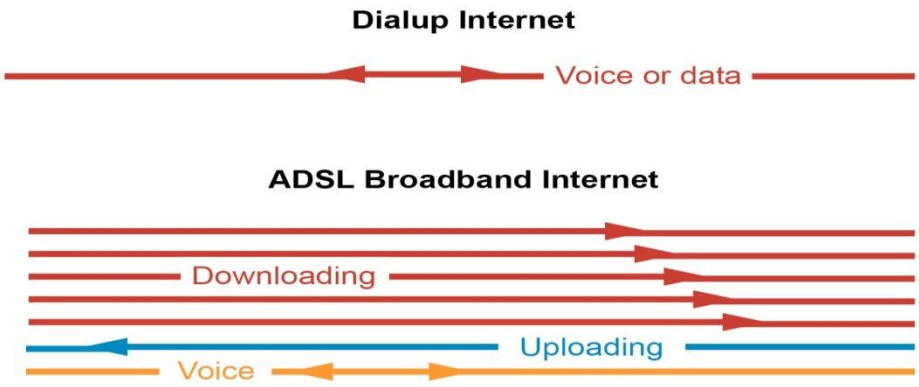


Figure 1 shows how the bandwidth frequency spectrums are sliced to allow data communication traffic (ADSL) to co-exist with voice communication on a telephone line.

Similarly Figure 2 compares dial-up internet access where only voice or data communication is possible at one time with ADSL broadband internet which co-exists with voice communication on the same telephone line.

Figure 2 Comparison of Dial-up Internet versus ADSL Broadband Utilisation of Multiple Frequency Channels



Dialup and ADSL broadband use the same phone line, but ADSL broadband uses it much more efficiently. Where dialup sends only one voice or data signal down one channel, ADSL broadband divides the line into multiple channels, each of which can send data in parallel. Most channels (red) are used for downloading; a few are reserved for uploading (blue). You can also have a phone conversation at the same time (using the green channel) (Woodford 2013).

1.3.1 Current ADSL Standards

On whole ADSL2+ is widely available in Australia although this is qualified by whether a telephone exchange is ADSL/ADSL2+ enabled and the number of ADSL/ADSL2+ ports that have been made available in a PSTN telephone exchange. It should be noted that there are other emerging wired broadband technologies such as VDSL and VDSL2 which offer considerably faster download and upload speeds (Whalley 2013) (See Table 2 for a summary of these various broadband technologies which utilise the PSTN. However these broadband technologies are increasingly going to be implemented with FTTN but are restricted by the quality of the copper network and the distance between the copper network and the DSLAM.

Table 2 ADSL Technologies available for broadband internet access

ADSL Standard	Download speed Mbit/s	Upload speed Mbit/s
ANSI T1.413 Issue 2	up to 8 Mbit/s	1 Mbit/s
G.DMT, ITU-T G.992.1	up to 10 Mbit/s	1 Mbit/s
G.Lite, ITU-T G.992.2, more noise and attenuation resistant than G.DMT	up to 1,536 kbit/s	512 kbit/s
Asymmetric digital subscriber line 2 (ADSL2), ITU-T G.992.3	up to 12 Mbit/s	3.5 Mbit/s
Asymmetric digital subscriber line 2 plus (ADSL2+), ITU-T G.992.5	up to 24 Mbit/ s	3.5 Mbit/s
Very-high-bit-rate digital subscriber line (VDSL), ITU-T G.993.1	up to 52 Mbit/s	16 Mbit/s
Very-high-bit-rate digital subscriber line 2 (VDSL2), ITU-T G.993.2, an improved version of VDSL, compatible with ADSL2+, sum of both directions up to 200 Mbit/s. With the G.vector crosstalk cancelling feature (ITU-T G.993.5) this provides 100Mbps up to 500 meters	100 Mbit/s	100 Mbit/s

As mentioned previously with the Federal Coalition Government policy to move to FTTN in rolling out Fibre optic networks for the NBN, ADSL looks to be a technology that will be around for some time.

1.3.2 Incompatible Infrastructure - RIM (Remote Integrated Multiplexer)

A RIM, otherwise known as a Remote Integrated Multiplexer, is a device that Telstra uses to provision telephone services in areas where there is no existing copper, or the existing copper in the ground cannot support the demand for services in the area. RIMs are a fairly modern and flexible Pair Gain system designed mainly for urban areas in cities due to their ability to multiplex a large number of lines.

A lot of newer housing estates have telephone services supplied by a RIM. Large office buildings, shopping centres, apartment complexes are all likely candidates to be serviced by RIMs. In rural and remote areas, older telephone exchanges can often be replaced by a RIM unit that utilizes the existing fibre infrastructure to communicate to an exchange of a larger community.

This means that instead of Telstra having to lay hundreds of pairs of copper wires for several kilometres to a new housing estate or industrial area, a single pair of optic fibres could carry all the phone calls. Hundreds of pairs of copper were still used in the final few hundred metres of the network to deliver normal analogue lines, but for a much shorter path back to the RIM instead of all the way back to the exchange.

However the downside for the customer on a RIM is that their line is not directly connected to the telephone exchange where the providers have their ADSL2+ equipment installed (and therefore the customer is unable to get ADSL2+).

This is a potential problem in many of the population centres (six localities) in WDR in that the telephone exchange may be ADSL/ADSL2+ enabled but still households who are connected to a RIM may have no way of accessing ADSL/ADSL2+ Broadband Internet.

However, Telstra has recently addressed this problem by upgrading thousands of RIMs and installing TopHats designed to upgrade these ageing RIM cabinets and provide ADSL2+ services to thousands of people who previously did not have access to ADSL2+ services (Taylor 2012).

1.3.3 Geographical coverage of ADSL/ADSL2+ in WDR displayed in Maps

The geographical coverage of ADSL/ADSL2+ in WDR is graphically represented in a series of maps (ADSL2 Exchanges 2013). The ADSL coverage maps for the main population centres in WDR are accessible from ADSL 2 Exchange web site (www.adsl2exchanges.com.au) and show the availability of ADSL/ADSL2+ ports , the boundaries of the public telephone exchanges and the ADSL speeds on these public telephone exchanges that have been self reported by residents in these communities.

The following maps and tables show the ADSL coverage, availability of ADSL ports in telephone exchanges, surrounding population centres and their nearest exchange for each of the six localities in WDRC.

Figure 3 ADSL coverage for Dalby (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

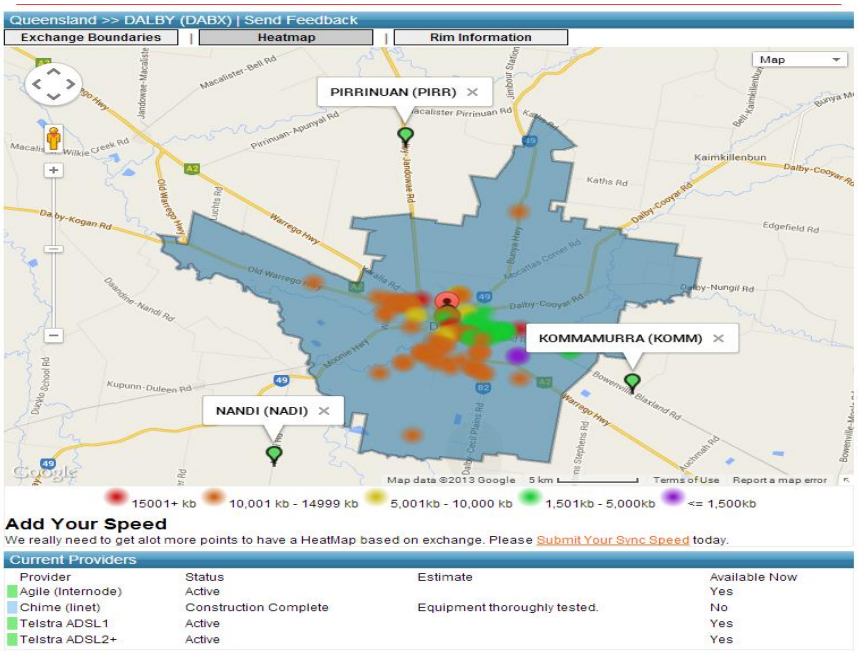


Figure 3 shows the ADSL broadband speeds that have been self reported and the current providers for the town of Dalby. Figure 3 also shows small surrounding towns with telephone exchanges which are not currently ADSL enabled (See Table 3 for more detail)

Figure 4 Availability of ADSL ports in Dalby (Source: http://www.adsl2exchange.com.au)

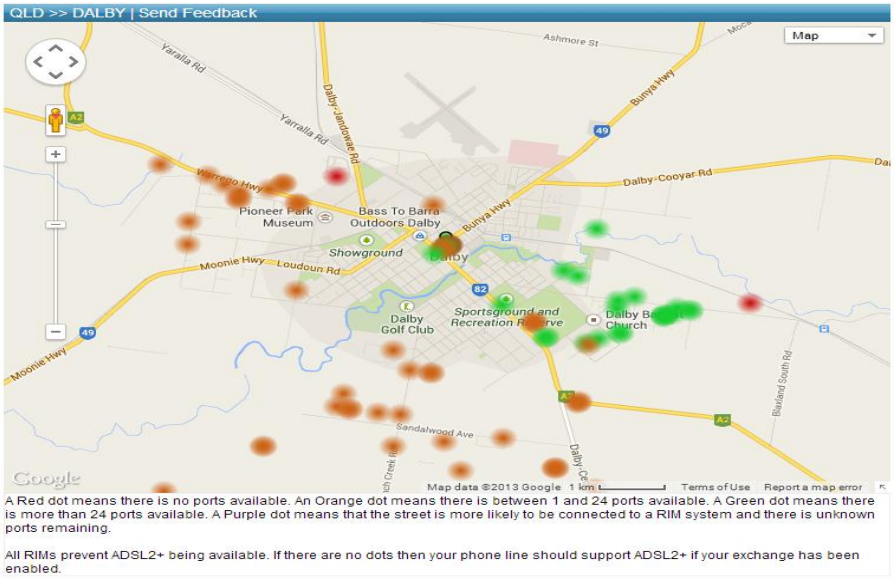


Figure 4 shows that in Dalby in different locations, the range of ADSL ports available varies from none, 1-24 to more 24.

Table 3 Surrounding population centres for Dalby and closest exchanges (Source: http://www.adsl2exchange.com.au)

Surrounding Suburbs		
Suburb	Post Code	Distance
BLAXLAND	4405	13.21 KM
PIRRINUAN	4405	17.62 KM
RANGES BRIDGE	4405	19.32 KM
TIPTON	4405	27.38 KM
ST RUTH	4405	23.55 KM
IRVINGDALE	4404	24.7 KM
KAIMKILLENBUN	4406	21.68 KM
DUCKLO	4405	25 KM
MACALISTER	4406	24.11 KM
WAINUI	4404	24.71 KM

Closest Exchanges		
Exchange	Distance	ADSL2+
DALBY	0.12 KM	Available
PIRRINUAN	14.62 KM	Planned
KOMMAMURRA	12.31 KM	Planned
TIPTON	20.98 KM	Planned
NANDI	15.36 KM	Planned

Table 3 shows the surrounding surburbs and nearest population centres relative to Dalby and the closest exchanges and whether these are ADSL/ADSL2+ enabled.

Figure 5 ADSL Coverage in Chinchilla (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

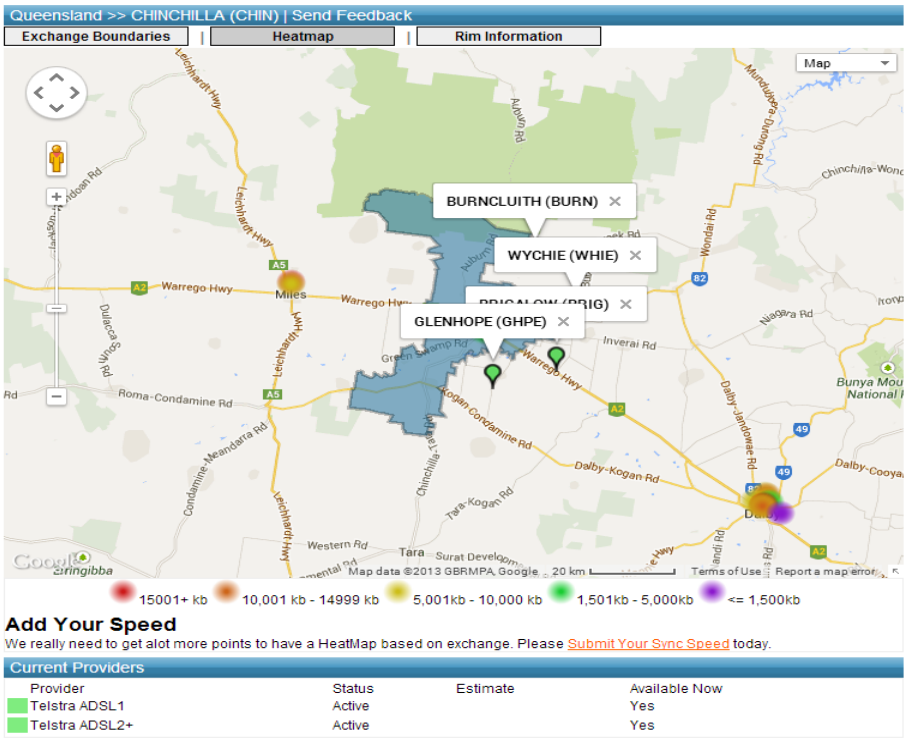


Figure 5 shows the ADSL broadband speeds that have been self reported and the current ADSL providers for the town of Chinchilla. Figure 5 also shows small surrounding towns with telephone exchanges which are not currently ADSL enabled (See Table 4 for more detail)

Figure 6 Availability of ADSL ports in Chinchilla (Source: http://www.adsl2exchange.com.au)

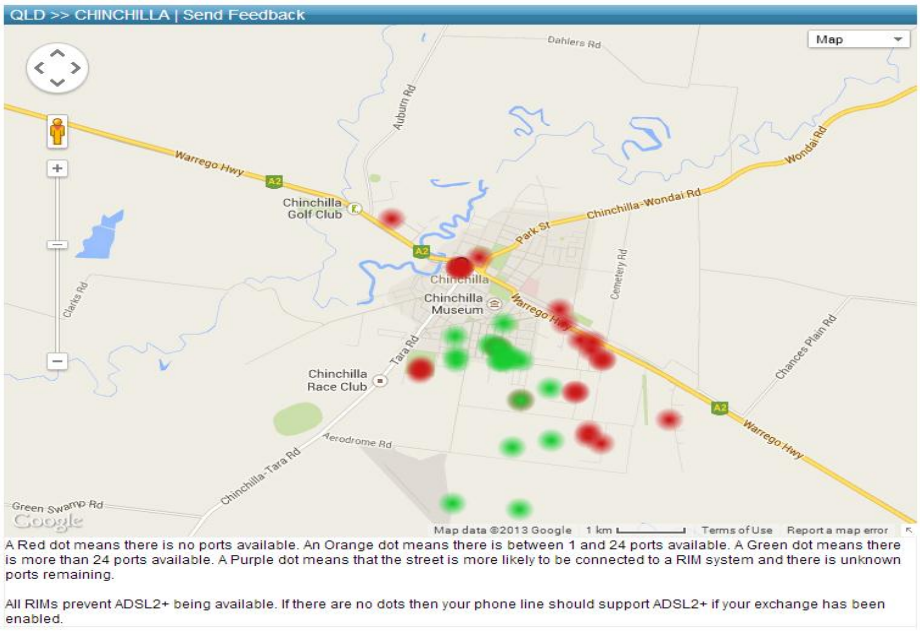


Figure 6 shows that in Chinchilla in different locations, the range of ADSL ports available varies from none, to more 24. Furthermore a large part of Chinchilla is not well serviced by ADSL/ADSL2+.

Table 4 Surrounding population centres for Chinchilla and closest exchanges (Source: http://www.adsl2exchange.com.au)

Surrounding Suburbs

Suburb	Post Code	Distance
CHANCES PLAIN	4413	10.09 KM
BAKING BOARD	4413	8.73 KM
BOONARGA	4413	11.33 KM
HOPELAND	4413	16.3 KM
BURNCLUITH	4413	14.53 KM
BRIGALOW	4412	20.11 KM
MONTROSE	4370	31.07 KM
MONTROSE	4413	31.07 KM
COLUMBOOLA	4415	30.03 KM
CANAGA	4413	30.33 KM

Closest Exchanges

Exchange	Distance	ADSL2+
CHINCHILLA	0.03 KM	Available
GLENHOPE	16.39 KM	Planned
WYCHIE	20.7 KM	Planned
BURNCLUITH	19.6 KM	Planned
BRIGALOW	20.14 KM	Planned

Table 4 shows surrounding suburbs and nearest population centres to Chinchilla and the closest exchanges and whether these are ADSL/ADSL2+ enabled.

