Second Submission to the

Department of Broadband and the Digital Economy

for the

Practical Business Case for the NBN

By

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NBN Implementation Study
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Dear Team

Having read through the NBN Implementation Study, there were a number of processes and practices that concerned me as while academically may look good but in practical network engineering practice are really wanting of much deeper scrutiny and/or telecommunications engineering experience to optimise many scenarios through synergetic network structures. My initial submission on the NBN Implementation Study addressed most of those issues.

This second submission looks to address many of the issues that were raised from my first submission and this submission draws on my specialist knowledge of the Australian telecommunications network infrastructure, and capitalises on creating an economical inland Backhaul network infrastructure that will merge with existing Backhaul infrastructures to create a large high capacity optical fibre 'grid' that will support intensive Broadband content and services virtually everywhere in populated Australia.

From an experienced telecomms engineering aspect I found this Implementation Study to be seriously lacking in innovation, which resulted from poorly understood systematic solutions that would be far better suited in Europe, (or parts of the USA) than in Australia.

For example it appears that FTTP is being artificially limited 10 km, when FTTP is quite capable of providing services upwards of 45 km with less optical splitting. I really urge your engineers to look beyond the obvious handouts from equipment providers and get innovative, as this will result in far more of the last percentile being Broadband connected with a considerably lower financial budget, and largely without the need for point-to-point radio / satellite connections.

This submission includes an alternative approach to the Implementation Study in that this alternate Business Case focuses on putting in a grid of high capacity Backhaul (primarily where backhaul is non-existent or is very thin) so that existing Backhaul can be integrated to maximise its economics. Detail of proposed FTTP CAN structures in Australia have not been included, as this would require thousands of man-hours from many knowledgeable engineers and thousands of detailed maps to develop a meaningful overview (and I simply don't have that resource). This CAN detail is also missing from the Implementation Study, but an overview is included in this document.

If the Implementation Study had a business justification then I missed it, but in Appendix 7, of this submission there are community expense offsets showing that remote consumers can justify upwards of $14,000 pa to have FTTP connected, and these offsets can be exponentially scaled back (with distance) to break even at about $1,000 in major capital cities. This is not a commercially competitive justification and this submission explains why the NBN must never be 'privatised'.

To simplify the referencing, I have included many references as appendices at the back of the main document, as some of these references may be 'hard to find'!

Should you wish, I am available at short notice to assist any/all of your team in developing innovatively structured networks with the intent to make the NBN a real success.

Please do not hesitate to contact me for further information, assistance or guidance.

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Introduction

Creating a Business Case

On reading through 501-page document titled the "National Broadband Implementation Study" it was very difficult to find any meaningful financial and traffic figures that could relate that document to being a Business Case. Broad costings based on ABS population densities tried to relate to 'percentiles of population' and that is a concern as this does not relate to the physics of how the premises (and non-premises) are connected via the CAN and Backhaul Networks. **Appendix 7** (Submission 45b to the Select Senate Inquiry on the NBN 2, July 2009; ***Senator Nick Minchin – Infrastructure Regime***) gave a very precise explanation on how a business case for anything like the NBN would be formulated, and it clearly showed that the NBN cold never be justified on commercially competitive grounds, but the NBN could easily be justified on community, health, education and business equalisation grounds to provide Broadband to virtually all Australians; especially those beyond the metro fringes where the Backhaul network is significantly too thin and/or the CAN is too long for ADSL technologies, but perfect for long FTTP applications.

The Broadband infrastructure problem in Australia is that since privatisation was forced into the telecommunications infrastructure business in 1982, on a global basis there have been many very highly productive technology-based advances since then. These technology advances have in general not been recognised for making almost all components of all telecommunications infrastructures far more economic. Because these telecommunications infrastructures are now privatised not only is a high proportion of the internal revenue wasted on competitive marketing into what is really a captive audience, but the business focus has dramatically moved away from what was a service industry operated under a government arm into a commercial business / company / industry focussed on maximising shareholder profit.

The Fundamental Flaw

To compound this fundamental economic flaw of privatising what is effectively essential services, commercially 'competitive' telecommunications infrastructures in Australia have grown (with considerable government 'assistance') and it has been proven several times that "competitive infrastructures is highly uneconomic" and **Appendix 8** (which was extracted from Submission 45b to the Select Senate Inquiry on the NBN 2 in July 2009). Competitive HFC Rollout clearly demonstrates an appalling waste of revenue in Australia. On a global basis, governments are now actively nationalising their telecommunications infrastructures to provide the essential economic services necessary for their commercial industries and their communities to be economically viable.

In Australia, the privatisation push following the Davidson Report in 1982 [1] resulted in a radical change in the management of infrastructure philosophy where the telecommunications infrastructure was to be operated as a commercial business, instead of an infrastructure business as they were operating beforehand. In this new 'competitive regime' (commercial business philosophy) in general the only infrastructures that were seriously maintained and developed were those that provided the maximum return for investment (ROI). Consequently, as foreseen in the Davidson Report, the Universal Service Obligation (USO) was established to partially fund the 'non-commercial' (non-metropolitan) areas such that all telephony services of the day would be comparable to metropolitan areas.

In the past decades in Australia; digital switching was introduced 1980, optical fibre backhaul was introduced in 1985, optical CAN was introduced for larger businesses from about 1992 and a range of other economic technologies (including SDH transmission, IP switching and ADSL transmission) have since been introduced that have radically reduced the overhead costs and increased customer available bandwidths.

Appendix 1, (which is extracted from my Submission to the DBCDE / NBN Expert Committee, March 2008), that shows a reasonably comprehensive range of telecommunications Backhaul Network and CAN technologies, their useful life-spans, and a graph that is highly indicative of the expected service life of telecommunications infrastructure equipment in the future. The table clearly shows that typically current telecommunications equipment has a limited lifespan and currently that lifecycle in Australia spans about 22 years for active equipment and about 30-40 years for passive equipment.

[1] J.A Davidson et al "Report of the Committee of Inquiry into Telecommunications Services in Australia" 1982 Australian Government Publishing Service cat. no. 822007X (v. 1); 8220081 (v. 2); 8220093 (v. 3).

Appendix 2, (extracted from my submission to the Regional Telecommunications Review October 2007) of which the DBCDE should have been totally across – shows a graph that backs up the later data provided in **Appendix 1**. It should be now more clear than ever that the process of installing equipment for the NBN will not be a once-only "install and privatise" affair, but a continuum of continual growth, and replacement and that scenario does not sit comfortably in a commercial environment because the equipment and labour is expensive and that impacts on 'super' profits.

Instead of transferring the economies of technology advances onto commercial businesses and the community, these competitive telecommunications infrastructure vertically integrated businesses have squandered most of these economic advantages in competitive advertising, marketing, unnecessary legal stoushes, shareholder profits and extraordinarily high executive pay.

Appendix 3, (which was extracted from my Submission to the RTR October 2007) shows that even though the cost of new telecommunications equipment was dropping (and continues to drop at a commensurate rate) the savings made by the drop in equipment and overhead costs, and the equivalent wider bandwidth available at commensurate costs have in no way been passed onto the end users with anything like the equivalent savings in service fees.

This realisation in **Appendix 3** totally capsizes the argument that privatisation of (telecommunications) infrastructures actually is in the best interest of the end users, and it shows clearly that the savings are totally due to technology changes and nothing else. Further it is clearly seen that the money is not going back to maximise the infrastructure – but to maximise the very uneconomic commercial expenses that come with competition. Even though the cost of infrastructure bandwidth had dropped by a good 70% (as clearly shown in **Appendix 4**) virtually no infrastructure had been installed beyond the metro fringes, leaving the infrastructure still 'Capital City Centric'.

The Telstra (Transition to Full Private Ownership) Bill 2005 admirably showed just how pig-headed the Howard Government was. Even then it was obvious with alarm lights flashing and horns blaring the warning signs that privatisation of telecommunications infrastructure is a fundamentally flawed concept the Howard government still pressed on to fully privatise Telstra. Unfortunately the very poorly hidden agenda was to include a viable telecommunications sector on the ASX so that the financial businesses could maximise their profits and the superannuation funds would be able to spread their funds. In practice only a financial idiot would invest in a listed company what has a long-term negative growth value such as Telstra. This reasoning is why the Howard government kept kicking the dead horse.

Amongst the plethora of Rudd Government ill-conceived, poorly-timed, generally unsynchronised and/or ill-managed projects to revitalise Australian infrastructure, the NBN is a highly credible project, primarily because it was blatantly clear that the commercial 'competitive' businesses would never build telecomms infrastructure beyond the metro fringes – as such infrastructures would never be profitable in a commercial sense anywhere near those in the metropolitan areas!

The Cost-Centre scenario is particularly interesting because it aligns where telecommunications infrastructure businesses will invest their funds – and likewise – it also dictates where funding is minimised. The hard lesson to learn is that in a competitive regime (ie where 'money talks all languages'), investment is 'loaded' into areas that have the highest ROI.

This 'investment loading' is not a linear function of population density; it is an exponential function of population density; and that surely explains why competitive infrastructures are only in built-up (urban) areas. The exponential telecommunications infrastructure / financial loading is based around business density on a land area basis; so it is no surprise that CBDs in capital cities have excessive infrastructures to what they require, while regional and rural cities and towns and remote areas are starving of essential telecomms infrastructure (even if from only one infrastructure provider).

Lack of Funding Outside Metro Areas

Concurrently, with the push for privatisation of the telecommunications infrastructure in Australia since the Davidson Report 1982, the amount of funding to replace technology dropped away since about 1985; mainly because the high economic inefficiencies of competition (multiple managements, expensive competitive advertising and marketing projects, greatly increased legal costs. When you consider that say 4,000 legal staff are employed in Telstra, and their average wages plus overheads amount to about $250,000 each, then this competitive overhead of say $1,000,000,000 per year has to come from somewhere, and the somewhere came from infrastructure refurbishments.

Collectively the industry investment into telecommunications infrastructure in Australia has spread from the main Telecom Australia / Telstra into several much smaller telecommunications businesses that operate with much lower economies of scale (meaning that the 'competitive' commercial businesses cannot obtain the economic leverage to purchase much larger quantities of equipment at substantially reduced contract prices. Consequently, these not so competitive telecommunications infrastructure and retailing businesses cannot be 'competitive' on a similar level playing field!

Looking at the costs of legal representations a little deeper, then the telecommunications businesses that are collectively competing against Telstra will also have typical competitive overhead costs totalling about $1,000,000,000 ($1Bn) per year, and then there is competitive advertising! If competitive advertising was totalled for the whole industry at say; $500,000,000, then the total bill for the total telecommunications industry in Australia will easily top $2.5 Bn per year, every year that is lost to the economic inefficiencies of competition and lost from non-metropolitan infrastructure.

Getting the Balance Right

Correcting the Infrastructure Underspend

Considering that in about 1980 the total infrastructure equipment bill for Telecom Australia was about $2.5 Bn and according to the Davidson Report the finances were still particularly tight following WW2 and the Depression Mentality of the executive management then this expenditure (telecomms investment) figure should have been about double or about $5 Bn per year. Aligning this infrastructure investment with the Australian population (which was about 15 M in 1980); with nominally 22.4 M Australians in 2010, the total infrastructure equipment bill for Telstra (and the rest of the infrastructure providers) should be about $7.47 Bn per year, or about $59.7 Bn in the past eight years, and that figure puts the proposed NBN $43 Bn on the low side for a similar timeframe and investment.

Now, considering that about $2.5 Bn per year is 'wasted' on competitive/legal overhead costs, then this money is opportunity cost revenue that is effectively removed from telecommunications infrastructure investment, making the infrastructure investment (spend) more like about $5.0 Bn per year (of which Telstra would be about 60% or about $3.0 Bn per year). Looking at this in another light, consider that about $2.5 Bn per year has been 'wasted' on competitive regime legal/management overhead costs, then over the past two decades (ie since about 1990), the underspend on telecommunications infrastructure investment (spend) is about $50 Bn.

All this competitive waste is/was at the expense of installing and commissioning a far more comprehensive telecommunications network that would have extended well beyond the fringes of the high ROI 'metro' areas (Sydney, Melbourne, Brisbane/Gold Coast, Adelaide and Perth). As a direct consequence of this privatisation philosophy introduced in the 1980s, Australia is now burdened with the economic need to rebuild the Broadband Network (Backhaul Network and Customer Access Network (CAN)) beyond the metro areas, because telecommunications infrastructure investment in the non-metro areas has been a financial desert for decades.

Rewarding Technological Productivity

Appendix 3 (extracted from the Submission to the RTR in October 2007) clearly shows that while overhead costs have significantly decreased and the bandwidth availabilities have radically increased but the reasons for this massive increase in productivity is totally due to technology and not competition. In fact the costs of the competitive regime bled the productivity gains.

Appendix 3 also clearly shows that competition actually prevents the benefits of introduced new technologies from flowing onto the end users, and in that light, the Productivity Commission should be actively curtailing competition of (telecommunications) infrastructures. The problem is that if the Productivity Commission were to step in and prevent competitive telecommunications infrastructures, then the Australian Consumer Competition Commission (ACCC) would have a greatly minimised role – which in itself would be a massive productivity improvement; as it would displace a large percentage of the staff in the ACCC and displace a large percentage of the staff in the Telecommunications Industry Ombudsman (TIO) offices too!