Figure 7 ADSL Coverage in Miles (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

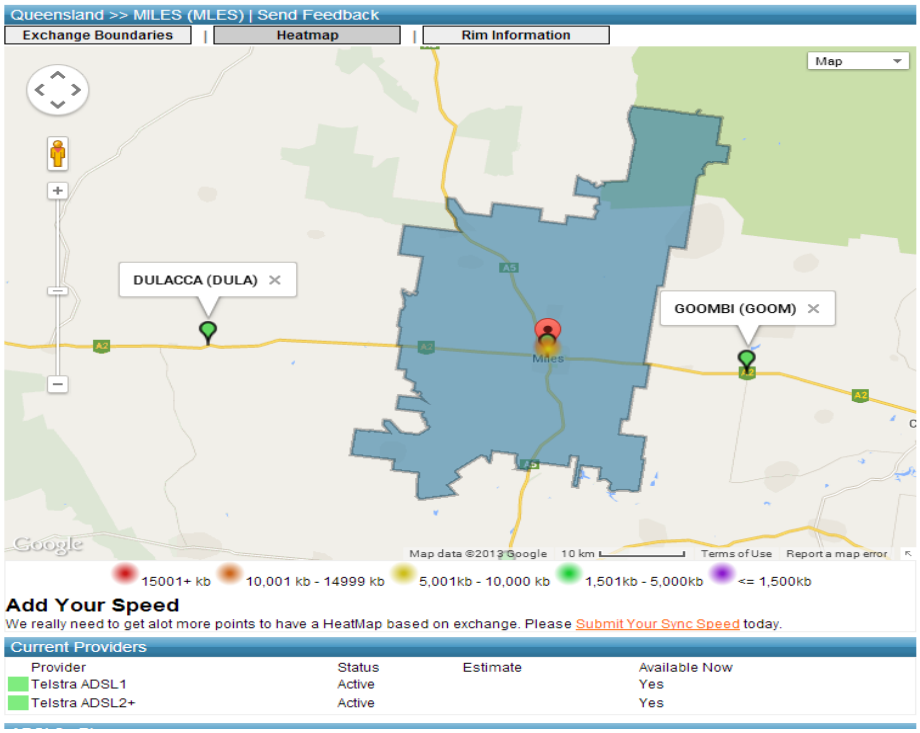


Figure 7 shows the ADSL broadband speeds that have been self reported for Miles and the current providers for Miles. Figure 7 also shows small surrounding towns with telephone exchanges which are not currently ADSL enabled (See Table 5 for more detail)

Figure 8 Availability of ADSL ports in Miles (Source: http://www.adsl2exchange.com.au)

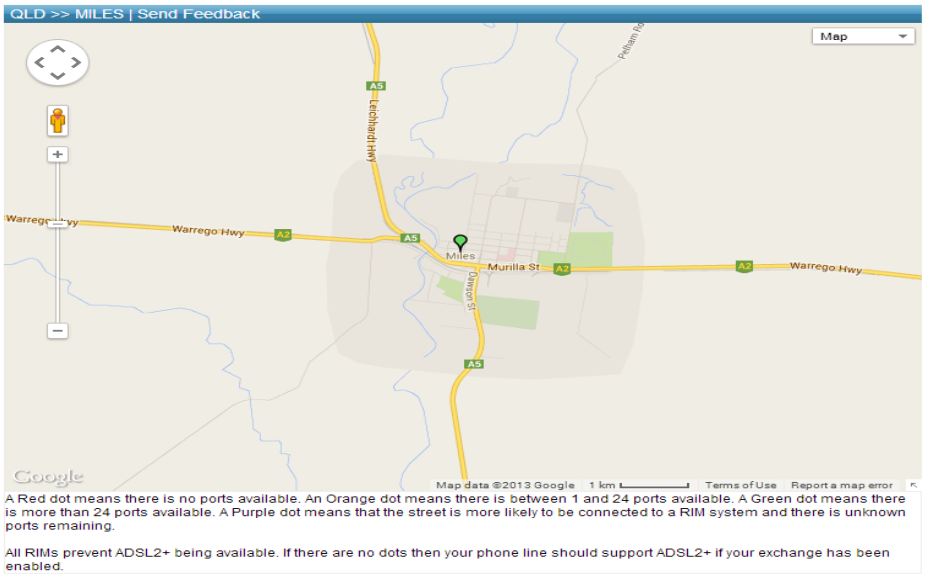


Figure 8 shows that in Miles the range of ADSL ports available has not been self reported. However we know from the previous Figure 7 that a large part of Miles is not well serviced by ADSL/ADSL2+.

Table 5 Surrounding population centres for Miles and closest exchanges (Source: http://www.adsl2exchange.com.au)

Surrounding Suburbs			Closest Exchanges		
Suburb	Post Code	Distance	Exchange	Distance	ADSL2+
MYALL PARK	4415	8.83 KM	MILES	0.07 KM	Available
DALWOGAN	4415	10.22 KM	GOOMBI	22.44 KM	Planned
COLUMBOOLA	4415	14.75 KM	CONDAMINE	30.25 KM	Available
DRILLHAM	4424	20.13 KM	DULACCA	38.25 KM	Planned
HOOKSWOOD	4415	17.93 KM	CHINCHILLA	44.7 KM	Available
KOWGURAN	4415	18.26 KM			
DRILLHAM SOUTH	4424	21.23 KM			
CONDAMINE	4416	30.29 KM			
GURULMUNDI	4415	29.75 KM			
NANGRAM	4416	29.17 KM			

Table 5 shows surrounding suburbs and nearest population centres to Miles and the closest exchanges and whether these are ADSL2+ enabled.

Figure 9 ADSL Coverage in Tara (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

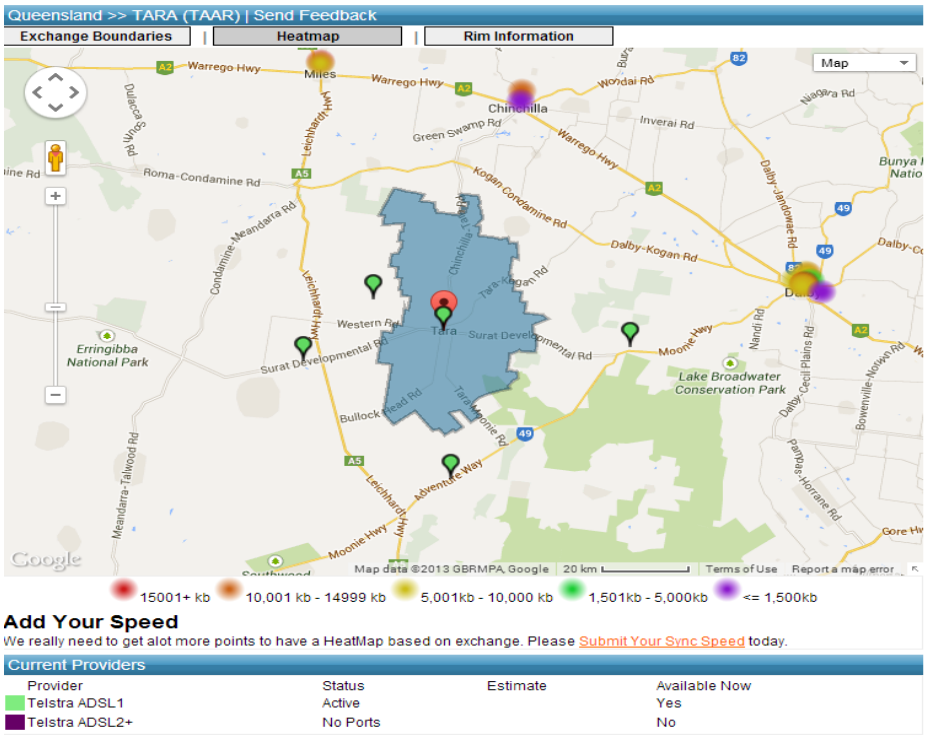


Figure 9 shows the ADSL broadband speeds that have not been self reported for Tara and the current providers for Tara. Figure 9 also shows small surrounding towns with telephone exchanges which are not currently ADSL enabled (See Table 6 for more detail)

Figure 10 Availability of ADSL ports in Tara (Source: http://www.adsl2exchange.com.au)

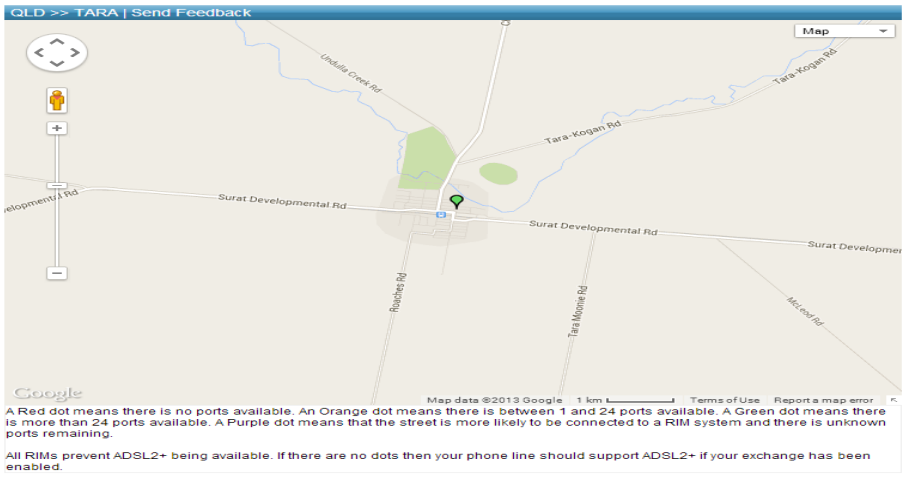


Figure 10 shows that in Tara the range of ADSL ports available has not been self reported. However we know from the previous Figure 9 that a large part of Tara is not well serviced by ADSL/ADSL2+ ports enabled in the Tara telephone exchange.

Table 6 Surrounding population centres for Tara and closest exchanges (Source: http://www.adsl2exchange.com.au)

Surrounding Suburbs			Closest Exchanges		
Suburb	Post Code	Distance	Exchange	Distance	ADSL2+
TARA STATION	4725	0.14 KM	TARA	0.06 KM	Available
GORANBA	4421	13.81 KM	BENNETT	17.76 KM	Planned
WERANGA	4405	25.85 KM	MOONIE	39.65 KM	Planned
WIEAMBILLA	4413	31.84 KM	THE GUMS	31.92 KM	Planned
THE GUMS	4406	27.89 KM	KUMBARILLA	41.36 KM	Planned
MONTROSE	4370	33.28 KM			
MONTROSE	4413	33.28 KM			
HANNAFORD	4406	40.48 KM			
MARMADUA	4405	35.22 KM			
WEIR RIVER	4406	47.95 KM			

Table 6 shows surrounding suburbs and nearest population centres to Tara and the closest exchanges and whether these are ADSL2+ enabled.

Figure 11 ADSL Coverage in Jandowae (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

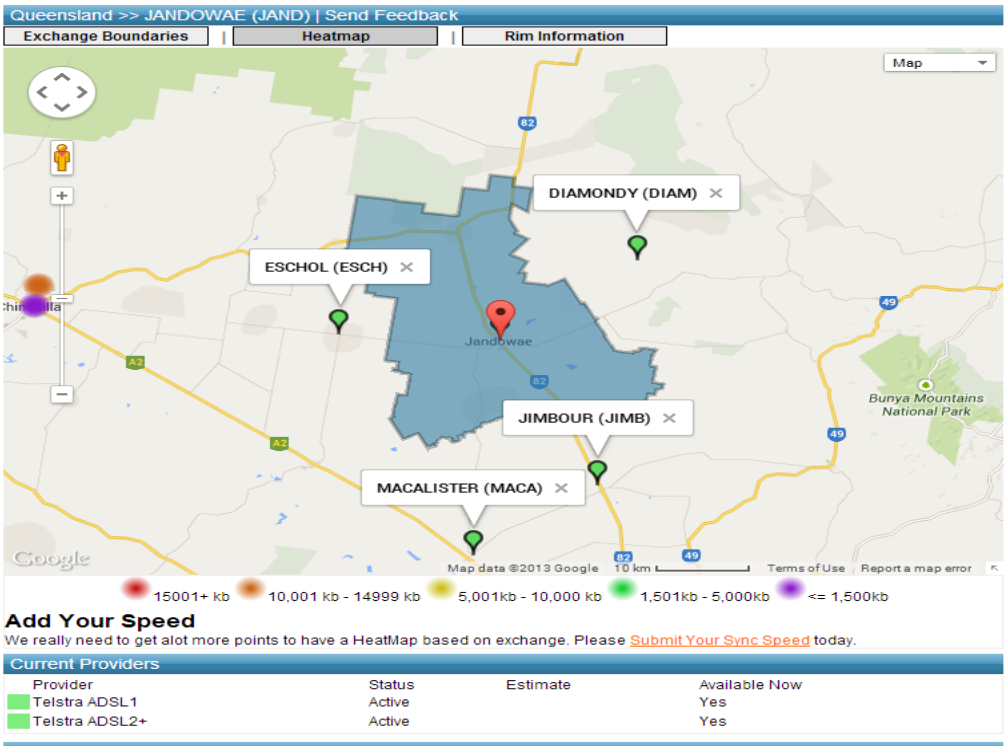


Figure 11 shows the ADSL broadband speeds that have not been self reported for Jandowae and the current providers for Jandowae. Figure 11 also shows small surrounding towns with telephone exchanges which are not currently ADSL enabled (See Table 7 for more detail).

Figure 12 Availability of ADSL Ports in Jandowae (Source: http://www.adsl2exchange.com.au)

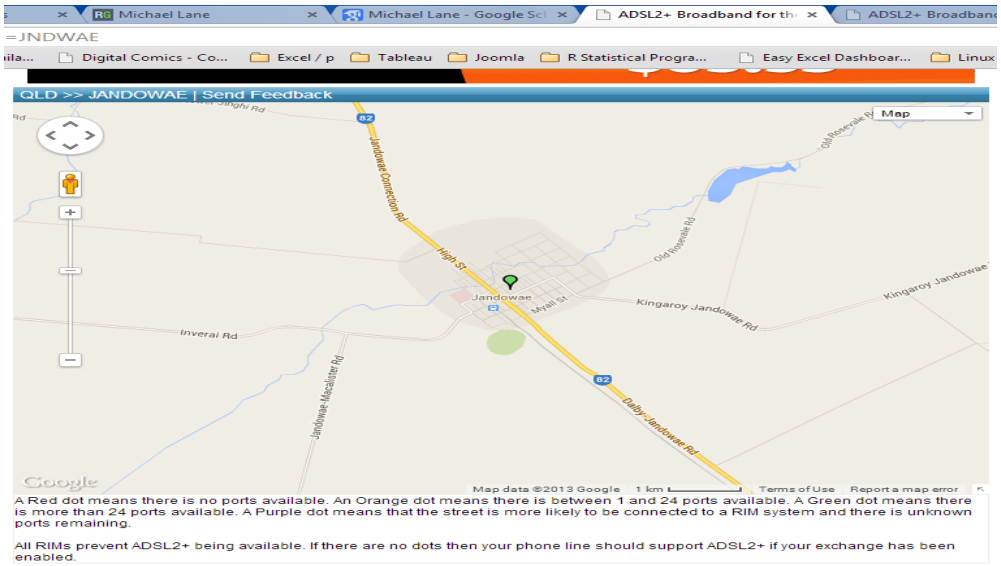


Figure 12 shows that in Jandowae the range of ADSL ports available has not been self reported. However we know from the previous Figure 10 that a large part of Jandowae is not well serviced by ADSL/ADSL2+.

Table 7 Surrounding population centres for Jandowae and closest exchanges (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

Surrounding Suburbs			Closest Exchanges		
Suburb	Post Code	Distance	Exchange	Distance	ADSL2+
MACALISTER	4406	29.41 KM	JANDOWAE	0.19 KM	Available
CANAGA	4413	22.22 KM	ESCHOL	16.38 KM	Planned
WARRA	4411	25.08 KM	DIAMONDY	17.87 KM	Planned
PIRRINUAN	4405	30.05 KM	JIMBOUR	21.85 KM	Planned
BRIGALOW	4412	32.44 KM	MACALISTER	28.83 KM	Planned
BOONARGA	4413	38.84 KM			
CHANCES PLAIN	4413	38.26 KM			
RANGES BRIDGE	4405	42.74 KM			
BOYNESIDE	4610	40.22 KM			
BELL	4408	37.58 KM			

Table 7 shows surrounding suburbs and nearest population centres to Jandowae and the closest exchanges and whether these are ADSL enabled.

Figure 13 ADSL Coverage in Wandoan (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

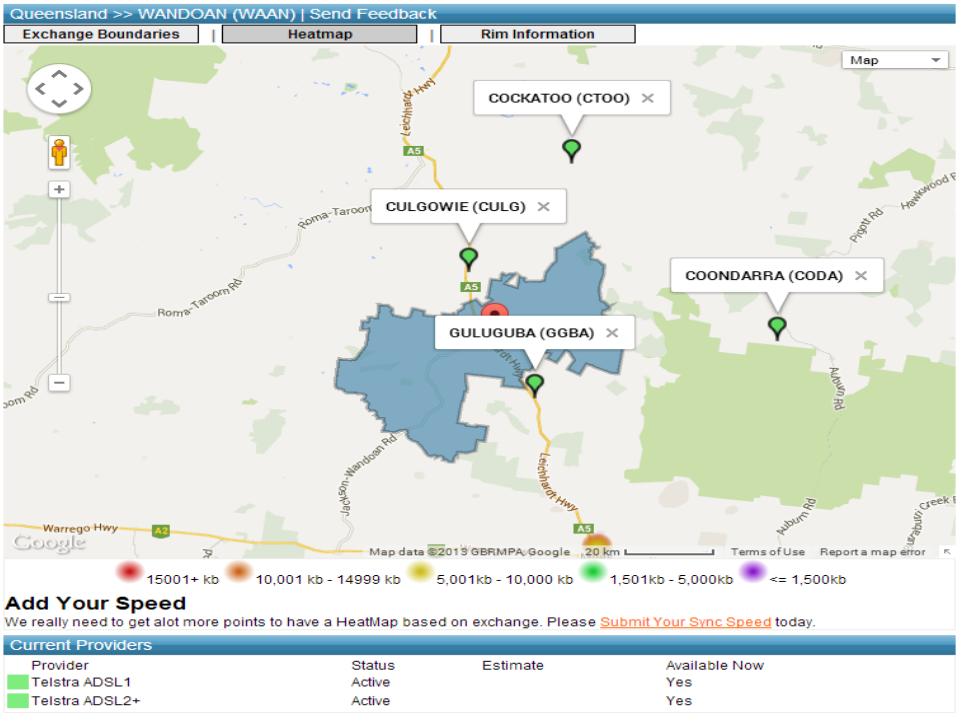


Figure 13 shows that ADSL broadband speeds have not been self reported for Wandoan telephone exchange and the current providers for Wandoan. Figure 13 also shows small surrounding towns with telephone exchanges which are not currently ADSL enabled (See Table 8 for more detail).