Balancing the Infrastructure

Appendix 5 (extracted from the Submission to the Select Senate Inquiry on the NBN2, July 2009) took this lack of productivity argument a little further and proposed that Telstra be split into two separate organisations, and the Retail / Reselling part be rebadged as "Bigpond" and listed on the ASX, while the Wholesale/Infrastructure part be re-positioned as a sub-Government Commission. In discussions with various Senators while giving evidence, it was very obvious that some Liberal Senators were ‘rather disturbed’ by the rationality of this argument – and by the fact that the so-called “Future Fund” would become a “Present Fund” – but not a present for retired Liberal Party parliamentarians, or their friends in financial institutions. The Future Fund would be the revenue to fund the severe shortfall in telecommunications infrastructure particularly in non-commercial areas (ie beyond the metro defined areas)!

In hindsight of the thoughtless financial wreck that the Rudd Government has dropped on Australian ‘working’ families in the first half of 2010, this desperately wasteful situation clearly demonstrated that Government Departments should never be allowed to manage funds for any form of infrastructure; and that self-sustained sub-government commissions must be the authorities that must have the accountability and responsibility to manage their portfolios. This would have to include a change in management structure so that staff at all levels can be hired and fired (unlike the stay-forever clause in the Australian Public Service (APS)). One problem is the degree of greed that these private (competitive) businesses gouged in for funds, but the hypocrisy is that most of the businesses that did the intense gouging are large businesses that would be strongly Liberal Party biased; which should mute any honest Liberal Party member from complaining about the funds gouging. It also sends a very clear message that funds distribution in the future must never come via a Government Department – but should only come via prudent Commissions!

So, to prevent further price gouging when the NBN is rolled out, the contracts for the work must come via the NBN as a commission, and not the DBCDE or any other Government Department.

Reading a GIS Map

The Implementation Study for the NBN gave a vague understanding of reading a Global Information System (GIS) based map, of Australia to get an understanding of the population densities in a geographic basis and relate this to network construction techniques.

This Implementation Study is fundamental flawed through reading GIS population density maps in a blind assumption that the population densities are evenly distributed over the areas described by the maps, and the CAN costs will relate in percentiles. The Australian Bureau of Statistics (ABS) nominates areas as Major Cities, Inner Regional, Outer Regional, Remote, and Very Remote. In parliamentary voting seat language this mapping technique and naming procedure has merit, but unfortunately, this nomenclature does not readily translate into ‘telecomese’! (Even though Telstra’s Exchange Switching Areas (ESAs) can usually be fairly closely grouped and then aligned with the ABS parliamentary seats!)

The ABS (http://www.abs.gov.au/websitedbs/D3310114.nsf/home/frequently+asked+questions) clarifies the areas as:

How does the ABS define Urban and Rural?
The ABS Section of State (SOS) Structure of the ASGC defines Urban and Rural.
In each state, the SOS categories of:

- *- Major Urban: urban areas with a population of 100,000 and over*
- *- Other Urban: urban areas with a population of 1,000 to 99,999*

are regarded as Urban.

The SOS categories of:

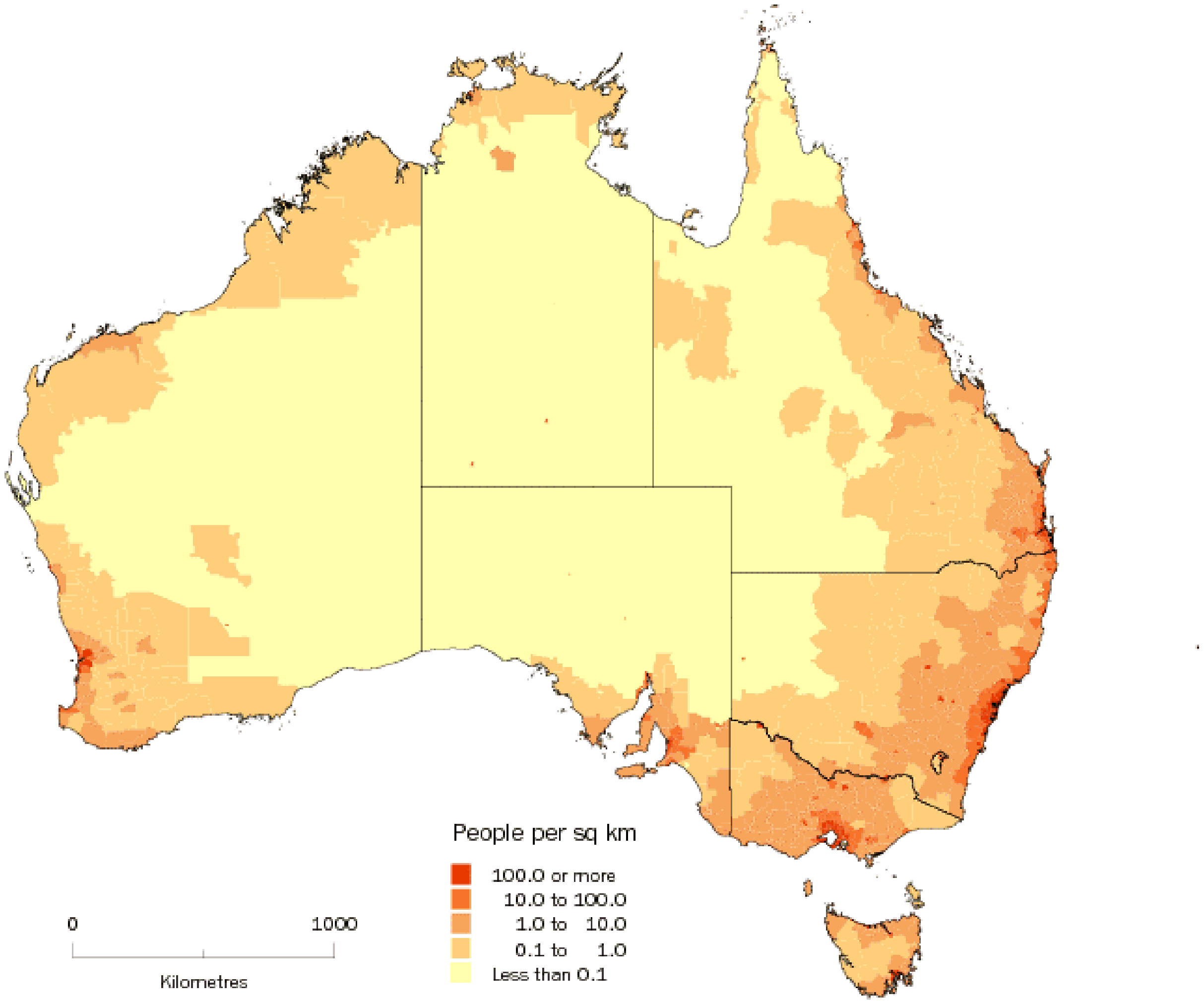
- *- Bounded Locality: small towns with a population of 200 to 999*
- *- Rural balance*

are regarded as Rural.

In ‘business telecomese’ the metropolitan areas are defined as Sydney, Melbourne, Brisbane/Gold Coast, Adelaide and Perth. ***Everything else (regional, rural and remote) is ‘non-metropolitan’***! This reasoning is simple because the metropolitan area is the only area that makes good profits (meaning that all other areas are cost centres) – making financial losses.

Unfortunately, when the ABS-based GIS mapping is applied to telecommunication infrastructure by people that do not have a detailed telecom engineering background and experience, the result is a rather academic result that calculates the population coverage in ‘percentiles’! Another common mistake is where radio coverage is incorrectly mapped as circular and with a finite radius.

In the ABS Website at http://abs.gov.au/ausstats/abs@.nsf/Products/3218.0~2008-09~Main+Features~Main+Features?OpenDocument#PARALINK1 there is a simple population density map shown below:



It really does not take that much intelligence to comprehend that Australia's population density is basically coastal and then by extending that logic very slightly (with the Cost Centre scenario described in the topic "The Fundamental Flaw") it is obvious that the huge bulk of the telecommunications infrastructure is very coastal, and (as given evidence at the Select Senate Inquiry on the NBN 2 in July 2009 - Hansard), I stated that these Backhaul Networks are very 'capital city - centric' as virtual Star networks beaming out from each capital city.

From extensive experience in the Australian telecommunications industry I know that these Backhaul Networks are actually 'tiered star' networks, where capital cities have relatively thick transmission links out to regional cities, and these regional cities have relatively thin transmission links out to regional towns and the regional towns have very thin links to villages and/or 'copper centres' to minimise the overall expenditure of the CAN. The hard lesson to learn is that the non-metropolitan network is not profitable because the relative usage is low, and the distances are much greater than the typical mesh nature of the metropolitan Backhaul Networks.

Even then, this teaching was all spelt out in 1982, but nobody wants to read unfashionable historical reports! The trouble is that basically nothing has changed in almost 30 years – the non-metropolitan areas are still Cost Centres, and a lot more now than it was then!

Positioning the Inland Backhaul

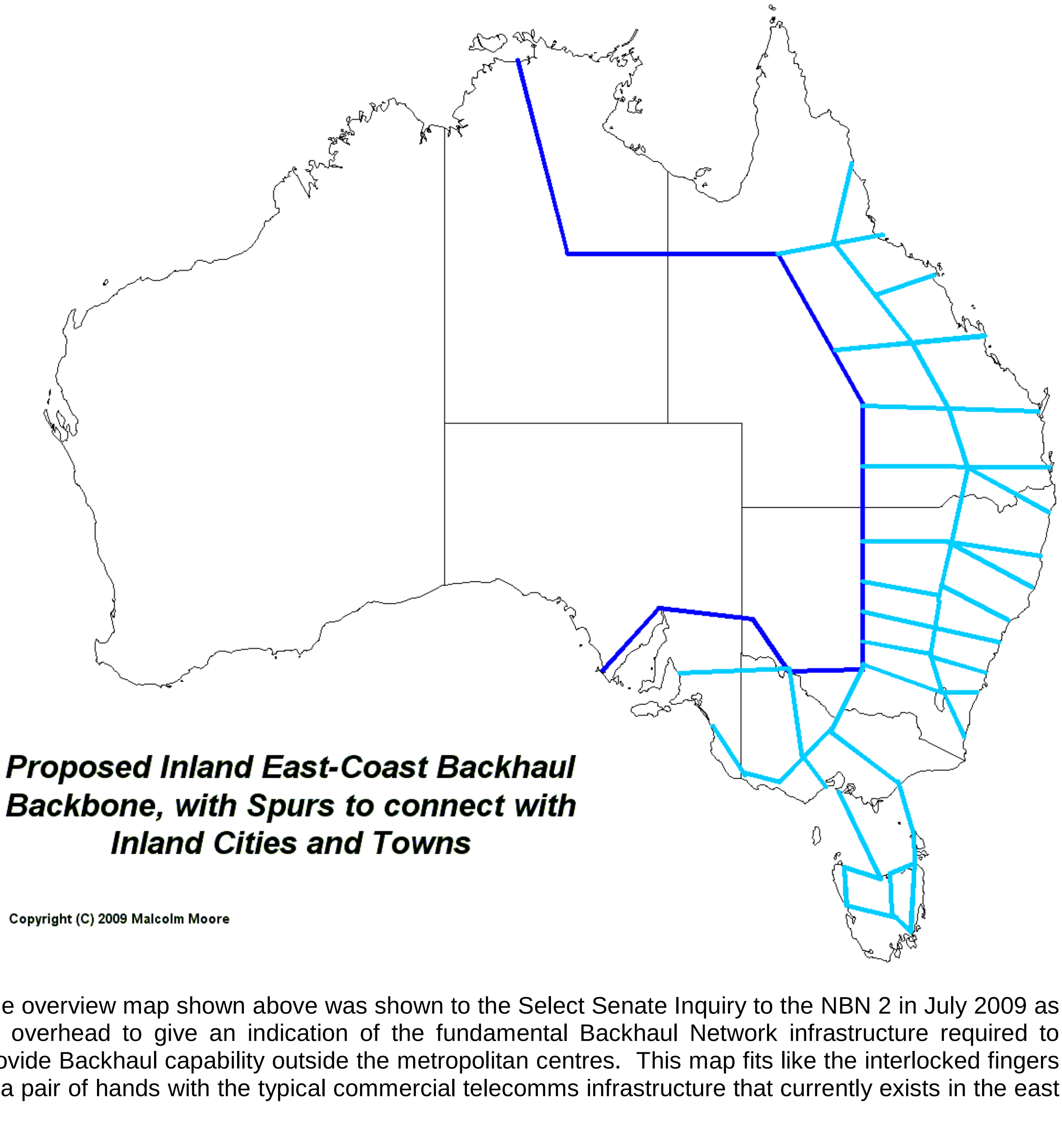
There is absolutely no engineering sense in working out what CAN to put in place if there is not any Backhaul Network to connect with. Again, telecommunications engineering experience has shown that connecting customers with a satellite is a shallow thought-out solution – unless that satellite connection can be both universally used (like a Global Positioning System – GPS), and the satellite connection has an alternative use that more than pays for itself (like military / marketing intelligence).

Since living as a child in central west NSW in the 1950s, being a telecom technician in many parts of NSW in the 1960/70s and in the 1980/90s engineer / manager with a national network responsibility, it was extremely obvious to me that Australia's Backhaul Network beyond the metropolitan areas and outside the "Golden Boomerang" was far too thin. This observation was again backed up in 2006 / 2007 when supervising Telstra's Cable Broadband total infrastructure rebuild in Sydney and later supervising several much thinner Backhaul Network connections to regional cities from Sydney.