Figure 14 Availability of ADSL ports in Wandoan (Source: http://www.adsl2exchange.com.au)

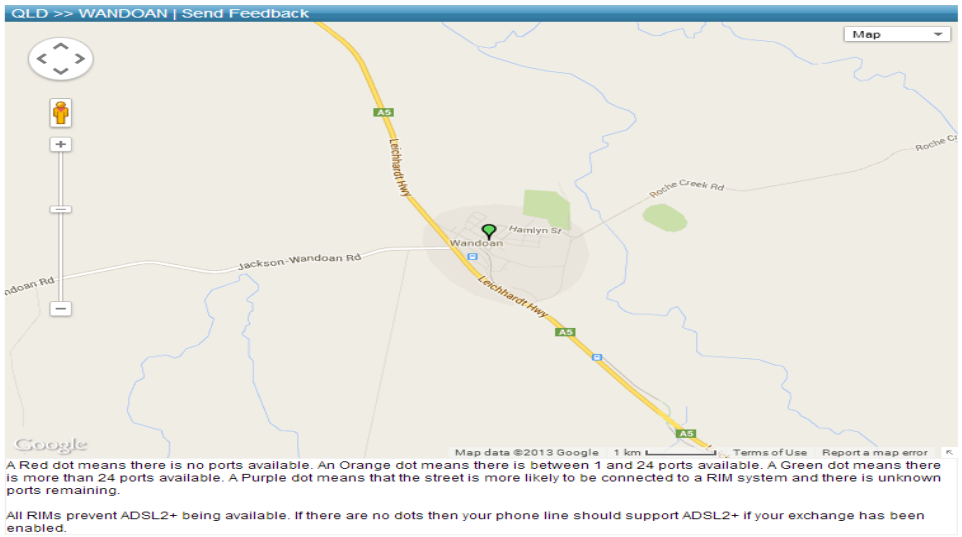


Figure 14 shows that in Wandoan the range of ADSL ports available has not been self reported. However we know from the previous Figure 13 that a large part of Wandoan is not well serviced by ADSL/ADSL2+.

Table 8 Surrounding population centres for Wandoan and closest exchanges (Blue shaded area is the extent of the telephone exchange coverage) (Source: http://www.adsl2exchange.com.au)

Surrounding Suburbs		
Suburb	Post Code	Distance
GULUGUBA	4418	17.75 KM
GROSMONT	4419	20.82 KM
GURULMUNDI	4415	34.25 KM
GLENAUBYN	4424	42.95 KM
KOWGURAN	4415	45.67 KM
DRILLHAM	4424	57.78 KM
BOGANDILLA	4425	47.55 KM
CLIFFORD	4427	59.31 KM
DALWOGAN	4415	53.5 KM
TAROOM	4420	55.87 KM

Closest Exchanges		
Exchange	Distance	ADSL2+
WANDOAN	0.12 KM	Available
GULUGUBA	17.84 KM	Planned
CULGOWIE	20.36 KM	Planned
COCKATOO	52.45 KM	Planned
COONDARRA	61.2 KM	Planned

Table 8 shows surrounding suburbs and nearest population centres to Wandoan and the closest exchanges and whether these are ADSL2+ enabled.

All of the larger population centres in WDR have some form of ADSL/ADSL2+ service. Telstra is providing most and in some towns all of the digital infrastructure required to provide ADSL/ADSL2+ services in the six main population centres of WDR. Some questions that need further investigation include:

- How well serviced are the population centres in WDR in terms of ADSL/ADSL2+? As it would appear that the smaller population centres in WDR are poorly serviced in terms of the availability of ADSL/ADSL2+ services.
- How well utilised are these existing ADSL/ADSL2+ services in WDR?
- What are the key factors inhibiting the use of ADSL/ADSL2+ services in WDR?

- Is it Cost, Digital Literacy, Lack of Available ADSL/ADSL2+ Services (Quality – speed and coverage)?

Table 8 provides a summary of two main suppliers of ADSL services and associated costs. Note other Internet Service Providers can provide ADSL/ADSL2+ services but they would be using Telstra ADSL ports in the public telephone exchange.

Table 9 Comparative costs of Big Telecos/ISPs (Telstra and Optus) for ADSL/ADSL2+

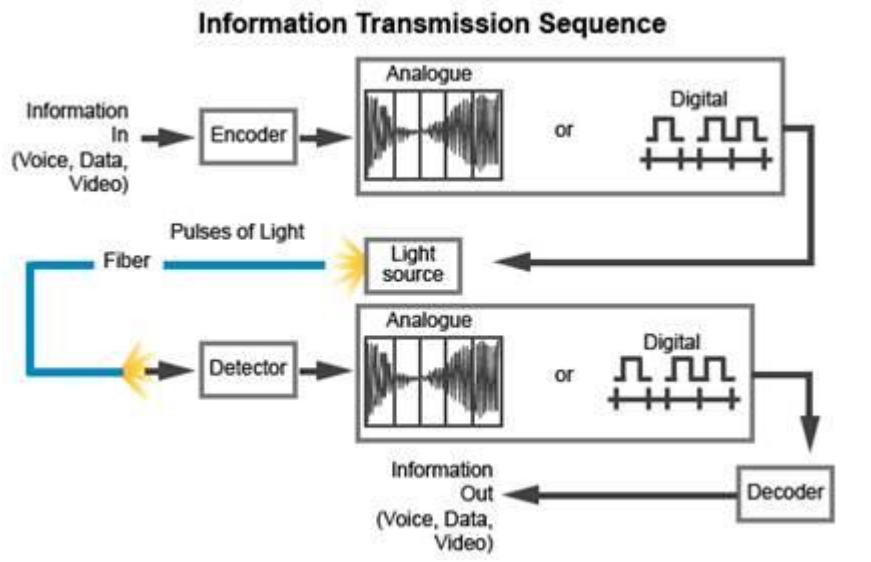
Provider (24 months contract)	Data	Cost/ month
Optus	30 GB	$55
	200 GB	$80
	Unlimited data	$100
Telstra	50 GB	$73
	200 GB	$93
	500GB	$113

1.4 Fibre Optic Networks in WDR

Fibre-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fibre. The light forms an electromagnetic carrier wave that is modulated to carry information (Wikipedia 2013d). First developed in the 1970s, fibre-optic communication systems have revolutionized the telecommunications industry and have played a major role in the advent of the Information Age. Because of its advantages over electrical transmission, optical fibre has largely replaced copper wire communications in core networks in the developed world.

The process of communicating using fibre-optics involves the following basic steps: Creating the optical signal involving the use of a transmitter, relaying the signal along the fibre, ensuring that the signal does not become too distorted or weak, receiving the optical signal, and converting it into an electrical signal (see Figure 15).

Figure 15 Information Transmission Sequence for Fibre Optic



When the first fibre optic transmission systems were developed, it was thought that the fibre optic cabling and technology would be prohibitively expensive (Poole). However, this has not been the case and costs have fallen to the extent that fibre optics now provides the only viable option for many telecommunications applications. In addition to this it is also used in many local area networks where speed is a major requirement.

Advantages of fibre optics

There are a number of compelling reasons for widespread adoption of fibre optic cabling for telecommunications applications:

- Much lower levels of signal attenuation
- Fibre optic cabling provides a much higher bandwidth allowing more data to be delivered
- Fibre optic cables are much lighter than the coaxial cables that might otherwise be used.
- Fibre optics do not suffer from stray interference pickup that occurs with coaxial cabling

Although fibre-optic systems excel in high-bandwidth applications, optical fibre has been slow to achieve its goal of fibre to the premises or to solve the last mile problem. However, as bandwidth demand increases, more and more progress towards this goal can be observed. In Japan, for instance EPON has largely replaced DSL as a broadband Internet source. South Korea's KT also provides a service called FTTH (Fibre To The Home), which provides fibre-optic connections to the subscriber's home. The largest FTTH deployments are in Japan, South Korea, and China. Singapore started implementation of their all-fibre Next Generation Nationwide Broadband Network (Next Gen NBN), which was slated for completion in 2012 and was installed by OpenNet. Optic Fibre Network coverage in Singapore reached 100% coverage nationwide in 2013.

More importantly the cost of fibre optic cabling has fallen substantially and is now one-tenth of the price it was 10 years ago while the cost of copper wire has increased substantially. Hence fibre optic networks are now a much more viable option for local area networks than was the case previously. Moreover, there are a number of existing fibre optic backbone networks in WDR which will now be discussed in turn.

Nexium Networks Fibre Optic Backbone Network

Nexium Networks which is a commercial subsidiary of Ergon provides an extensive fibre optic backbone network for key population areas in the state of Queensland. This fibre optic backbone network runs through the three main population centres (Towns of Dalby, Chinchilla and Miles) in WDR and the fibre optic backbone network can be viewed from the Nexium website http://www.nexium.net.au

Nexium (Nexium Telecommunications 2013) also work with mining companies provide telecommunications solutions that use a combination of wireless and fibre optic telecommunications infrastructure. Nexium is also a licensed reseller of satellite telecommunications services.

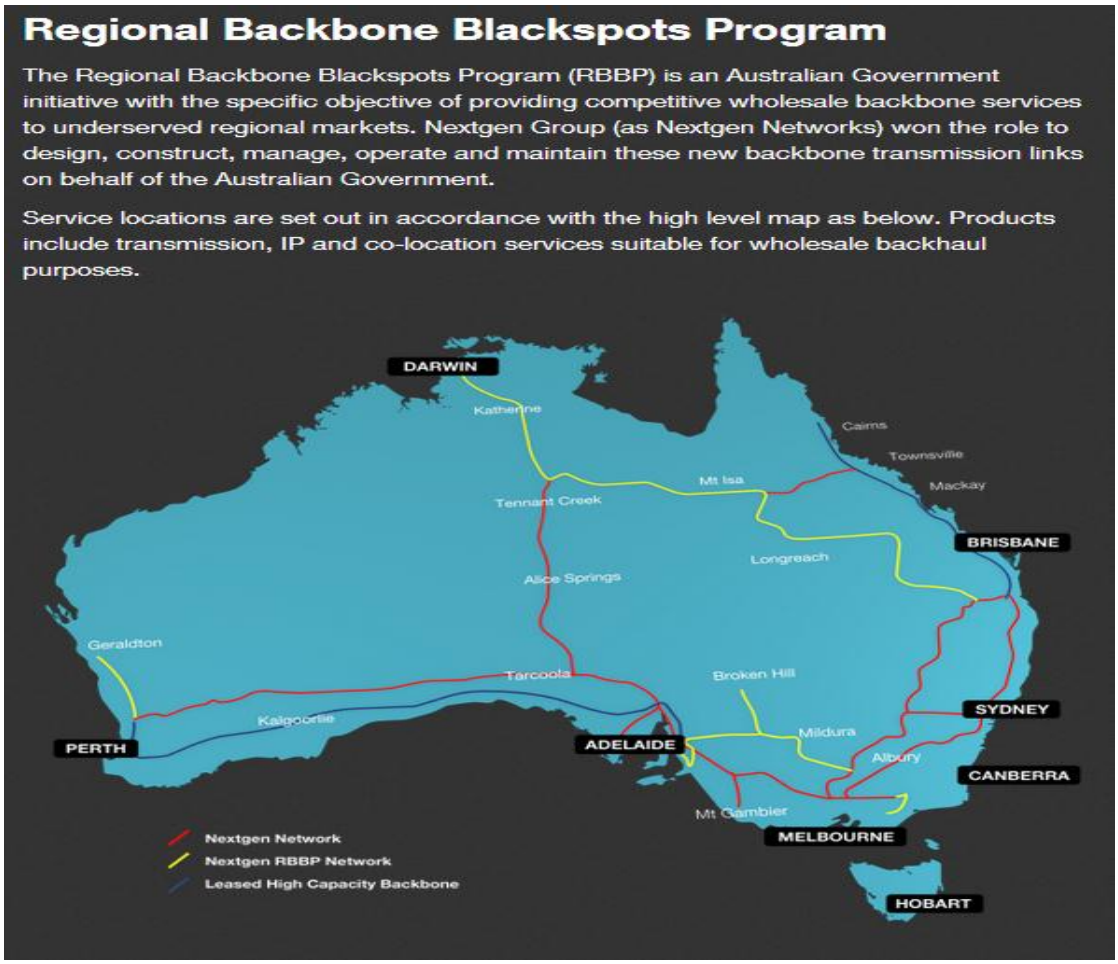
NextGen Group Fibre Optic Backbone Network

The NextGen Group also provides an extensive fibre optic backbone network for the whole of Australia including the State of Queensland and the major population centres in WDR.

The Regional Backbone Blackspots Program (RBBP) is an Australian Government initiative with the specific objective of providing competitive wholesale backbone services to underserved regional markets. Nextgen Group (as Nextgen Networks) won the role to design, construct, manage, operate and maintain these new backbone transmission links on behalf of the Australian Government (NextGen Group 2013) (See Figure 16). Service locations are set

out in accordance with the high level map as below. Products include transmission, IP and co-location services suitable for wholesale backhaul purposes.

Figure 16 NextGen Group Fibre Optic Backbone Network
(Source: http://www.nextgengroup.com.au/about/infrastructure)



Some other fibre networks in WDR have been laid by mining companies as part of their telecommunications infrastructure to connect and remotely manage the many coal seam gas wells that have been sunk in different parts of WDR. However this is commercially sensitive information that mining companies are unlikely to make public. There has been a similar occurrence in relation to private mobile data networks with mining companies such as QGC – BG group having one of the largest mobile data networks in the country but this is a private commercial network with limited access given to government only for emergency services.

1.5 Fibre Optic Network Speeds

Because the effect of dispersion increases with the length of the fibre, a fibre transmission system is often characterized by its bandwidth–distance product, usually expressed in units of MHz and km. This value is a product of bandwidth and distance because there is a trade off between the bandwidth of the signal and the distance it can be carried. For example, a common multi-mode fibre with bandwidth–distance product of 500 MHz * km could carry a 500 MHz signal for 1 km or a 1000 MHz signal for 0.5 km. Telecommunication Engineers

are always looking at current limitations in order to improve fibre-optic communication, and several of these restrictions are currently being researched.

Record speeds - Each fibre can carry many independent channels, each using a different wavelength of light (wavelength-division multiplexing). The net data rate (data rate without overhead bytes) per fibre is the per-channel data rate reduced by the FEC overhead, multiplied by the number of channels (usually up to eighty in commercial dense WDM systems as of 2008). Table 10 highlights the rapid evolution of Fibre optics and the speeds that are being achieved in test environments.

Table 10 Progress of Record Speeds achieved with Fibre Optics (Source Wikipedia 2014)

Year	Organization	Effective speed	WDM channels	Per channel speed	Distance
2009	Alcatel-Lucent (2009)	15 Tbit/s	155	100 Gbit/s	90 km
2010	NTT (2010)	69.1 Tbit/s	432	171 Gbit/s	240 km
2011	KIT (Palmer 2011)	26 Tbit/s	1	26 Tbit/s	50 km
2011	NEC (Hecdt 2011)	101 Tbit/s	370	273 Gbit/s	165 km
2012	NEC, Corning (Peach 2011)	1.05 Petabit/s	12 core fibre		52.4 km

While the physical limitations of electrical cable prevent speeds in excess of 10 Gigabits per second, the physical limitations of fibre optic networks have not yet been reached as yet. In 2013, New Scientist reported that a team at the University of Southampton had achieved a throughput of 73.7 Tbit per second, with the signal traveling at 99.7% the speed of light through a hollow-core photonic crystal fibre (Aron 2013).

In the Australian context and in light of the roll out of the NBN, Fibre optic network speeds of up to 100 mbps are readily available for end-users as can be seen in other parts of Australia where the NBN has already been rolled out. For instance in the nearby City and Business Hub of Toowoomba, the City CBD and households in East Toowoomba are already connected to the NBN. Businesses and households are able to access high speed broadband internet services with speeds up to 100 Mbps.

1.6 Wireless Cellular mobile networks (2GSM, 3G, LTE (4G))

In this section we provide a review of 2G, 3G and 4G mobile networks. The review of 2G mobile networks is historically as 3G mobile networks have become a defacto standard although many 3G mobile network services will drop back to underlying 2G or 2.5G mobile networks if 3G mobile network coverage is poor in a particular area (Telco Antennas 2013).

It has been argued that Wireless broadband will be viable alternative to FTTH in many instances (Middleton & Given 2011). Moreover Barack Obama in June 2010 highlighted wireless broadband as a major initiative and the next transformation revolution in information technology. The data available from the ABS on the different Internet access technologies tends to bear out this claim.

2G, other wise known as GSM, is standard on almost all phones (except CDMA phones in the USA). Most new phones come with quad band GSM support. A quad band GSM phone supports 850, 900, 1800, and 1900MHz. 2G is old technology and provides a fall-back position when 3G coverage and 4G coverage is unavailable.

Table 11 lists the mobile network frequencies and their general coverage nationally as at June 2013 as a first starting point to understanding coverage as provided by Telstra, Optus and Vodafone. It should be noted that the telecommunications infrastructure that underpins mobile phone networks is a fast moving field as there is increasing 4G coverage in the major towns in WDR. Table 12 lists the other telcos using these mobile networks known as virtual mobile network operators (Whirlpool 2013; Wikipedia 2013e).