If inland Australia (ie not the capital cities) is to have Broadband telecommunications services, then it is imperative that there is more than adequate Backhaul Network infrastructure installed in the inland, and this inland Backhaul Network infrastructure must then have solid spurs or tributaries extending to the capital cities (and many other coastal cities) so that the cost of this Backhaul Network can be adequately compensated by considerable Backhaul through capital cities and international traffic.

As a Network Engineer (1985) in Telecom Australia, I strongly advocated an 'inland Sydney bypass' Backhaul route (Brisbane – Dubbo – Melbourne/Adelaide) – and yes, this happened many years later!

In 2007 I expressed deep concerns that the Regional Telecommunications Review was nothing more than a 'junket' travel by people that really did not comprehend the engineering requirements to fix the telecommunications infrastructure imbalance. From there I set out to formulate an infrastructure that would provide the necessary bandwidth for massive data exchanges outside the restrictions of the metropolitan regions.



The overview map shown above was shown to the Select Senate Inquiry to the NBN 2 in July 2009 as an overhead to give an indication of the fundamental Backhaul Network infrastructure required to provide Backhaul capability outside the metropolitan centres. This map fits like the interlocked fingers of a pair of hands with the typical commercial telecomms infrastructure that currently exists in the east coast of Australia, and largely it provides no competition to the current telecomms infrastructure – and it provides a very rich pick of alternative high capacity Backhaul Network routes that could very easily relive the 'Golden Boomerang' of chronic overload and very poor geographic diversity.

Appendix 4 is an extract from the Submission to the NBN Expert Committee October 2007 that provides far more detail about what Backhaul transmission routes could connect to where.

With this Backhaul Network put in place, then this Inland Backhaul Network would have the capability to connect with what is currently Telstra's highly unprofitable non-metropolitan Backhaul Network. The win-win-win situation is that even though Telstra's regional, rural and remote backhaul is very thin – positioning this thick mesh of Backhaul over it provides a few thousand Backhaul optical fibre spurs that can be radically upgraded to carry 1 Gb/s or 10 Gb/s to quite remote locations at a very reasonable investment, and this will provide the connectivity that is necessary for Broadband.

It seems that the Implementation Study missed out on this Backhaul – Backhaul synergy described directly above – and if so, that is unforgivable, because this win-win-win considerably reduces the NBN CAN construction costs by almost totally removing the need for any satellite CAN, and considerably reducing the need for Radio CAN, while maximising the FTTP CAN bandwidth and use.

Failed Political Piecemeal Programmes

The other unfortunate issue is a plethora of piecemeal projects that were established by both major governments over the past decade to 'put out the spot-fires' without looking at addressing the problem on a national scale and solving it with a far more economical and far-reaching approach.

Some of these classical piece-meal projects included the "***Networking the Nation***" – giving what is the role of telecomms network engineers to townsfolk who have almost no business and technical knowledge in telecomms engineering. This resulted in hundreds – if not thousands of very frustrated small committees that were totally out of their depth and ended up with lots of partial networks and a total waste of coordinated resources. The "***Higher Internet Broadband Incentive Scheme***" (HIBIS) – another harebrained piecemeal scheme to develop pockets of Backhaul for small groups of businesses, without consideration that Backhaul has to be large scale and have diverse geographic paths. "***Connecting Australia – Wireless Broadband***" – a very short sighted spoof to use wireless technology where mobile radio coverage already exists, but without any Backhaul to connect and provide Broadband-like service, and a gross ineptitude in thinking that all radio broadcast patterns would be circular and full strength, and without shadow areas.

The so-called '***Black Spots for Broadband***' programme, apparently to address pockets of low capacity customer Broadband without really fixing up all the Backhaul to stop the problem once and forever.

The Backhaul Network Grid proposal I have provided here will literally eliminate all black spots and provide a very high degree of network diversity that will prevent other black spots from again arising within 20 years in the areas covered by the grid.

Providing Broadband to Birdsville

An example of a non-commercial Business Case strategy complete with costings is in **Appendix 7** as an extract of a supplementary answer (Submission 45a Select Senate Inquiry on the NBN July 2009) provided on notice to Senator Ian MacDonald (Liberal, Qld) on a supposedly rhetoric question of ***connecting Birdsville (far south west Queensland) with Broadband***.

The answer would provide Birdsville with Broadband, and also provide potential Broadband to an area of about 168,000 sq km (south-west of Longreach, and west of Charleville) and costing less than $5 M for the whole project without resorting to satellite anywhere. Unfortunately this solution would still use considerable long-haul radio in the Backhaul Network, limiting the available backhaul capacity to 155 Mb/s. By slightly extending and re-equipping with a 1 Gb/s fibre system out of Longreach to inter-connect to this long-haul Radio at Galway Downs, this could cut the radio system into three much shorter long-haul systems, and very inexpensively increase the virtual throughput by about 300%.

This strategy would provide the Backhaul Network capacity back to Longreach so that Birdsville and other homesteads on those Backhaul paths could inexpensively have basic Broadband facilities. The Business Case for the justification was also covered in **Appendix 7** for Senator Nick Minchin (Lib SA), on non-commercial terms this Broadband service ***will have paid for itself within 9 months***.

The Basics of Optical Fibre Transmission

Optical Fibre is an elegant technology that is particularly suited to Australia, because the CAN lengths are in general much longer than almost everywhere else in the so-called ‘developed world’.

In general most medium-long haul optical fibre systems have a typical optical ‘budget’ of about 25 dB to 30 dB, where the typical transmitter sends at about +10 dBm to 0 dBm and the typical receiver operates in the range of about -20 dBm to –30 dBm. What has to be allowed for is for ageing and production spread, so giving a little bit here and there almost all systems with these (nominal) tolerances will operate with a few dB in their optical budget.

With Backhaul Network transmission systems each fibre is used directionally, which means there are two fibres; one for transmit and the other for receive. Since mid 1985, when optical fibres came out of laboratories and into production, single mode developments have dropped the nominal attenuation from about 0.7 dB/km to about 0.43 dB/km, and with new fibre technologies, the nominal attenuation is about 0.32 dB/km. Considering that splicing adds about 0.1 dB per splice or connection, then in ‘round figures’ a nominal 0.40 dB/km is a good starting point to comprehend the distance capabilities of metropolitan CAN optical fibre cables.

If the optical budget were say 30 dB for a long-haul Backhaul transmission system, and the cable joints were few and far between (say the cable drum had say 25 km when fully loaded), then the nominal loss would be close to 0.32 dB/km; and the maximum range would be about 90 km between optical terminals. This situation is typical for green-fields Backhaul in the inland.