Table 11 Three major mobile network operators, mobile technologies, bandwidth frequencies, subscribers and ownership

Rank	Operator	Mobile Network Generation Technology and Bandwidth Frequencies	Subscribers (in millions)	Ownership
1	Telstra Mobile	2G: GSM-900/1800 (GSM/GPRS, EDGE) 3G: 850/2100 MHz UMTS, HSPA, DC-HSPA+ 4G 1800 MHz LTE	15.1m [8] (June 2013)	Telstra
2	Optus Mobile	2G: GSM-900/1800 (GPRS, EDGE) 3G: 900/2100 MHz UMTS, HSDPA, DC-HSPA+ 4G: 1800 MHz FD-LTE, 2300 MHz TD-LTE	9.53m [9] (June 2013)	Singapore Telecommunications
3	Vodafone	2G: GSM-900/1800 (GPRS, EDGE) 3G: 850/900/2100 MHz UMTS, HSDPA, DC-HSPA+ 4G: 1800 MHz LTE	5.614m [10] (Jun 2013)	Vodafone (50%) Hutchison Telecom (50%)

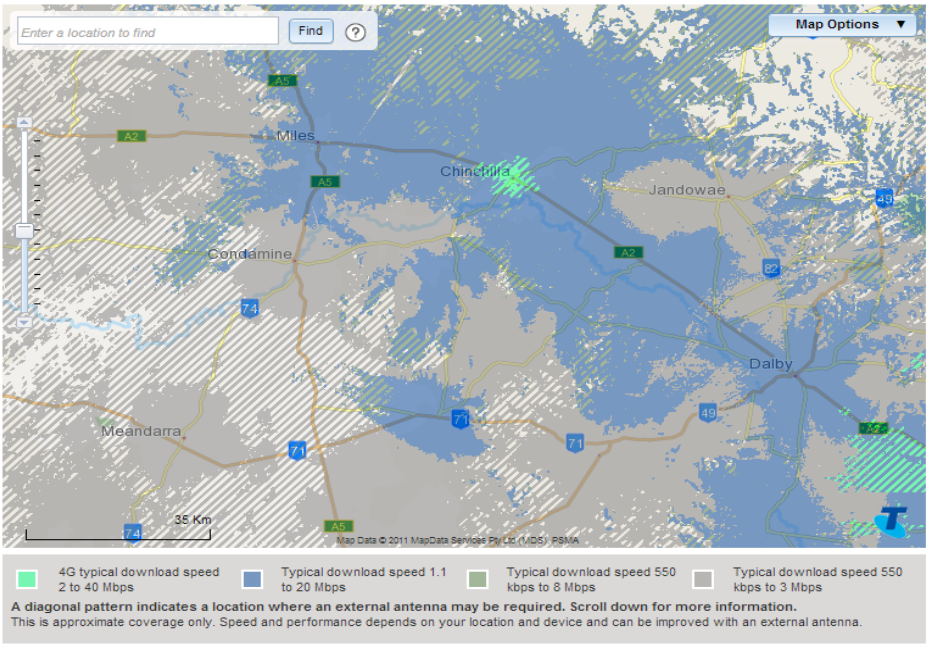
Table 12 Telstra, Optus and Vodafone Resellers - Mobile Virtual Network Operators (MVNO)

	MVNOs
Telstra Resellers (MVNO's)	Currently Boost Mobile is the only reseller of the full Telstra Next-G network. Kogan and Aldi Mobile resell part of the Telstra Next-G network, but connections are limited to HSPA 7.2Mbps, and only a limited number of cell towers resulting in 97% coverage.
Optus Resellers (MVNO's)	Amaysim, Austar, Boost Mobile, ClubTelco, Dodo, Exetel, iiNet, Internode, Live Connected, ONEmobile, People Telecom, Pivotel, Primus, Soul, TPG, Virgin Mobile, Woolworths Mobile.
Vodafone Resellers (MVNO's)	Crazy Johns, GoTalk, JustMobile, Lebara Mobile, Red Bull Mobile, Revolution Telecom, Reward Mobile.

1.6.1 Mobile network coverage 2G, 3G and 4G by Telstra, Optus, Vodafone in WDR

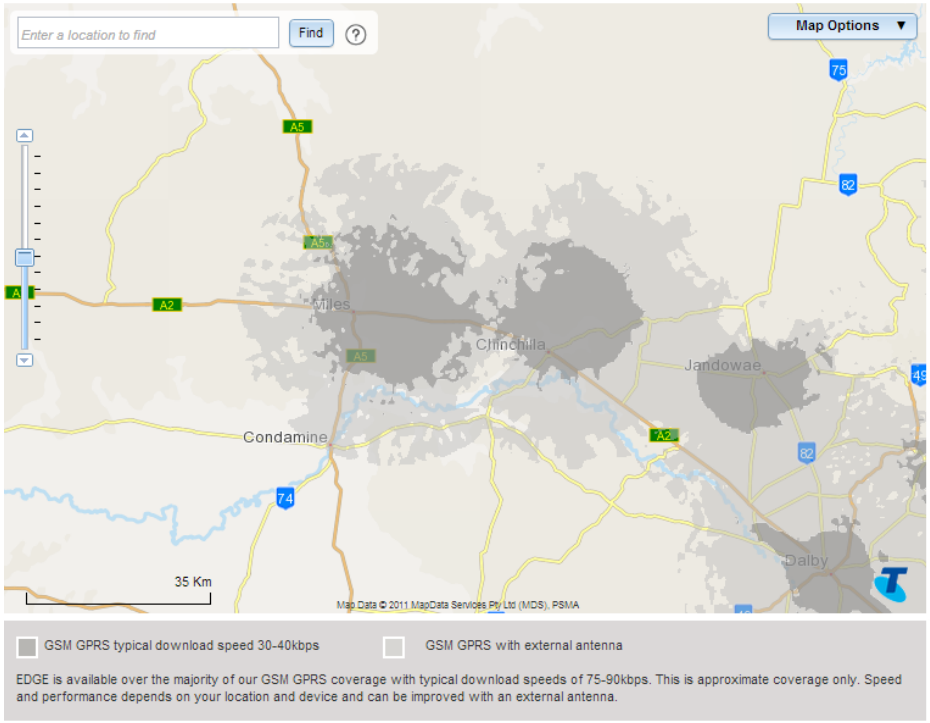
This section provides an overview of the mobile network coverage by the three key mobile network operators in Australia – Telstra, Vodafone and Optus.

Figure 17 Telstra 3G and 4G mobile network coverage of WDRC (Source: http://www.telstra.com.au/mobile-phones/coverage-networks/our-coverage/)



From Figure 17 it is quite apparent that there is a quite extensive 3G mobile network coverage provided by Telstra but 4G mobile network coverage is presently limited to major towns in WDR such as Dalby Chinchilla and Miles.

Figure 18 Telstra 2G GSM Mobile network coverage (Source: http://www.telstra.com.au/mobile-phones/coverage-networks/our-coverage/)



Similarly the 2G mobile network and related GPRS coverage is extensive as shown in Figure 19 but limited to the main population areas and main traffic routes in WDR.

Figure 19 shows the Optus 2G mobile phone network coverage in WDR. The Optus 2G mobile network coverage in WDR is quite limited compared to Telstra's 2G coverage as large parts of WDR have no Optus 2 mobile network coverage.

Figure 19 Optus 2G GSM Mobile Network Coverage
(Source: https://www.optus.com.au/network/mobile/coverage)

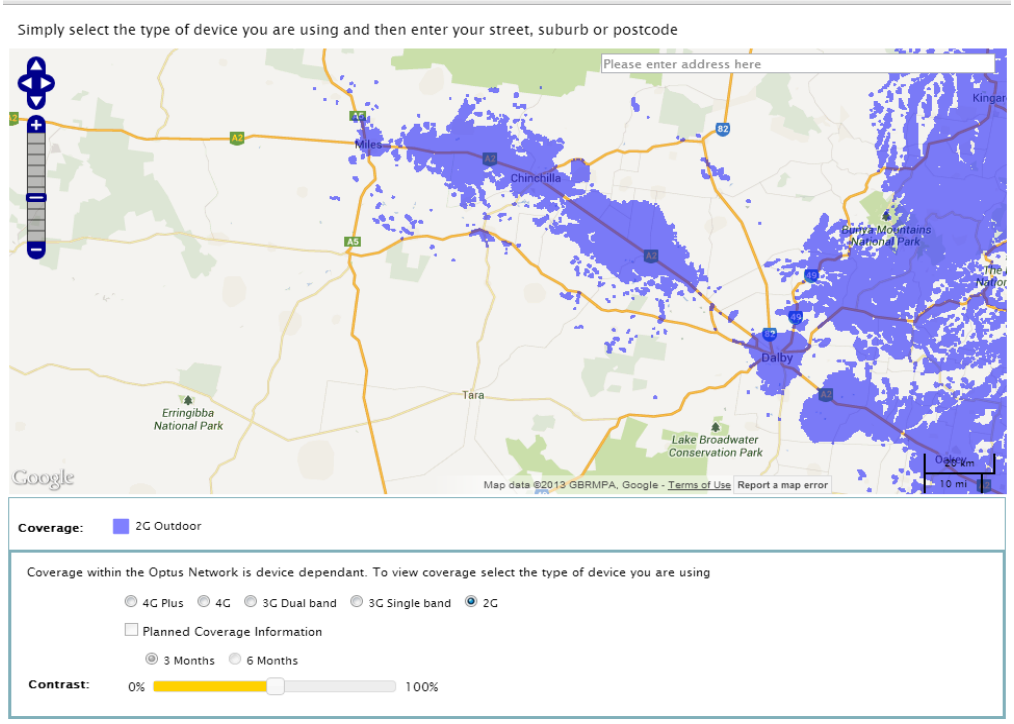
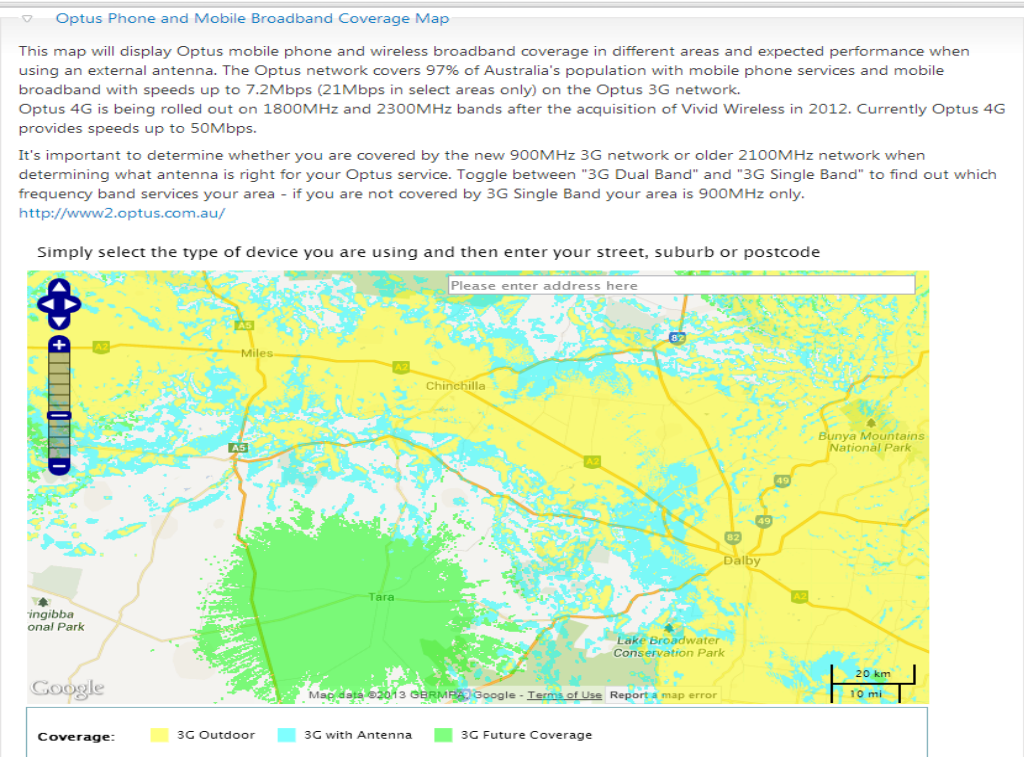


Figure 20 shows the Optus 3G and planned 4G mobile network coverage for WDR. Again the coverage is quite limited compared to Telstra's 3G and 4G mobile phone network coverage in WDR.

Figure 20 Optus 3G and 4G Mobile Network Coverage
(Source: https://www.optus.com.au/network/mobile/coverage)



Similarly Figure 20 show that Optus's 3G mobile network has a reasonable coverage across the three main population centres in WDR however areas such as Tara are yet to be covered by their 3G mobile network in the future. The Optus 3G mobile phone network coverage indicates that significant outlying areas require an antenna to get a reasonable 3G mobile phone signal.

Figure 21 Vodafone 2G GSM Mobile Network Coverage

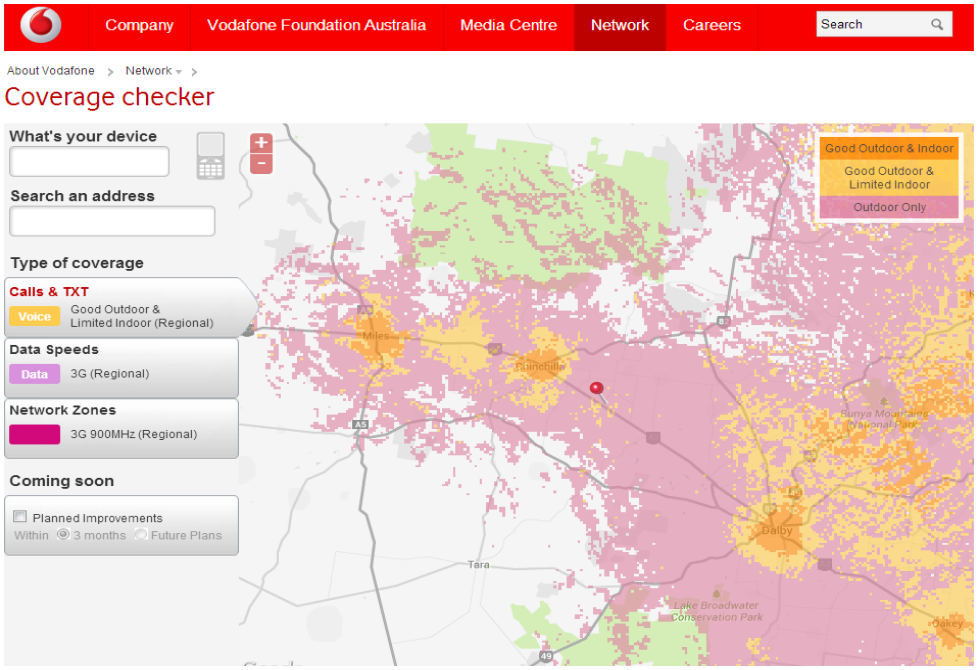


Figure 22 Vodafone 3G and 4G Mobile Network Coverage

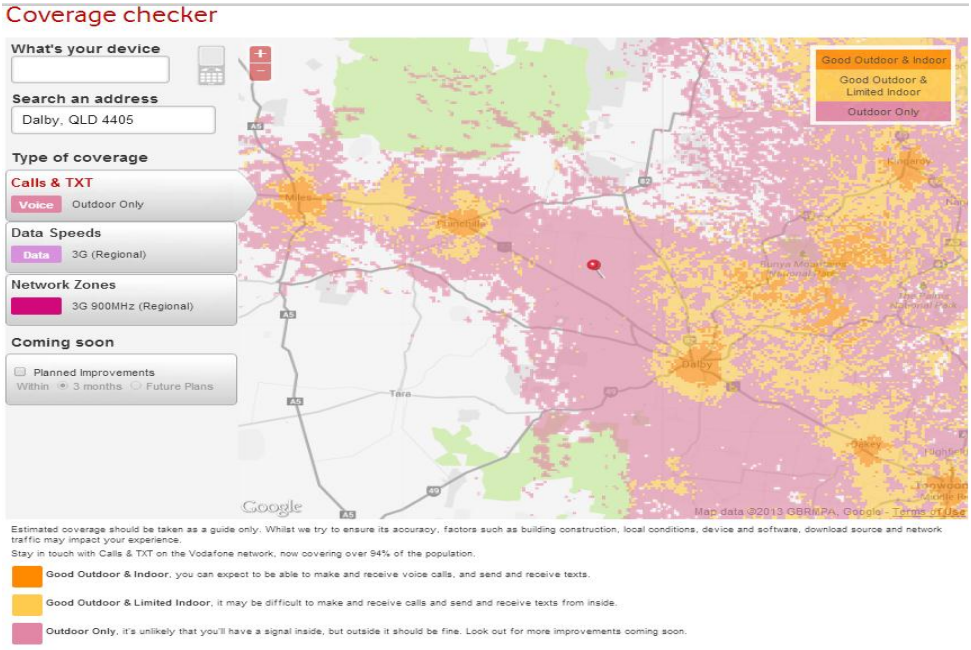


Figure 21 shows Vodafone's 2G coverage while Figure 22 shows the coverage of Vodafone's 3G mobile network coverage in WDR. Note currently Vodafone has not rolled out a 4G mobile network in WDR. Figure 22 paints a similar story to the coverage of the Optus 3G mobile phone network. Coverage is limited to three main population centres in WDR and the transport route linking Dalby, Chinchilla and Miles, the Warrego Highway. Outside of this, the mobile phone signal might only be accessible outdoors or antennas are required to get a useful signal.

Table 13 shows the comparative costs for Telstra and Optus mobile broadband internet services.

The populated areas of WDR are generally well serviced by mobile phone networks although the coverage of the Optus and Vodafone mobile phone networks is not where as extensive as Telstra's NextG mobile phone network. Overall the coverage of Telstra would appear to be far superior across WDR in comparison to Optus and Vodafone who are sharing mobile network infrastructure.

In rural areas the signal strength of mobile networks can be problematic and can be enhanced with a directly coupled car kit and an external antenna or with a patch lead and an external antenna. Furthermore wireless broadband is not robustly competitive and features high barriers to entry (Economides 2011). Scarcity of electromagnetic spectrum and very significant network investments limit the number of viable wireless competitors as is evidenced in the Australian market place and more specifically in WDR (ACMA 2014). The following questions are raised in relation to mobile phone networks in WDR.

- Is WDR adequately covered by these three key 3G/3.5 Mobile Phone Networks?
- How reliable are these mobile phone networks in WDR particularly the 3G/3.5G Mobile Phone Networks?

- Is the cost of subscribing to one of these Mobile Phone Networks prohibitive?

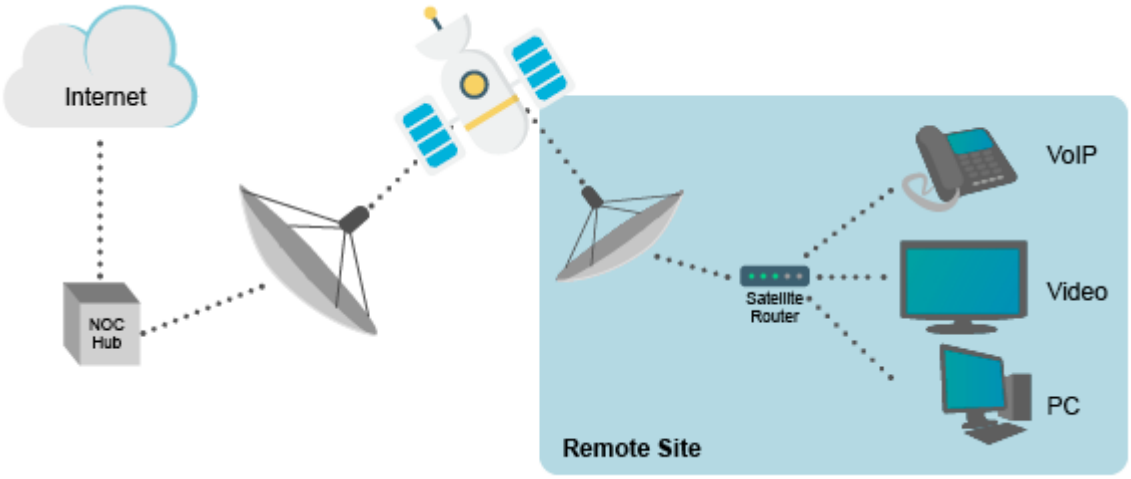
Table 13 Comparative costs of Big Three Telecos/ISPs for mobile broadband internet services

Provider (24 months contract)	Data	Cost/month
Optus	1 GB	$20
	4GB	$30
	7GB	$45
	10 GB	$60
Telstra	1 GB	$25
	4 GB	$35
	8GB	$50
	15GB	$95
Vodafone	2.5 GB	$20
	4GB	$30
	8GB	$45

1.7 Wireless Satellite interim service provided by NBN Co

WDR is already covered by the wireless satellite interim service provided by the NBN Co. This satellite interim service is available to people living in remote areas and who do not have access to wired broadband internet or mobile broadband internet. Figure 23 provides an overview of satellite broadband architecture and the flow of data from the internet to the end user.