Where regional cities and towns a typically spaced by stagecoach change points (about 35 km), and a ‘round figure’ of 0.40 dB/km is used then the allowable optical budget is typically 14 dB and rather cheap Gigabit Interface Cards (GBICs) can perform very well in these situations. In these situations is it not uncommon to include optical attenuators (like sunglasses) to drop the transmitted level (at the transmitter side of the GBIC) to minimise the backscatter and prevent overload of the receiver.

Working with CAN Technologies

Why ADSL on Pair Copper Fails

Copper CAN has a limited life and **Appendix 1** clearly shows that pair copper as used for almost all the non-commercial CAN in Australia (ie to residences) is already about 10 years well past its use-by date and is well into the expensive maintenance area of its life-cycle. This means that the pair copper technology has outlived its usefulness (and radio is not the non-metropolitan answer).

On a technological aspect, pair copper CAN was an enigma as it replaced open wire (aerial) lines. From a space / environment aspect, pair copper cables were excellent, as the cross sectional area is a very small fraction of that used by overhead telephone wires! Where about 1.5 square metres in cross section could carry about 36 pairs of aerial CAN, the same 36 pairs could easily fit into a cable about 19 mm in diameter (albeit with thinner diameter wires). This is a cross sectional space saving of about 284/15,000,000 or almost 530,000 times – and they can be buried under the footpaths!

Electronically, pair copper cable is a disaster, because the series resistance component totally dominates the electronic distributed constants causing the impedance below about 50 kHz to be highly dependent on line length, distant termination and frequency. With 0.4 mm pair cable as used in urban CANs, above about 10 kHz this extra resistance makes the attenuation per unit length too lossy for ADSL past about 2 km. Also, because it is very difficult to control the impedance / frequency / distance relationship; some rather poor compromises lead to excessive echo, muffled responses, unstable pair gain systems, unworkable ADSL and other situations that really don't 'assist' end users!

Appendix 6, (extracted from my Submission to the NBN Expert Committee March 2008) shows the practical limits for ADSL2+ on various pair copper configurations. Standard 0.40 mm pair copper as used in almost all metropolitan and urban regional situations has a limited distance range of about 2.6 km, which leaves about 60 % of all these ADSL customers with poor Broadband services.

It is 'interesting' to note that the <u>NBN Implementation Study</u> allows for ADSL to operate up to <u>5 km</u> (and it therefore must assume that 12 Mb/s downloads are possible at this length in all situations). This statement is grossly wrong because there is documented proof that urban areas (using standard 0.4 mm pair cable) cannot get downloads greater than 12 Mb/s past a nominal <u>2.6 km</u> distance, which covers about 27% of the customer area specified by the 5 km distance limit. This leaves 73% consumers with useless ADSL in that Study.

To further compound the ADSL on pair copper issue; CAN pair copper cable was engineered with specifications for the voice frequency (that is less than 4 kHz, or 0.04 MHz). One of the cable specifications is **crosstalk** where signal from one pair is induced into other pairs (or signal from other pairs is induced into what should be a 'silent' pair)!

Crosstalk is largely an inter-pair capacitance unbalance (manufacturing) issue that usually gets worse as the frequency is increased, and it usually follows an asymptotic 20 dB/decade curve. With the understanding that ADSL2+ uses frequencies exceeding 1.1 MHz, then it has to be understood that 1.0 MHz is two decades above 10 kHz, and therefore because the attenuation per unit length is so great by 1.0 MHz, then ***Crosstalk interference is the major issue that raises the noise floor to make ADSL technology very 'awkward / unworkable' on CAN pair cable.***

Over several decades, pair copper cable technology has stepped through many manufacturing, maintenance and operational issues that have not assisted ADSL being used on pair copper cable. Lead sheathing was replaced with plastic sheathing that resulted in longitudinal noise because the earth currents in the lead sheathing created a magnetic shield. Paper insulation required gas (air) pressure to keep the paper dry, but plastic / lead sheath joints did not necessarily provide airtight seals – and water gets in. Soldered joints were replaced with 'clip-locking' joints that commonly sprung open after some few years. Random <u>pair</u> jointing was introduced to minimise overhead costs – but this was misinterpreted as random <u>wire</u> jointing, resulting in a huge number of excessive crosstalk problems. White plastic insulation (without colour-coding) resulted in 'unfixed' plastic that crumbles with age. Jelly-filled cables (to remove the air and prevent water ingress) ended up with the jelly attacking and corroding the copper – and the list of maintenance / service problems goes on!

These same CAN cables are now being used for ADSL transmission, but these cables were never engineered for Broadband capabilities, so they are plagued with excessive high frequency crosstalk, which manifests itself as a somewhat synchronised noise floor. This noise floor rises with frequency and distance, and usually this noise is the primary cause for severely limited Broadband bandwidths as distance is increased.

This lack of engineering knowledge about CAN construction should explain why some idiots have set up league tables for comparing Broadband in Australia with little parts of Europe and little parts of Asia, and bits of the USA. Probably it is to amuse other idiots who really don't know what the engineering construction of those other countries CANs are, and the unique cable manufacturing / repair specifications / practices!

FTTP and Optical Splitters

Residential use of optical fibre in the CAN generally uses only one fibre to the premises, and that fibre is used for bi-directional transmission. In its simple form the optical terminal (at each end) includes what is called an optical Hybrid (or 'Splitter'), where the light path is directionally split and this incurs a 3dB attenuation penalty per splitter.

Where the optical budget was nominally 25 dB, the optical budget is now nominally 19 dB because a total of 6 dB has been lost in the splitters (3 dB at each end).

The next loss factor to consider for FTTP is the use of Passive Optical Network (PON) technology, where the optical line termination (OLT) at the local exchange is connected to one fibre and sent into the Exchange Switching Area (ESA), where it connects to a tiered splitter that typically connects to 16 or 32 fibres, which then connect to the 16 or 32 premises.

The financial advantage of connecting to an optical splitter in the ESA is that the number of OLTs is dramatically reduced, and the amount of fibre in the CAN is also dramatically reduced. The disadvantage of connecting to a splitter in the CAN is that the services become shared at this point (but it has to be realised that the services will be shared in the Backhaul also) so this situation is not all that bad – providing all the customers are with the same wholesaler!

A simple optical splitter breaks one connection into two with an attenuation of 3 dB. A 1:16 optical splitter is a tiered set of splitters in the form where 2^4 = 16, so there are four layers of splitting, and the overall attenuation is therefore 4 * 3 dB = 12 dB. With a 32 way splitter, 2^5 = 32 therefore five levels of splitting, so 5 * 3 dB = 15 dB.

Assuming an optical budget of 19 dB then it is rather simple to develop a table to characterise the splitting and the available CAN length using PON FTTP, based on an attenuation of 0.40 dB/km for the optical fibre.