Figure 23 Flow of data in Satellite Broadband Internet



Satellite Internet has the ability to transmit and receive data from a relatively small satellite dish on Earth and communicate with an orbiting geostationary satellite 22,300 miles above Earth's equator (Ground Control: Global Satellite Internet Solutions 2013). The orbiting satellite transmits (and receives) its information to a location on Earth called the Network Operations Centre or NOC (pronounced "knock"). The NOC itself is connected to the Internet (or private network), so all communication made from a satellite dish connection to the Internet must flow through the NOC. Data communication via satellite is not much

different than someone using a land based data provider, at least from the end-users standpoint. However some hardware such as the satellite router will be different.

NBN Co has introduced an Interim Satellite Service for premises across mainland Australia and Tasmania that previously had limited access to broadband. This service is designed to provide a transition from the Australian Broadband Guarantee (ABG) program previously managed by the Department of Broadband Communications and Digital Economy (NBN Co 2012).

People in homes, small businesses, Indigenous communities, not-for-profit organisations and educational, health and local government facilities in some of the most remote areas of Australia are among the first users of a new high-speed satellite service provided over the National Broadband Network.

NBN Co's Interim Satellite Service was launched 1st July 2011 and has been available to eligible individuals, small businesses, not for profit organisations and Indigenous communities on the mainland and across Tasmania, with the first priority being given to those eligible customers who currently have no alternate access to commercial broadband services. From 1st July 2012, eligible educational, health and local government facilities were also able to access the service.

Eligible end users will need to order broadband services from a participating retail service provider. A list of registered retail service providers offering services is now available. Therefore any one in WDRC filling the criteria for an eligible end user for NBN Co's interim satellite service would be able to apply for access to this alternative broadband internet service.

The Broadband Service Locator will also indicate whether a location is eligible for an NBN Co Interim Satellite Service. The Broadband Service Locator tool also provides a service registration process for eligible customers.

Premises that are in remote areas that do not have access to metro-comparable broadband services may be eligible to receive NBN Co's Interim Satellite Service.

Priority one eligible customers are those who have never had an ABG service and according to the Broadband Services Locator (BSL), do not have access to a metro-comparable broadband service,

Priority two eligible customers, according to the Broadband Services Locator (BSL), do not have access to a metro-comparable broadband service, but have a working ABG service that was connected more than three years ago or have lost their ABG service through no fault of their own.

Full eligibility rules are outlined in the Eligibility Criteria document for N Co's Interim Satellite Broadband Internet which is downloadable from: http://www.nbnco.com.au/content/dam/nbnco/documents/eligibility-criteria-interim-satellite-service.pdf

Metro-comparability

Metro-comparability ensures that:

Broadband services that are comparable to metro services will have the following features:

- Access to the internet at a peak data speed of at least 512/128 kbps and 3GB per month usage allowance (with no restrictions within these limits on downloads or uploads or usage time);
- Costing the consumer, over three years of no more than $2500 including equipment, installation, connection, account establishment, travel costs and ongoing provision of the service; and
- The retailer offering the broadband service can install the service within a reasonable period of time.

Cost of interim satellite service:

Under the interim satellite service, the satellite equipment and standard installation will be provided by NBN Co, via retail service providers.

NBN Co is an open-access wholesale provider; this means customer does not buy interim satellite services directly from NBN. Instead, they buy from registered retail service providers. NBN provides the network upon which these companies are able to deliver services to retail customer.

As an open-access wholesaler, NBN Co cannot offer retail pricing advice. Table 12 lists the retail satellite service providers for the NBN satellite interim service.

Table 14 NBN Co List of Retail Satellite Service Providers

Service provider	Phone	Website
Activ8me	1800 804 410	www.activ8me.net.au
ANT	1300 886 230	www.antcom.com.au
Bordernet	1300 73 03 02	www.bordernet.com.au
Clear Networks	1300 855 215	www.clearnetworks.com.au
Harbour ISP	1300 366 169	www.harbourisp.com.au
iiNet	1300 455 806	www.iinet.net.au
IPSTAR Australia	1800 477 827	www.ipstaraustralia.com
Reachnet	1300 798 007	www.reachnet.com.au
*SkyMesh	1300 TRY NBN (1300 879 626)	www.skymesh.com.au
TransACT	13 30 61	www.transact.com.au
Westnet	1300 455 806	www.westnet.com.au

1.8 WiMax

WiMAX (Worldwide Interoperability for Microwave Access) is a wireless communications standard designed to provide 30 to 40 megabit-per-second data rates, (Weinschenk 2010) with the 2011 update providing up to 1 Gbit/s for fixed stations. WiMAX is a technology standard for long-range wireless networking. WiMAX equipment exists in two basic forms - base stations, installed by service providers to deploy the technology in a coverage area, and receivers, installed in clients (Mitchell 2013). WiMAX supports several networking usage models:

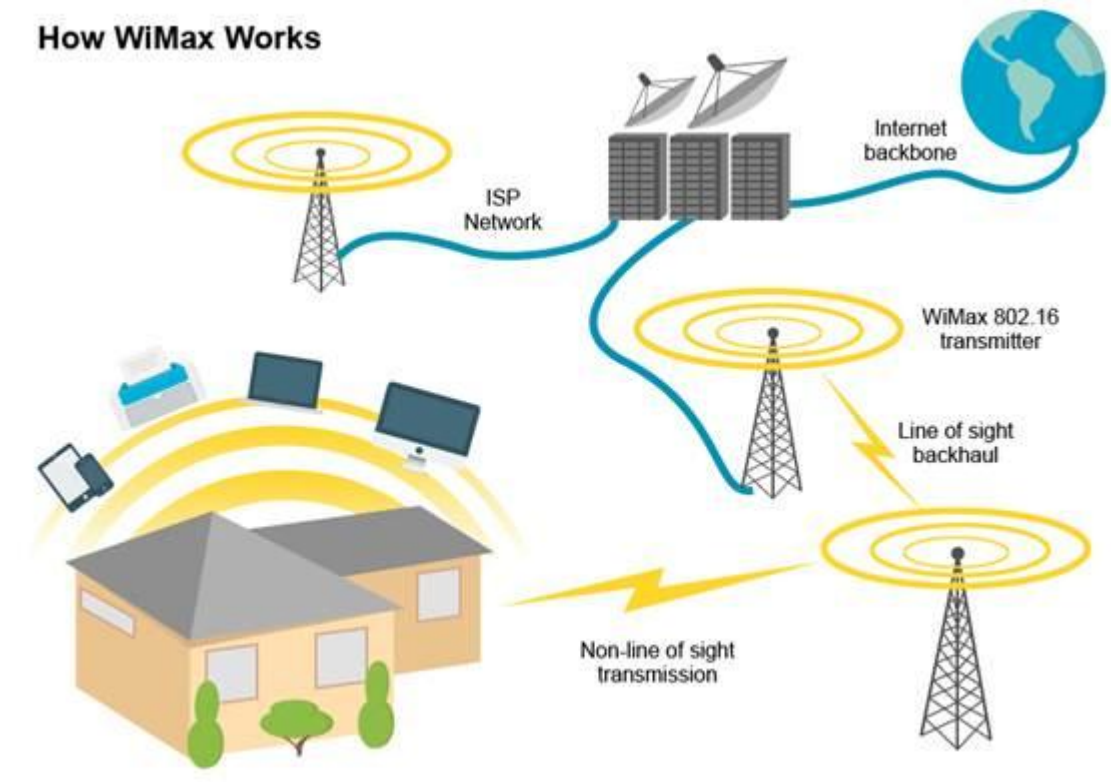
1. a means to transfer data across an Internet service provider network, commonly called backhaul)

2. a form of fixed wireless broadband Internet access, replacing satellite Internet service

3. a form of mobile Internet access that at one time competed directly with LTE technology

While at one time WiMAX was envisioned to be a leading form of Internet communications across all three of the areas above, it's adoption has been limited (Mitchell 2013). Figure 23 shows how WiMAX works as means to transfer data across an ISP's network and as a form of fixed wireless broadband internet access.

Figure 24 How WiMAX works in delivering broadband Internet access



WiMAX is developed by an industry consortium, overseen by a group called the WiMAX Forum. The Forum certifies WiMAX equipment to ensure it meets the technology standards. Its technology is based on the IEEE 802.16 set of wide-area communications standards. WiMAX signals can function over a distance of several miles (kilometres) with data rates

reaching up to 75 megabits per second (Mb/s). A number of wireless signalling options exist ranging anywhere from the 2 GHz range up to 66 GHz.

Primarily due to its much higher cost, WiMAX is not a replacement for Wi-Fi home networking or Wi-Fi hotspot technologies.

There are no mobile network operators providing WiMAX broad internet services in WDR at this point in time.

Table 15 summarises the spectrum of broadband technologies available in terms of transmission media, connection, peak speed and practice distance for which each of these technologies can be deployed.

Table 15 Broadband technologies in term of media, connection, peak speed and practical distance

Service Type	Physical connection	Connection type	Household gadget	Peak Speed range	Practical Distance
ADSL	Copper wire	Telephone plug	ADSL modem	0.5Mbps – 24Mbps	400m – 4km
HFC Cable	Coaxial Cable	Customer Access Unit	Cable modem	0.5Mbps – 100Mbps	100km
WiFi	Public spectrum	Antenna	Wireless adaptor	0.5Mbps – 50Mbps	180 m
WiMAX	Licensed/Public Spectrum	Antenna	WiMAX modem	10 Mbps	30 km
Satellite	Licensed spectrum	Antenna	Satellite modem	1 Mbps – 12 Mbps	National
3G	Licensed spectrum	Internal antenna	Dongle / 3G modem	100 Kbps – 3 Mbps (real-world average)	5 km
4G	Licensed spectrum	Internal antenna	Dongle / 4G modem	50Mbps – 5 Mbps	????
FTTP	Fibre-optic cable	Termination unit	Gateway / router	100 Mbps – Gbps	20 km
FTTN	Fibre-optic cable / copper wire	Telephone plug	ADSL Modem	25 Mbps	500 m – 1km

1.9 Key findings regarding existing telecommunications technologies

There is significant existing digital (telecommunications) infrastructure in WDR in terms of wired and wireless technologies. WDR is extensively covered by the PSTN, 3G mobile networks and NBN Co interim satellite. These digital infrastructure potentially have capability to deliver broadband internet services via ADSL/ADSL2+ and 3G and more recently 4G mobile broadband for the majority of residents in WDR. However these networks currently are lacking due to the state of the copper network and backhaul capacity of 3G and 4G mobile broadband networks to support the data traffic of users. The reach of

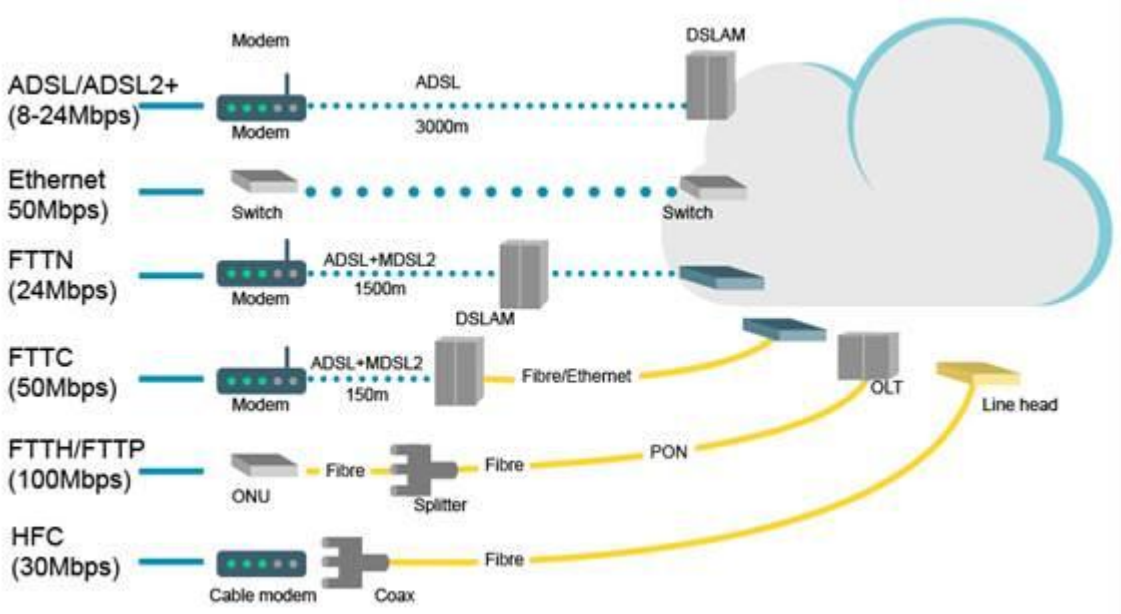
satellite broadband internet is ubiquitous across WDR but is limited to remote residents who do not have access to ADSL/ADSL2+ or 3G mobile broadband internet. Moreover there is already significant backbone network in terms of at least two fibre optic backbone networks running through the three main population centres of WDR (Dalby, Chinchilla, Miles). There are other fibre networks in WDR that have laid by mining companies but these are closed proprietary networks which does not help the current situation of a lack of reliable high speed broadband internet services across WDR. Hence many of the residents of WDR have access to broadband internet but these services are not reliable and/or do not have adequate broadband download and upload speeds. Wireless is a great complementary technology for deployment alongside fast fixed networks, and is also useful for delivering broadband to a small number of users in remote areas (NBN Myths 2011). But it is incapable of doing so in densely populated urban areas. Furthermore, there are a number of sound arguments as to why wireless broadband will not be a replacement technology for fixed wired broadband. These include the following:

- Physical limitations prevent practical wireless speeds from approaching those available over fibre-optic cables
- There is insufficient radio spectrum to allow wireless to replace fixed networks
- To even partially overcome the above limitations, we would need to build over 75,000 new mobile transmission towers across Australia
- Wireless network connections are prohibitively expensive, typically being 3-4 times more expensive than wired network connections, for less data volume and at a much slower speed (NBN Myths 2011).

2 Proposed digital infrastructure to be delivered by Coalition NBN Co

With the recent release of the NBN: Strategic Review Report it is apparent the NBN will now use a combination of high speed broadband technologies as shown in Figure 25 Fibre X Architecture (ADC Krone 2009) (NBN CO 2103) and also including fixed wireless broadband Internet and satellite broadband internet (NBN CO 2103).

Figure 25 Fibre X Architecture – FTTN, FTTC, FFTH/FTTP



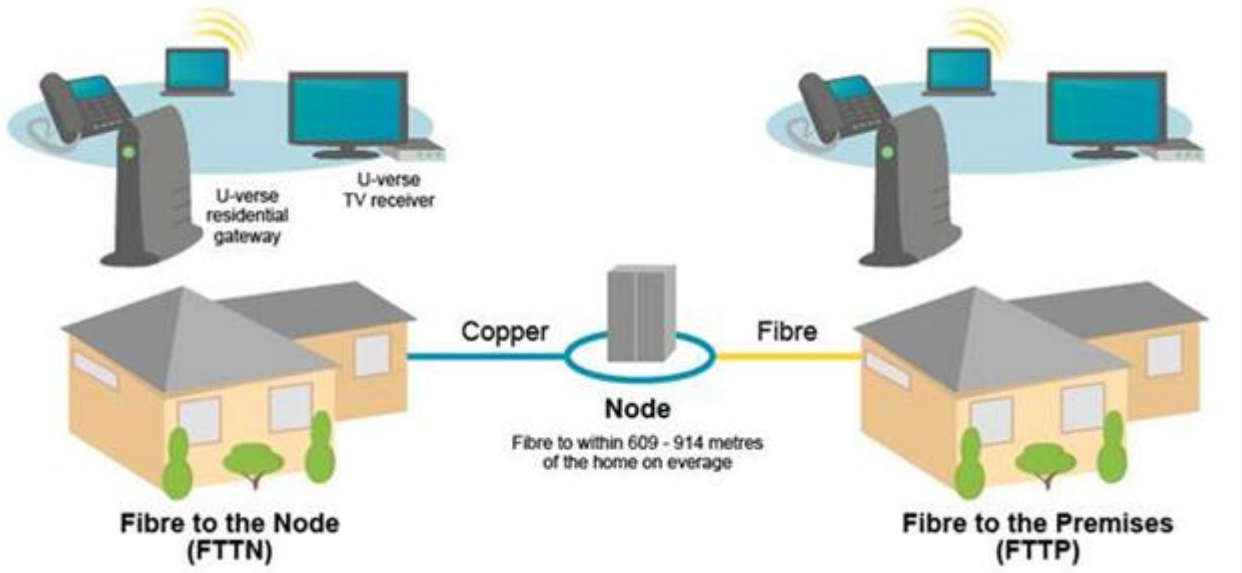
2.1 Wired Fibre optic high speed broadband to home/node

The NBN Co under the coalition will focus on rolling out Fibre to the Node, while honouring any existing contracts to roll out Fibre to the Home in phase 1 and phase 2 roll outs of the NBN. The Fibre to the Node option will require the NBN Co to negotiate an agreement with Telstra to access its copper network.

Fibre to the node or neighbourhood (FTTN), is sometimes identified with and sometimes distinguished from fibre to the cabinet. FTTN is a telecommunication architecture based on fibre-optic cables run to a cabinet serving a neighbourhood (see Figure 26). Customers typically connect to this cabinet using traditional coaxial cable or twisted pair wiring. The area served by the cabinet is usually less than one mile in radius and can contain several hundred customers. (If the cabinet serves an area of less than 1,000 ft (300 m) in radius, the architecture is typically called FTTC/FTTK.)

FTTN allows delivery of broadband services such as high speed internet. High speed communications protocols such as broadband cable access (typically DOCSIS) or some form of digital subscriber line (DSL) are used between the cabinet and the customers. The data rates vary according to the exact protocol used and according to how close the customer is to the cabinet.

Figure 26 Fibre to the Node versus Fibre to the Premises



Unlike FTTP, FTTN often uses existing coaxial or twisted-pair infrastructure to provide last mile service and is thus less costly to deploy. In the longer term, however, its bandwidth potential is limited relative to implementations that bring the fibre still closer to the subscriber.

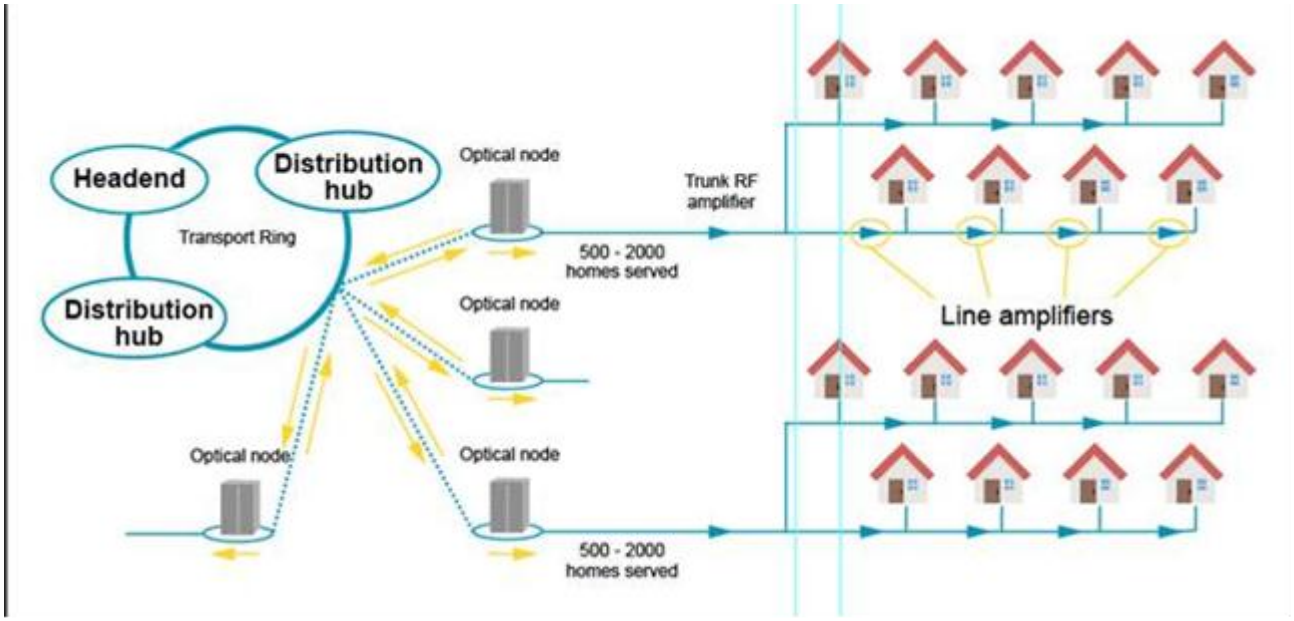
Interestingly NBN Co will also use Hybrid Fibre Coaxial (HFC) cable to roll out the NBN as one of its spectrum mix of high speed broadband technologies. The idea is make use of the extensive HFC cable that has been laid in the major capital cities by Telstra and Optus and new telecommunications advances in HFC as a broadband technology to deliver high speed broadband internet to households.

HFC (Hybrid Fibre Coax), more commonly known as the Cable TV network – was first deployed in Australia by Telstra and Optus in the early 1990′s (Hackett 2013). While it started out as a TV transmission system, it has also become a broadband service delivery

network for both of those carriers. It is quite a widespread system in a number of areas of Australia (mostly metropolitan, it is also in some regional centres).

The fibre optic network extends from the cable operators' master headend, sometimes to regional headends, and out to a neighbourhood's hubsite, and finally to a coaxial cable node which serves anywhere from 25 to 2000 homes (Wikipedia 2013b). A master headend will usually have satellite dishes for reception of distant video signals as well as IP aggregation routers. Some master headends also house telephony equipment for providing telecommunications services to the community. A fibre optic node has a broadband optical receiver, which converts the downstream optically modulated signal coming from the headend/hub to an electrical signal going to the homes. The coaxial portion of the network connects 25–2000 homes (500 is typical) in a tree-and-branch configuration off of the node. RF amplifiers are used at intervals to overcome cable attenuation and passive losses of the electrical signals caused by splitting or "tapping" the coaxial cable. Figure 27 provides an overview of the architecture of this high speed broadband technology (Wikipedia 2013b).

Figure 27 Hybrid Fibre Coaxial Architecture



NBN Strategic Review proposes to take the existing Telstra and Optus HFC cable networks, and to transform them into a modern broadband network via major investment in these areas (Hackett 2013). For standalone premises in the rollout areas concerned this includes repairing all existing lead-ins that need it, building all the missing lead-ins that were never done in the original HFC rollout, and expanding the HFC rollout into all the 'black spots' inside those overall rollouts that were left behind when the original rollouts ceased. The deployment also includes extensive network upgrades and capacity expansions to deliver high performance, low contention-ratio 100 megabit downstream rates.

However this is not an option in WDR as no HFC has been laid in the WDR.

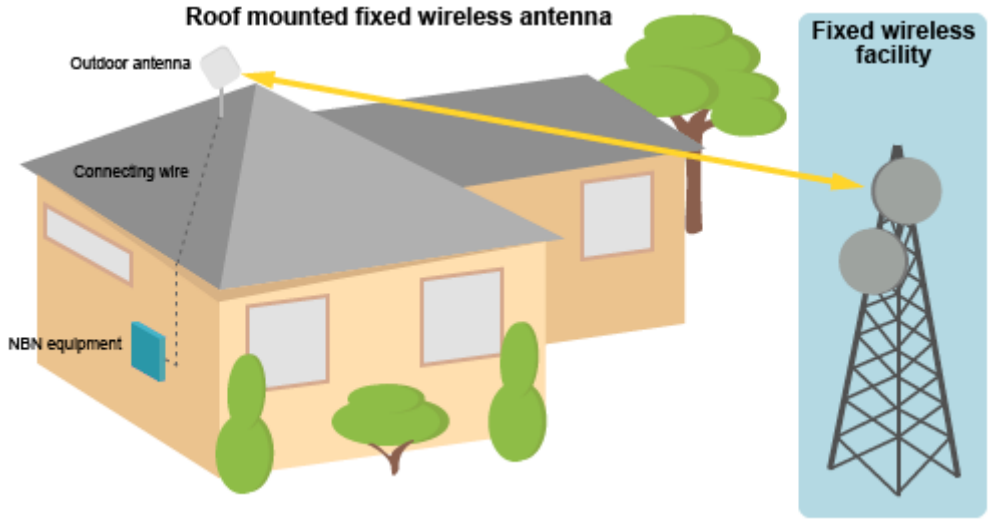
2.2 Fixed Wireless high speed broadband

The NBN's fixed wireless network, which uses advanced technology commonly referred to as LTE or 4G, is engineered to deliver services to a fixed number of premises within each coverage area. This means that the bandwidth per household is designed to be more consistent than mobile wireless networks, even in peak times of use. Unlike a mobile wireless service where speeds can be affected by the number of people moving into and out of the area, the speed available in a fixed wireless network is designed to remain relatively steady and better quality. Fixed wireless services are delivered through the air by radio communications by way of antennas that transmit a signal direct to a small outdoor antenna attached to a premise (see Figure 28).

Leading edge fixed wireless services are planned to reach the four per cent of Australians who will not receive fibre or satellite services. This technology is designed to provide real improvements in the internet speeds currently experienced by people in rural and regional areas.

NBN Co's fixed wireless network is designed to offer service providers with wholesale access speeds of up to 25Mbps for downloads and 5Mbps for uploads. With this fixed wireless service customer can have access to fast internet at speeds people in the city take for granted.

Figure 28 Fixed Wireless Broadband Internet



Fixed wireless services are delivered by radio communications from a fixed wireless facility direct to a small outdoor antenna attached to the premises. The antenna on the outside of a home will be connected by a cable running through the wall to the NBN connection box (which is a Network Termination Device) which will be located within the home. Generally customer phone or internet service provider will assist with the best means of connecting customer computer, TV or WiFi router to NBN connection box. That device sits within the house, and is hardwired to the outdoor antenna pointed at a fixed wireless site.

2.3 Wireless Satellite high speed broadband services

For the three per cent of Australians who live and work in the very remotest areas, NBN Co plans to use purpose built satellite services to provide high speed broadband so that internet service providers (ISPs) can provide improved services to their customers. The satellites, which are planned to be launched in 2015, will be designed to reach Australians living in outback areas and Australia's external territories such as Norfolk Island, Christmas Island, Macquarie Island and the Cocos Islands.

Until the two satellites are launched, an Interim Satellite Service (ISS) has already been introduced for people in homes, small businesses, schools, health services, local government facilities and indigenous communities in some of the most remote areas of Australia. These people previously had no access to metro-comparable broadband services and they are amongst the first users of an NBN satellite service.

Table 14 summarises the relative costs of different plans for connecting to a NBN Co FTTP plan for the two biggest telcos in Australia – Telstra and Optus.

Table 16 comparative costs of Big Telecos/ISPs (Telstra and Optus) for NBN FTTP

Provider (24 months contract)	**Data**	**Cost/month**	**Speed**	**Super fast Broadband Additional charges**
Optus	30 GB	$70	12 Mbps / 1Mbps	25 Mbps - 50 Mbps – 100 Mbps 5 Mbps – 10 Mbps – 40 Mbps $5 per month
	200GB	$90	12 Mbps / 1 Mbps	25 Mbps - 50 Mbps – 100 Mbps 5 Mbps – 10 Mbps – 40 Mbps $10 per month
	Unlimited data	$115	25 Mbps / 5 Mbps	25 Mbps - 50 Mbps – 100 Mbps 5 Mbps – 10 Mbps – 40 Mbps $20 per month
Telstra	50 GB	$73	25 Mbps / 5Mbps	100 Mbps / 40 Mbps $20 per month
	200 GB	$93	25 Mbps / 5Mbps	100 Mbps / 40 Mbps $20 per month
	500GB	$113	25 Mbps / 5Mbps	100 Mbps / 40 Mbps $20 per month

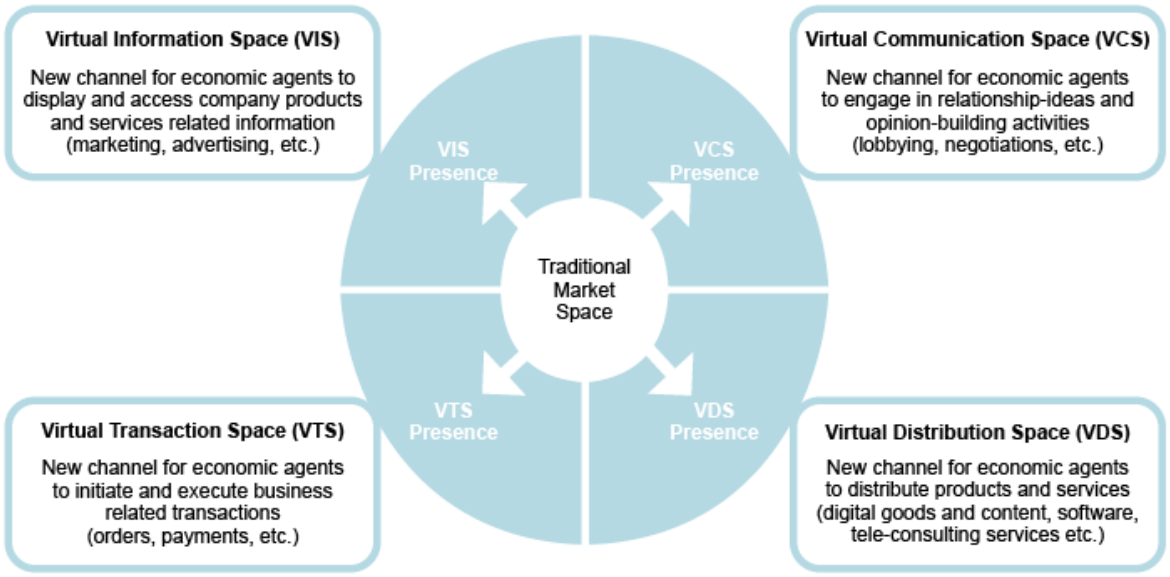
2.4 Key findings regarding proposed NBN digital infrastructure

Based on the NBN Co Strategic Review report (December 2013) (NBN CO 2103) it is clear now that a range or spectrum of broadband technologies will be utilised to deliver broadband internet services. For WDR it is most likely that FTTN, fixed wireless and satellite in remote areas will be used to deliver high speed broadband internet access.

3 Digital services delivered by current digital infrastructure in WDRC

Information Communications Distribution and Transaction Virtual Spaces (ICDT) Model (Angehrn 1997) is used to assess the digital services delivered by digital infrastructure in WDRC.

Figure 29 Information Communications Distribution and Transaction Virtual Spaces (ICDT) Model



Virtual Information space:

The Information Space consists of the channels by which organisation can provide information about themselves, their products, and their services. The area of greatest activity for the Information Space is the World Wide Web, an area of the Internet in which companies, government and individuals can set up 'home pages' that allow global reach and the ability to provide rich information.

Virtual Communication space:

The Communication Space allows for organisation to exchange information with the various stakeholders in their business: their suppliers, customers, and strategic allies. Unlike the information provision activity in the Information Space, communication in the Communication Space can go both ways.

Virtual Distribution space:

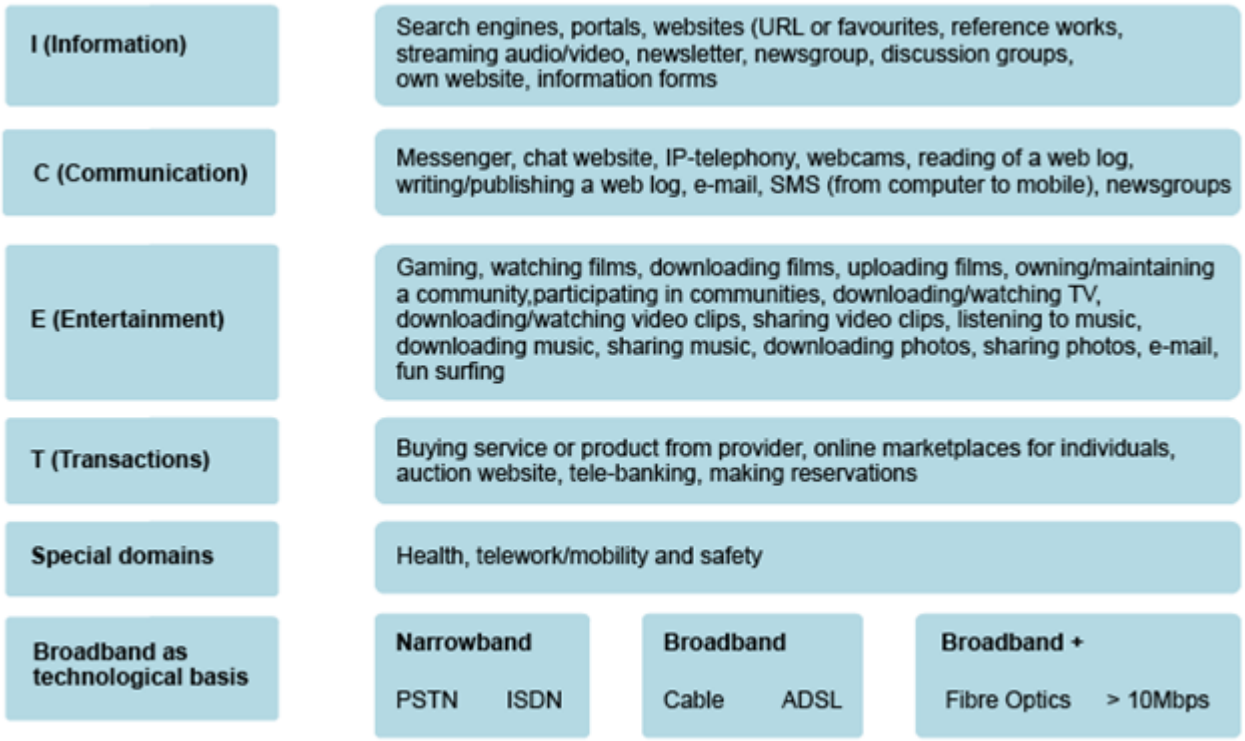
The Distribution Space is a distribution channel which organisations can use for their goods and services, especially those goods and services without a physical component, such as digital media (such as information, books, music, software, etc.) and services (consulting, technical support, education, financial services, health etc.).

Virtual Transaction space:

The Transaction space is used for the management of business transactions such as ordering invoicing and payment using electronic payment systems.

Figure 30 highlights the delivery of digital services via four virtual spaces of ICDT and the delivery more sophisticated digital services is currently constrained by the availability of Internet access from narrow band (Dial-up) through to high speed broadband (ADSL2+, FTTN/P, HFC, Fixed Wireless, Satellite) such as will be delivered by the NBN Co.