Splitter Fan-out	Splitter Loss (dB)	Remaining Budget (dB)	Maximum Range (km)
1	0 dB	19 dB	47.5 km
2	3 dB	16 dB	40 0 km
4	6 dB	13 dB	32.5 km
8	9 dB	10 dB	25.0 km
16	12 dB	7 dB	17.5 km
32	15 dB	4 dB	10.0 km
64	18 dB	1 dB	2.5 km

This table (above) shows that for maximum economy a 1:32 splitter in the ESA will cut the number of OLTs by 32 times and provide a distance range of 10 km, and this would suit virtually almost all urban areas in Australia, but it will not suit regional, rural or remote areas.

Any academic that is short of Australian telecommunications engineering know-how would jump at employing 1:32 optical splitters and naturally move for an optical FTTP limit of 10 km from the local exchange site, but a little lateral thinking will inexpensively connect almost all consumers using FTTP.

The Urban FTTP Strategy

To me it makes far more sense to leave the urban solution as the 10 km rule with 1:32 optical splitters for the meantime, with the option to reduce the optical splitter fan-out and/or eventually replace all the splitters with direct splices or optically patched as the data rates increase with time.

The big fallacy created by replacing the 4.1 km pair copper urban distance rule with a 10 km PON FTTP rule, is the thinking that because the comparative area covered by one ESA will increase by 5.94 times – the inept accountant would be strongly recommending to reduce the capital city/ suburban exchange sites by 5.94 times and still apparently have the same ESA coverage!

As Sydney / Melbourne (and their suburbs) have approximately 140 exchange sites, then thoughtlessly reducing the exchange sites by 5.94 times would reduce the count to about 24 exchange sites. While this strategy might sound economically very rational, especially because the number of OLTs would be reduced by nominally 32 times what the current; inside the next decade, the amount of data transferred will impact on the ability to use 1:32 optical splitters and a significant number of consumers (end users) will be requiring direct FTTP without splitters, or a much lower split ratio and these exchange sites will become the repositories for data centres and website servers.

With these restrictions in mind, it would be plausible to reduce the number of capital city/suburban exchange sites to half what are there now, and that is very significant – but almost all of these exchanges are supporting broadband routers and Headends for the Broadband Cable (HFC) CAN, so a significant change in this infrastructure would have to occur, plus there is very significant direct FTTP already in almost every local exchange site, so removing exchanges without serious consideration to the auxiliary services being provided from these would at the best be extremely inept.

The Non-Urban FTTP Strategy

Non-urban FTTP situations are incredibly simple to resolve if the Urban FTTP Strategy is put aside.

A high percentage of the non-urban situations can be covered by the urban FTTP strategy because a reasonably high percentage of premises are within 10 km, and that is too easy.

There are already several CAN situations that have greater than 10 km in optical fibre alone from the local exchange to a SCAX hut, where Remote Integrated Multiplexers (RIMs) connect optical fibre to pair copper to the premises – and that again may be several kilometres! These situations are ideal for inexpensive FTTP conversions where the total CAN distance would be longer than 10 km.

In many cases premises are in a group like small villages (5 to 150 premises), typically about 25 km from the nearest town, and those villages are connected with optical fibre cable connecting to a RIM and the premises are connected with pair copper. Consider that a typical thin optical fibre has say 16 pairs in it (or a total of 32 fibres), then if those fibres are connected to an OLT rack in the ‘nearby’ towns’ local exchange, then by ‘Urban FTTP Rules’ this scenario is well outside the FTTP allowance.

Assuming that the cluster of premises is less than say 2 km from the RIM in the SCAX hut, then there are farms spaced out about 4 km apart, and some bigger farms upwards of 10 km out from the SCAX hut site. The maximum distance would be about 35 km and the typical distance would be 25 to 30 km. The table above shows that if 1:8 splitters were used for the nearby residences covering the nominal 25 km range, 1:4 splitters were used for the residences less than 32.5 km away and a couple of residences were directly connected, then FTTP Broadband could connect up like the table below:

Distance km	Splitter Fan out	Splitter Loss	Fibre Count	Consumers
45 km	0	0 dB	2	2
35 km	1:2	3 dB	4	8
30 km	1:4	6 dB	10	40
25 km	1:8	9 dB	16	128
Total			**32**	**178**

This example shows that a typical SCAX hut (and there are more than 820 of them) could connect to virtually all the rural and remote premises that are within say 45 km of any town, and the cost would be relatively inexpensive – because a large portion of the optical fibre CAN already exists to SCAX huts.

The next scenario is almost as simple: If the SCAX hut is more than say 25 km from the local town, then an OLT rack is to be put into the SCAX hut, the fibre tail back to the local exchange is to carry a 1 Gb/s IP traffic as Backhaul and connect through to the district Router/Switch. The SCAX hut is now capable of connecting typically at least 50 to 250 OLT positions, and from that point the SCAX hut is the optical centre for the nominal 35 km (extending to 45 km for more remote customers). This will manage more than 1500 premises – including the scenario described above.

The next scenario builds on the above two scenarios in that a 1 Gb/s IP Optical Backhaul link can be daisy-chained on nominally 80+ km hops with Switch / Routers and at each hop, sub-spurs to OLTs in SCAX huts can be connected through to premises (partially in the same cable sheath). This strategy virtually eliminates any need for satellite or radio CAN, and comparatively is very economic.

100% FTTP CAN Rollout

Some non-metropolitan areas already have good Backhaul facilities, and it is these areas that should be 100% rolled out to all premises. As the Backhaul is brought through regional cities and towns, these communities should be 100% connected with FTTP.

The estimates for the Backhaul used typically 240 strand optical fibre cable everywhere, for the purpose that in most country areas the Backhaul and CAN will be in the same cable, and this facilitates spurs of Backhaul together with considerable CAN components along the way up to and exceeding 40 km from the OLT in the local or near local exchange.

As Backhaul is connected through non-metropolitan cities, towns, and villages; the FTTP CAN must be rolled out to connect every premises. As for Homesteads, the section above that provided three options for extending optical fibre either as Backhaul spurs to SCAX huts with FTTP CAN to the homesteads, and/or extended FTTP directly from towns and villages either directly or indirectly via SCAX huts to those homesteads.

With this rollout into country areas it is imperative that very serious consideration be given to utilising some special optical techniques like:

- Directional couplers to reduce the optical losses that otherwise occur in optical splitters from 3 dB to much less than 1 dB,
- The use of pair directional fibres, to reduce the effects of transmission loss and background scatter.
- The application of spare fibres so that remote radio base equipment can be located to service mobile communications in remote locations far from main highways (where most mobile's radio base stations are located),
- The use of CWDM to include FTA TV, Pay TV radio and datacasting over fibre to all premises, particularly those in rural and remote locations where reception is compromised / limited,
- The use of directionally different wavelengths to minimise backscatter issues and maximise service distance.