Figure 30 Delivery of digital services mapped across ICDT Model and constraints of broadband internet



4 Household Adoption of Broadband Services in WDR

This research used a large scale survey of households in Western Downs Region to collect quantitative data about household adoption and use of broadband internet. The survey instrument was developed from a number of previous studies of broadband technology adoption which have used instruments proven to be valid and reliable (Straub, Boudreau & Gefen 2004). The survey instrument in this study was pretested with a number of academics with extensive experience in survey research design. The survey was then piloted with a number of households before the main data collection was undertaken. The survey instrument is available on request from the authors. The printed version of the survey was distributed in person to randomly selected households using a stratified sampling method to ensure that the 1500 surveys were distributed to a representative sample population across population localities in WDR. In the survey invitation to participate letter, the targeted survey respondent was identified as the major decision maker in the household. The cover/invitation letter also explained that households which completed the entire survey were eligible to be entered in a random draw where they had a chance to win an iPhone 5S or a Samsung Galaxy 4. An ethics clearance letter was also provided so the survey participants were aware that this research was being conducted in an ethical manner with clearance from the University Ethics Committee. A self-addressed stamped return envelope was provided to the potential survey respondents so that they could return the completed survey at no cost to them other than the time taken to complete the survey. The surveys were returned by postal mail or by completion of an online version of the survey. Over Three hundred usable survey responses were obtained with a response rate of 20 percent was achieved which is comparable to similar previous studies (Brown & Venkatesh 2005; Dwivedi, Alsudairi & Irani 2010; Dwivedi, Choudrie & Brinkman 2006).

4.1 Demographics of the respondent households

The makeup of the respondent households in the survey is shown in Figure 31.

Figure 31 Different types of households (Source: this research)

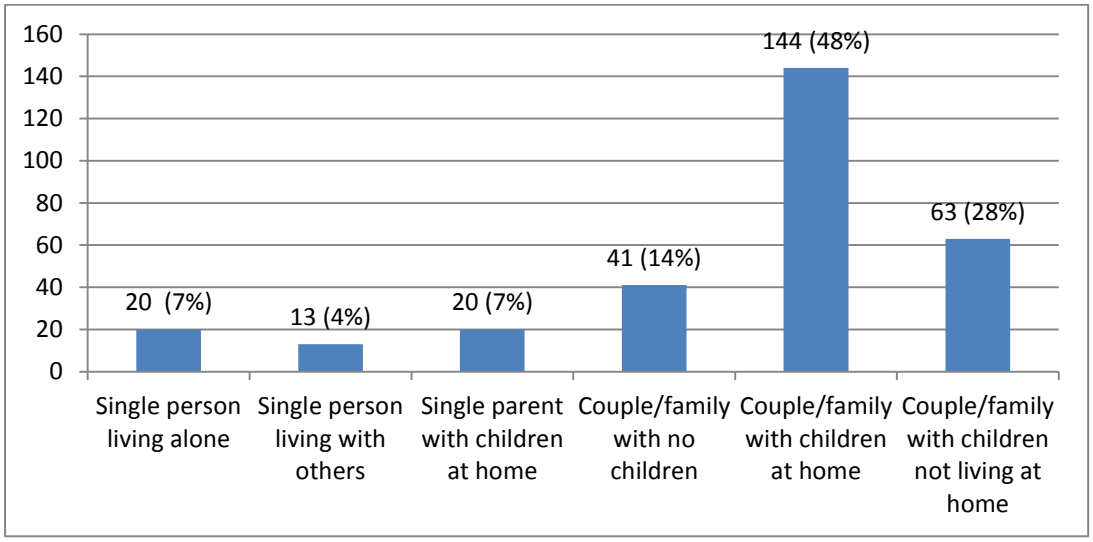


Figure 31 clearly shows that different configurations of couples dominate the respondent households and other household types make up less 20 percent of the respondent households.

Table 18 shows the geographical distribution of the household survey responses across Western Downs Region by district and relevant main population centres in each district.

Table 17 Geographical distribution of respondent households in Western Downs Region survey

Location in WDR	Household Responses	Live in	Nearest to	Combined district percentage
Dalby	126	126 (42%)	21 (7%)	**Dalby district combined 49%**
Live in Chinchilla	29	29 (10%)	10 (3%)	**Chinchilla district combined 13%**
Live in Tara	10	10 (3%)	12 (4%)	**Tara district combined 7%**
Live in Miles	13	13 (4%)	10 (3%)	**Miles district combined 8%**
Live in Wandoan	14	14 (5%)	4 (1%)	**Wandoan district combined 6%**
Live in Jandowae	15	15 (5%)	7 (2%)	**Jandowae district combined 7%**
Other place (please specify)	31	31 (10%)		**Other places in WDR 10%**
Total	302	100%		

Proportionately the respondent households in the survey are reasonably representative of the population distribution overall across the six main towns and districts in Western Downs Region.

Figure 32 shows the variance in household total income across the 301 respondent households. Figure 32 shows that there are clearly at least two distinct income groups in households in Western Downs Region which indicates that is a significant group of households with low total income and a significant group of households with high total income with a smaller group of households with middle total income. Household income has been shown to be important determinant of broadband adoption and use by numerous

previous studies. We would argue that while households with lower total income have adopted broadband services that their usage would be restricted compared to households with total higher income.

Figure 32 Total Household Income (Source: this research)

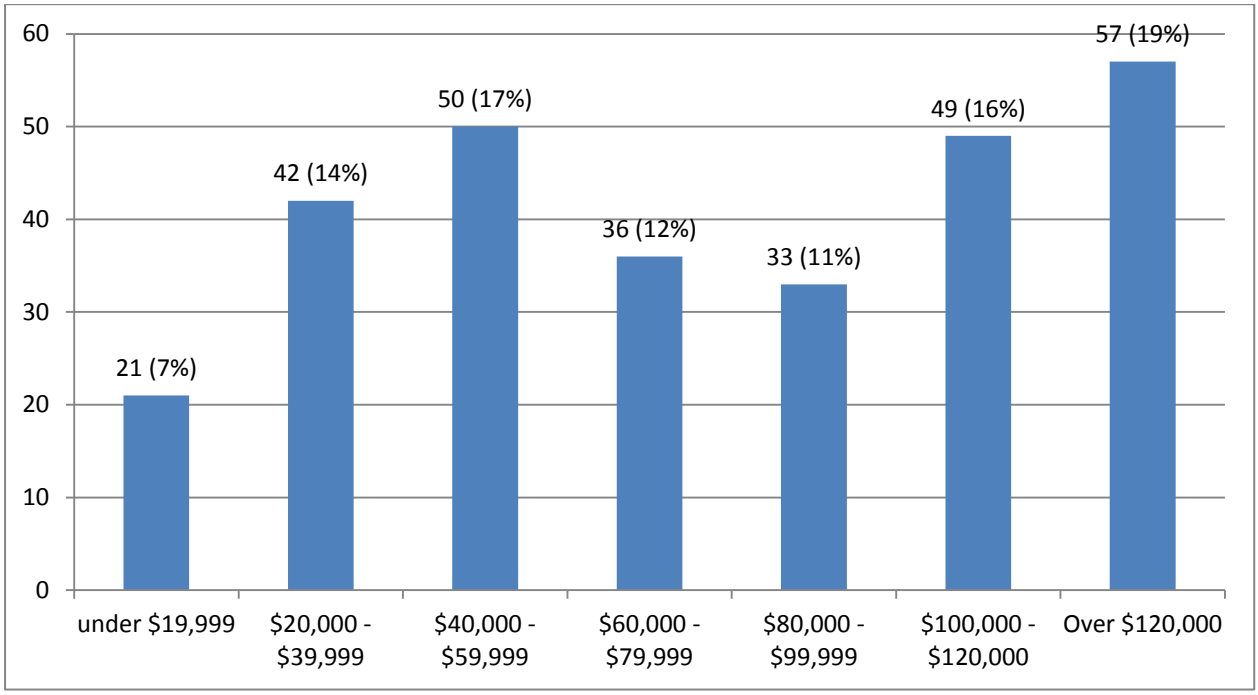


Figure 33 shows how long households have been using the Internet. The distribution is remarkably representative of a normal distribution. Three quarters of households have been using the Internet for six or more years. Interestingly almost 40 percent of households started using the Internet more than 16 years ago when the primary means of accessing the Internet was via a dialup modem. Moreover 60 percentage of households started using the Internet since ADSL broadband Internet services become readily available across Australia from 2005 when Telstra started to ADSL enable telephone exchanges on mass across the country (Wikipedia 2014).

4.2 Household use of Internet in WDR

This section reports on the result of the survey in relation to household use of Internet

Figure 33 Number of years since a household first started using the Internet

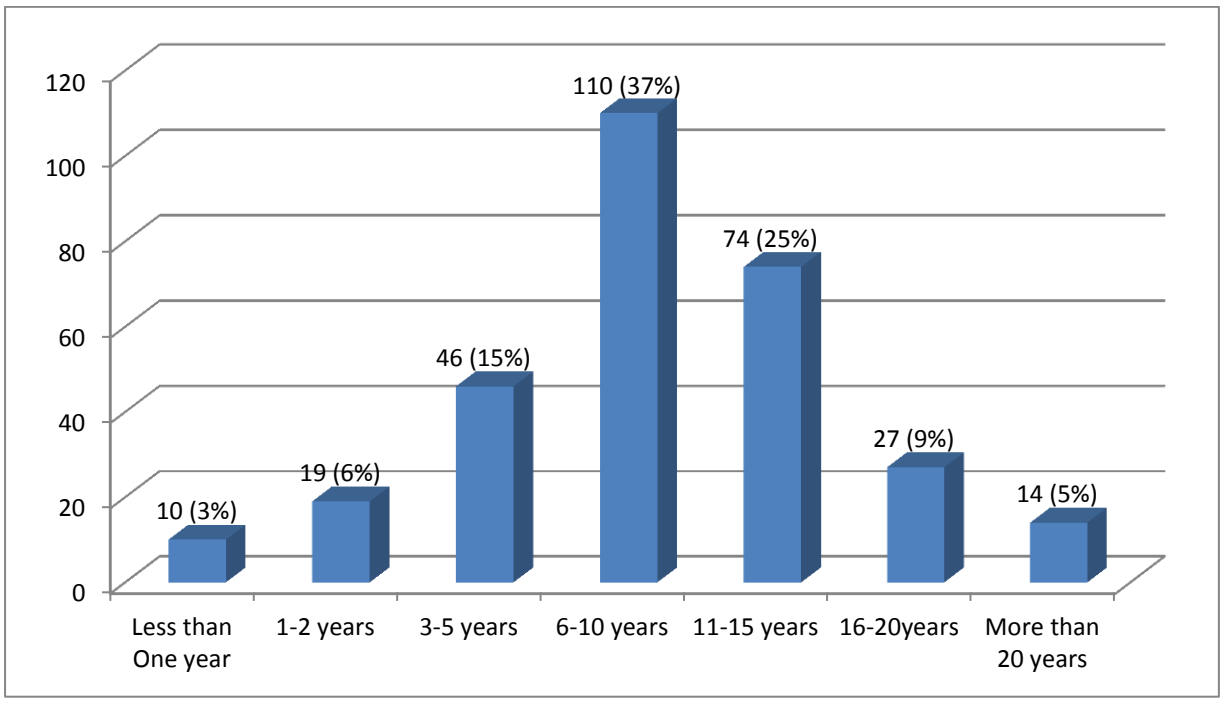
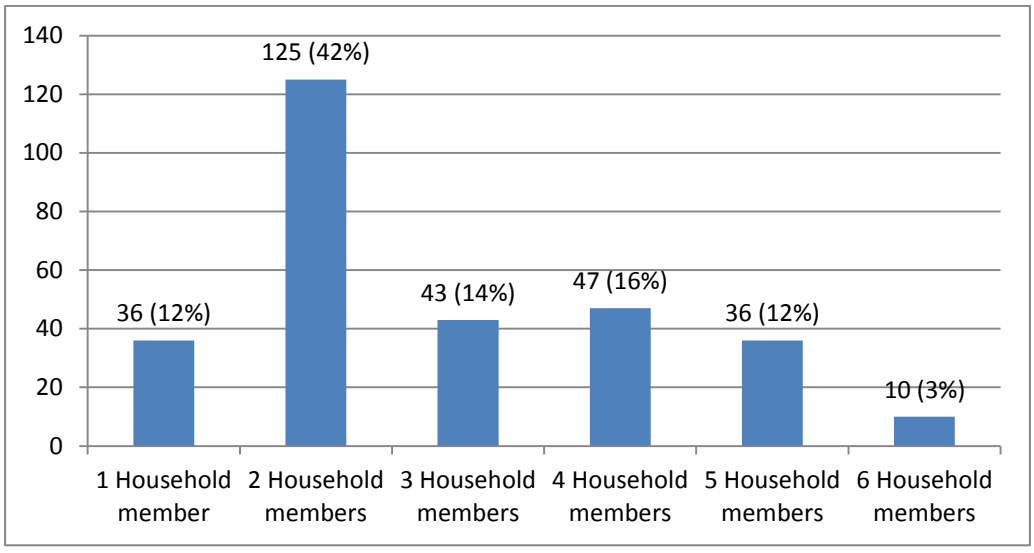


Figure 34 shows how many members of a household across the respondent households are using the Internet or in other words the density of internet users in a household.

Figure 34 Household Internet use density (source: this research)



Households with 2 members using the Internet accounts for more than 40 percent of the survey respondents 2-4 members using the Internet collectively accounts for more than 70 percent of the survey respondents.

4.3 How Households are accessing the Internet via broadband services

This section reports on the results of survey in terms how households in WDR are accessing the Internet via broadband services.

Figure 35 shows how frequently households are accessing the Internet over the time interval of a week. Clearly the majority of households (76%) are accessing the internet on a daily basis. A further 13 percent of households are accessing the internet on a weekly basis while only 1% of households are accessing the internet on a less than weekly basis.

Figure 35 Household Weekly Frequency of Internet access (source: this research)

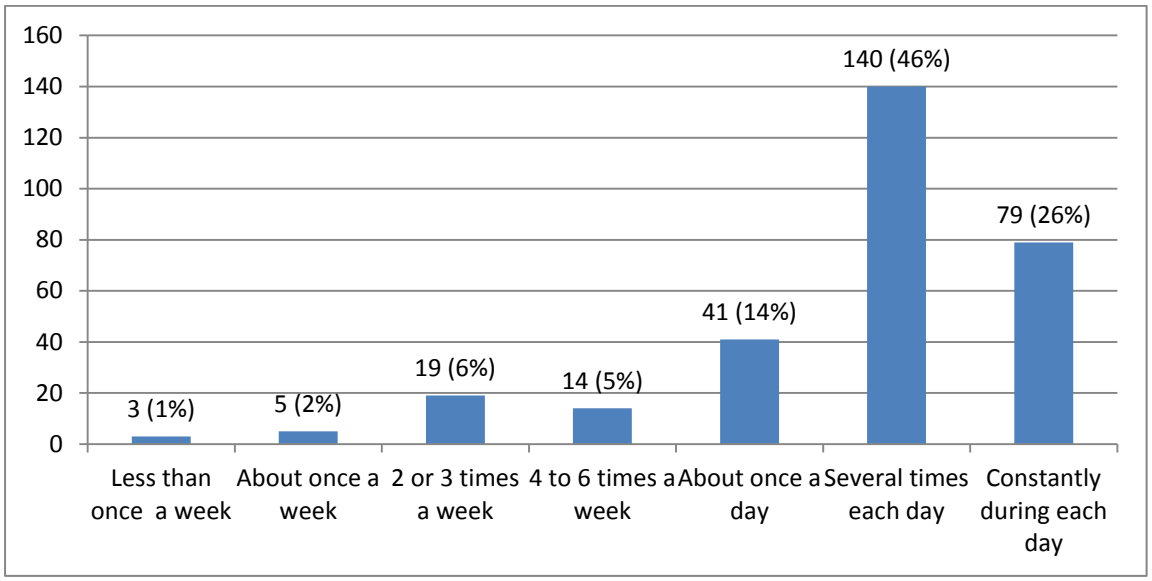
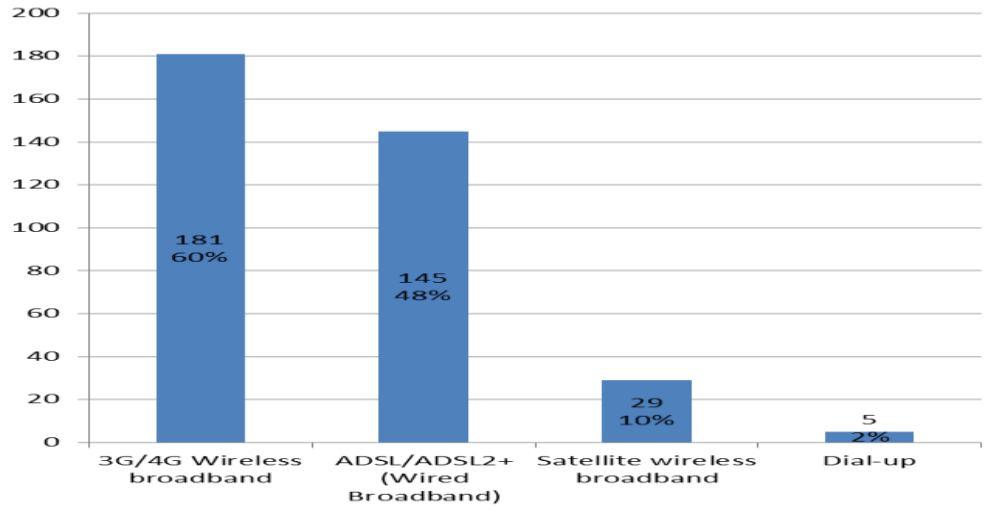


Figure 36 shows what type of Internet connection technology is used by households to access the Internet. Note that a household will increasingly use more than one type of internet connection technology but the most frequently used internet connection technologies in Western Downs Region are 3G/4G Mobile Broadband (60%), ADSL/ADSL2+ Broadband (48%) and Satellite Broadband (10%). Not surprisingly less than 2 percent of households are using dial-up modems to access the Internet. This shows that most households are using some sort broadband internet service. Twenty six percent of households are accessing the Internet constantly during each day which would indicate the increasing influence of mobile broadband Internet.

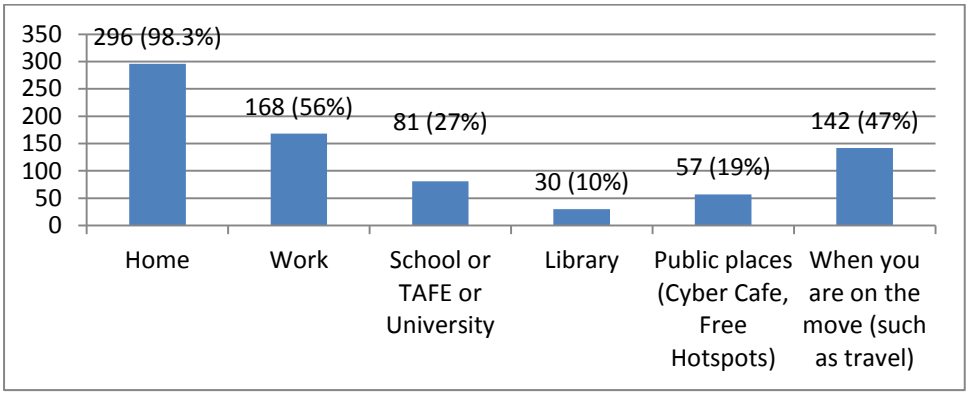
Figure 36 Type of Internet Connection used by Households (source: this research)



4.4 Where Household members are accessing the Internet via broadband services

This section reports on where household members are accessing the Internet via broadband services in WDR

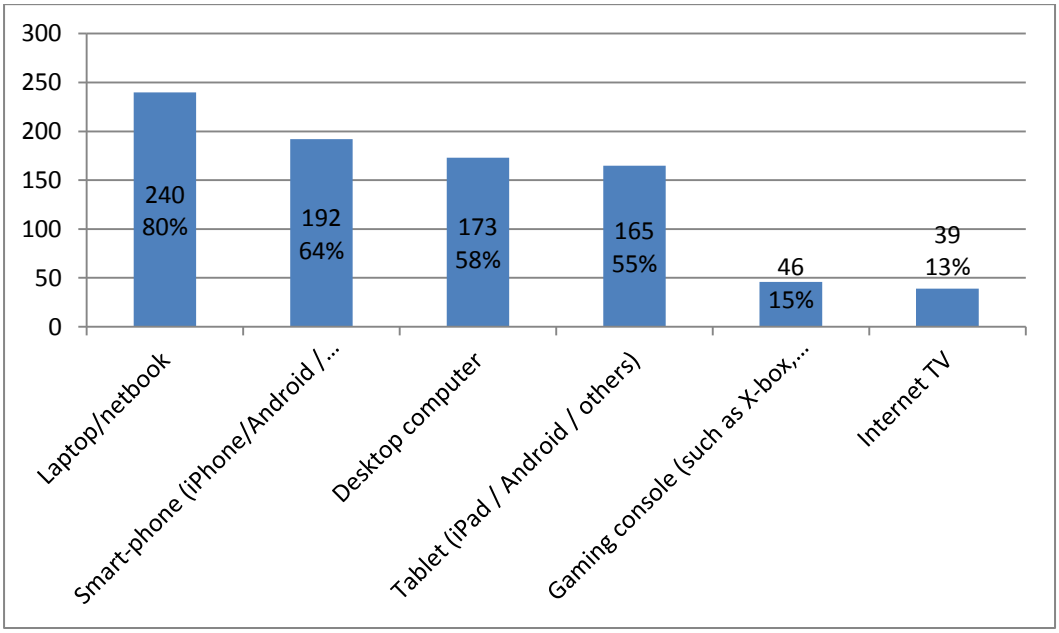
Figure 37 Where do members of household access the Internet



Ninety-eight percent of households are accessing the Internet from their home while almost 56 percent of households are accessing the Internet from work, 27 percent from school, TAFE or University, 19 percent from public places and 10 percent from a Library. Interestingly 47 percent are accessing the Internet while on the move (travelling) which again indicates the increasing influence of mobile devices and mobile broadband Internet.

Figure 38 shows the range of different devices used by households to access the Internet.

Figure 38 Different Devices used by households to access the Internet

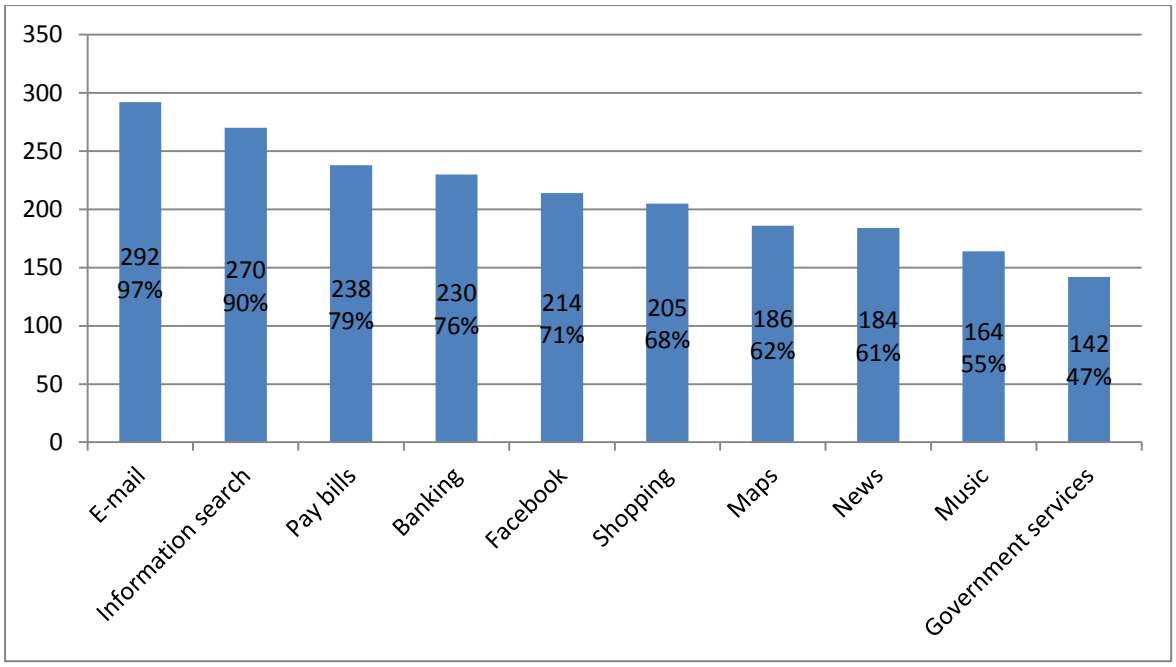


At 80% Laptops and Netbooks are the most common device used by households to access the Internet. At 64 percent Smart phones are the second most common device used by households to access the Internet. At 57% percent Desktop computers are the third most common device used by households to access the Internet. While at 55 percentage Tablets are also the fourth most common device used by households to access the Internet. To a

lesser extent at 15 percent and 13 percent respectively Gaming consoles and Internet TV are the fifth and sixth most common ways to access the Internet. Interestingly many of these devices can access the Internet via one or more broadband services such as fixed line broadband ADSL/ADSL2+ and WiFi LANS and/or via mobile broadband Internet.

Figure 39 shows the top ten Internet based digital services that are used by respondent households. Email is most widely used (97%) while government services come in at number 10 (47%) with almost half of the respondent households using government internet based digital services.

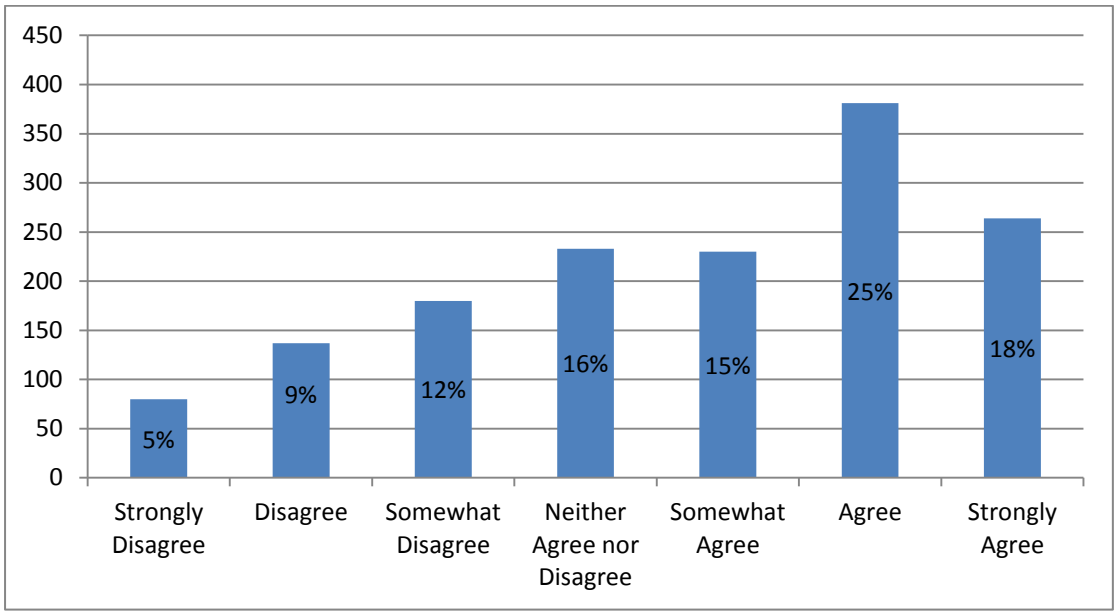
Figure 39 Household use of the Internet based digital services



5 Household Affordability and Satisfaction with Broadband Services in WDR

Figure 40 shows the respondent households beliefs regarding affordability of their primary broadband internet service.

Figure 40 Respondent households beliefs regarding affordability of broadband internet in WDR



Nearly 60 percent of the respondent households agree that their primary broadband internet service is affordable while 26 percent of households disagree that their primary broadband internet service is not affordable while 16 percent of households are undecided.

Figure 41 show the level of satisfaction with primary broadband services across the respondent households.

Figure 41 Household satisfaction with broadband services (source: this research)

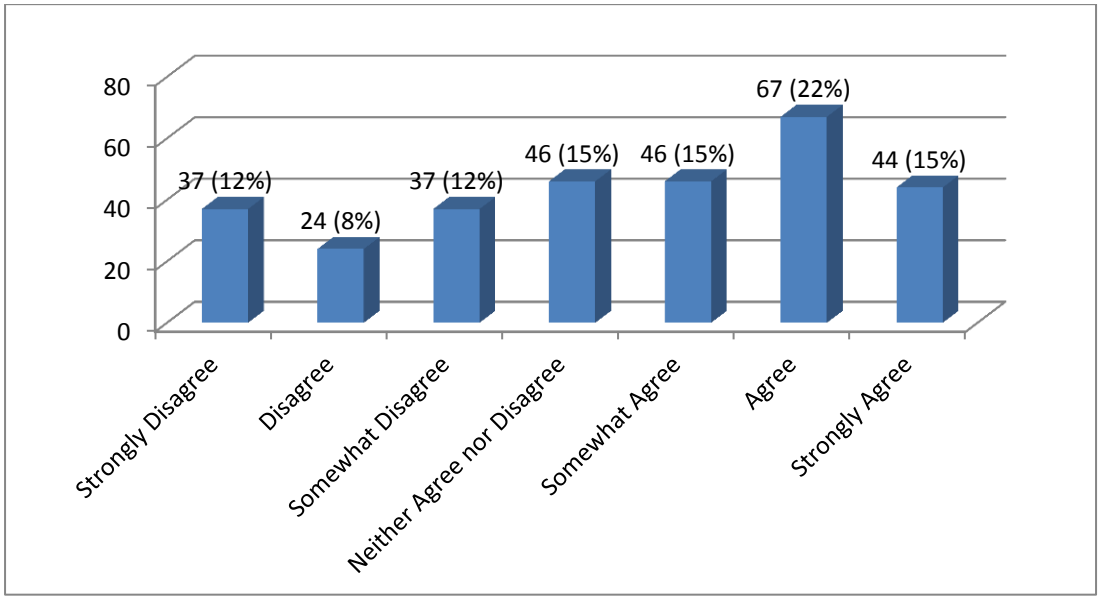


Figure 41 shows the level of satisfaction of households with their broadband services. Note that a household may be accessing more than one broadband service. Interestingly 32 percent of respondent households are dissatisfied with their broadband service while 52 percent of the respondent households are satisfied with their broadband services and 15 percent of

respondent households are non-committal about their satisfaction with their broadband services.

Table 19 breakdowns household satisfaction with broadband services by the type of broadband service. Here we see some interesting trends emerge. The level of satisfaction with ADSL broadband services is much higher (60 percent) compared to 3G/4G Mobile broadband services (46 percent) and Satellite broadband services (41 percent). This supports our previous findings that 3G/4G Mobile broadband services and Satellite broadband services are much more variable in terms of coverage, speed and reliability of service than fixed line ADSL broadband services hence the lower levels of satisfaction. Dial-up narrowband services have such a low usage these days that we consider its impact in this research as negligible.

Table 18 Level of satisfaction with type of broadband service (source: this research)

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree	Total	Percentage of households
3G/4G	28	14	24	31	22	40	22	181	60%
36% dissatisfaction	15%	8%	13%	17%	12%	22%	12%	46% satisfaction	
ADSL/ADSL2+	6	8	15	24	28	39	25	145	48%
20% dissatisfaction	4%	6%	10%	17%	19%	27%	17%	63% satisfaction	
Satellite	6	3	5	3	5	5	2	29	10%
48% dissatisfaction	21%	10%	17%	10%	17%	17%	7%	41% satisfaction	
Dial-up		1	1				3	5	2%
40% dissatisfaction		20%	20%				60%	60% satisfaction	

6 Key recommendations for WDRC Digital Economy Strategy

The following outlines and discusses the key recommendations from an audit of the digital infrastructure and services in WDRC with the view to informing its digital economy strategy.

- WDRC should consider including the development and utilisation of digital infrastructure as part of its short and long term strategic planning, in the form of a digital economy strategy. Ensuring that digital infrastructure in WDRC can provide access to reliable and affordable high speed broadband internet is critical if WDRC is to successfully participate in a digital future. It is paramount to building economic, human and social capital in WDRC by ensuring adequate access to high speed broadband internet;

- Existing digital infrastructure (both wired and wireless) in WDR needs to be better utilised and in many instances upgraded so the residents of WDR have access to reliable and affordable high speed broadband internet in short term while the NBN is being rolled out in WDR. This report found that while there is extensive digital infrastructure

covering WDR much of this infrastructure needs to be upgraded and/or infrastructure needs to be better utilised. For instance there are many mobile phone towers in the WDR but they don't have the backhaul capacity to support data traffic that users now want to transmit on these mobile networks. There is also a number of fibre optic backbone networks covering the main population centres of WDR but this backbone network capacity is not well utilised. Furthermore mining companies have also laid a significant amount of proprietary fibre optic and mobile networks so is there an opportunity to work with mining companies in a more collaborative manner so that the wider community in WDR can benefit from this digital infrastructure.

- It is also critically important to ensure through consultation with the key stakeholders that the roll out of the NBN infrastructure in WDR addresses the shortcomings of the existing digital infrastructure. The NBN Co Strategic Review released in December 2013 indicates that the Federal Coalition government is committed to making the roll out of the NBN a priority in underserved areas. Clearly this audit of the digital infrastructure of WDR already demonstrates that in terms of access to high speed broadband internet, WDR is an underserved area. The lack of access to high speed broadband internet is considered to be impediment to the strong economy growth that is predicted for WDR in the industries of agriculture and mining. Furthermore increasingly essential services such as health and education can be delivered much more effectively and efficiently via the Internet. Hence, it is critical that the key stakeholders (local, state and federal governments, education, health and community groups) work together to ensure that NBN roll out in WDR delivers digital infrastructure that provides all residents with reliable and affordable access to high speed broadband internet.

- It is also an imperative that a digital literacy plan is developed for residents of WDR so all residents can make the transition and be active participants in a digital future. Currently many people in WDR don't have knowledge and skill set to make the transition to a digital future. So even if the NBN roll out delivers universal access to high speed broadband internet if a significant number of the residents are unable to take advantage of high speed broadband internet and the associated rapid increase in the delivery of digital goods and services then they are going to be significantly disadvantaged. This will also significantly negatively impact on WDR as a whole as it already has a lower socio-economic status compared to other parts of the State of Queensland.

7 Glossary of key terms

PSTN

Public Switched Telephone Network is the international analog circuit switched telephone system. PSTN is the worldwide collection of interconnected public telephone networks that was designed primarily for voice traffic. PSTN in Australia is largely owned and operated by Telstra. Today, the PSTN is a network of computers and other electronic equipment that converts speech into digital data and provides a multitude of sophisticated phone features, data services, and mobile wireless access.

ADSL/ADSL2+

ADSL is Asymmetric Digital Subscriber Line service where data transmission through copper pair. ADSL is called asymmetric because data download and upload speeds are not same or symmetrical. In ADSL data download is faster than upload.

HFC

Hybrid fibre-coaxial is a broadband network combination of optical fibre and coaxial cable. Which is faster than ADSL/ADSl2+ and provides the Pay TV, internet and voice services.

Mobile network

A mobile network is number of towers through which mobile or cell phone can communicate or connect. This tower also sometime called mobile nodes that are dynamically and arbitrarily located in such a manner that interconnections between nodes are capable of changing on a continual basis. These tower owned by a one company or different company, and once a mobile phone registers with one of them, it can transparently switch to communicate with closet tower or mobile node.

NBN

NBN Co was created on 9 August, 2009 and from the start NBN has been building the company, developing a wholesale product offering, selecting technology and designing the network and systems. NBN are a wholly-owned Commonwealth company that has been prescribed as a Government Business Enterprise (GBE) and is represented by "Shareholder Ministers" - the Minister for Communications and the Minister of Finance. At NBN goals are simple - deliver Australia's first national wholesale-only, open access broadband network to all Australians, regardless of where they live. To reach everyone in country the NBN will be delivered by a combination of fibre, fixed wireless and satellite technologies.

Fibre Optic cable networks

A fibre optic cable is a network cable that contains strands of glass fibres inside an insulated casing. These cables are designed for long distance and very high bandwidth network communications.

Satellite

A satellite communication networks allow data transmission from one part of the world to another part. The signals are transmitted through these satellites which are located on high orbital altitude of over 35,000 kilometres above on the Earth. These satellites can have

significant role in communications like reflect signals from the Earth back to another location on Earth.

Fixed wireless

Fixed wireless network is advance technology commonly referred to as next generation technology 4G or LTE, is engineered to deliver services to a fixed number of premises within each coverage area.

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