In some cases it can be rather difficult to provide a 'standard connection' and the inept approach is to jump into a radio (or worse still a satellite) solution. The real issue is that optical fibre to the premises provides a huge bandwidth differential compared to any form of radio (including satellite – which also is radio). "Homestead Hopping" with thin aerial fibre under the power lines is a very cheap "Backhaul / CAN" ingenious engineering solution that requires significant investigation and development.

Why Pre-Measured FTTP Fails

While at the CeBIT Conference at Darling Harbour on 24-May-2010 in discussion with some representatives relating to equipment being trialled for the NBN rollout in Tasmania; there was talk about the Corning 'pre-measured and pre-terminated optical fibre CAN'. What I had long suspected about measuring on the wrong side of poles in some instances had led to the terminations being offset from the poles such that customer connections were hanging in the spans, off the poles.

While I am sure construction error this could be put down to 'initial technicalities' from my experience in network design and construction, there is always the "AsBuilt" documentation that includes all the corrected errors, omissions and variations that inevitably occur as every construction project proceeds, and therefore only the most inept of negotiators would even consider having an overhead optical fibre CAN pre-constructed before being rolled in! Even optical patch cables (a few metres long) in exchange sites are commonly specified with incorrect lengths – so rolling out pre-fitted optical CAN is just asking for major problems due to measurement differences and/or pole changes.

Considering the continuing annoyance that metropolitan Australian people have about the existing Cable TV HFC infrastructure which is largely strung up under power lines in these areas, it seems that stringing up even more CAN under power lines in metropolitan areas is literally asking for a strong political backlash, and such a practice should be actively avoided. In any case the (Telstra, Optus etc) ducting in all metropolitan streets that currently holds a mix of pair copper cable and an optical fibre cable will soon be just optical fibre cables.

What is ‘acceptable’ in the USA is not necessarily ‘acceptable’ here! In Canada the jointing pits are usually pole mounted so that lines can be serviced in 3 metres of snow – we barely have rain, let alone snow. The USA is ‘conditioned’ with 110 V AC pole mounted transformers every 200 m, ours power is 240 V AC and the transformers are underground or spaced at about 1 km centres.

Conversely, as most homesteads in rural and remote locations are connected with high voltage power lines (for example 11 kV) over a considerable distance, it does make very good economic sense to sling another wire (albeit a thin optical fibre cable) just under the high voltage lines to minimise the amount of essential service poles. This practice would radically reduce the cost of installing replacement CAN into most homesteads, and provide a degree of Quality workmanship that would minimise maintenance costs well below that of existing pair copper aerial cable to premises.

CWDM Radio, Television and the ASX

The synergy between Internet and Pay TV is very partially explored with Cable TV CAN component, the Hybrid Fibre Coax (HFC) being utilised to transport Broadband Internet over TV channels for downstream and the ‘Back Channels’ (also used for system maintenance and reporting) being used for upstream for Broadband Internet.

HFC has a lot in common with ADSL in that they both use very asymmetrical data transfer rates in their CAN bearers for downstream and upstream transport protocols. In engineering terms this is very efficient as the available bandwidth is fully explored for a maximum result with a minimum of cost.

HFC and ADSL again have a lot in common with Radio and TV broadcasting because Radio and TV broadcasting have a virtually zero upstream path except for people answering surveys, phoning back to calls and/or broadcast telephone, emails, twitter etc. messages.

FTTP has the facility for comparatively, a very fast download data rate and a comparatively fast upload rate compared to HFC and ADSL. FTTP could employ Coarse Wave Division Multiplexing (CWDM) so that different light frequencies / colours / wavelengths can be used on the same fibre to very economically provide virtual Broadcast and Datacast facilities on FTTP infrastructure.

When considering the geographic size of Australia with a multitude of countries in Europe – the populated areas of Australia is still bigger than all of Eastern Europe. In my opinion this CWDM PON FTTP technology is in its infancy, and this technology would provide both Pay TV and Free-To-Air (FTA) TV radio and datacasting services like live ASX trade data to everywhere in Australia with very little overhead!

With a slightly lateral engineering approach, there are a multitude of towns and suburbs that are geographically occluded from receiving reasonable quality TV and/or Radio, because these locations are in the shadow of mountains / hills and/or are located off escarpments and/or in valleys.

Instead of establishing special Broadcast repeater sites and further clogging the already scarce spectrum (as aptly demonstrated by the “Digital Dividend” strategy, FTTP can be directly connected to every premises so that apart from Broadband Internet / Telephony (VoIP), the FTTP connection would facilitate Pay TV, FTA TV, radio and datacasting at local, regional and national levels, Datacasting of ASX (and other countries) trade prices etc, so that premises located outside the metro area would in no way be disadvantaged because of their geographic locations.

A solid inland Backhaul backbone would be the core to transport this content, and this same Backhaul core would provide high capacity transport for Internet through the nation and internationally via Darwin, Cairns, Normanton, or other northern located coastal localities in Western Australia.

Costing the Backhaul

The process for costing the NBN is much like "how long is a piece of string"? What has to be well understood is that optical fibre cable is comparatively cheap compared to any form of metallic cable (coax, twisted pair, twisted quad, or any combination of the above), and it is well known that the most expensive component in laying optical fibre is the cost of digging the trench to lay the cable.

Using Industry Benchmarks

From first-hand experience in the telecommunications installation and commissioning industry, I know that the typical cable purchasing / delivering / laying / splicing / terminating / reinstatement process is about $30,000 per kilometre, and it really does not mater too much what size (number of fibres) the cable is! The associated engineering includes walking through and marking out cable route, arranging concurrences with all stakeholders, creating the design drawings, tendering / purchasing / delivering / installing / terminating into ODFs, commissioning and amending the design documents to match reality, and then cutting over into service. Supervision, and Management costs are all inclusive (but not exchange building costs).

In this exercise I deliberately used 240 fibre cable everywhere for the reason that CAN growth and usage can be used almost everywhere in the inland, and although the use of 240 strand fibre cable might seem extravagant, there is a big economy of scale and it has to be understood that typically 4 to 32 fibres would commonly be used for Backhaul, and that leaves about 200 for Broadband consumers who are en-route – or within a 45 + km range of the Backhaul core, and in remote areas splitters will not be commonly used.

Almost all locations will have or need two racks with switch / routers – or optical amplifiers, and suitable powering equipment / batteries, alarm monitoring. These racks do not include CAN OLT interfacing – which is a separate issue and not financially accounted for in this document. A 'round figure' of $100,000 per (Backhaul Network) rack is assumed and economies of scale and simple flexibility will include the design engineering which includes walking through and marking out the floor space, arranging concurrences with all stakeholders, creating the design drawings, tendering / purchasing / delivering / installing / commissioning / socialising and amending the design documents to match reality, and then cutting over into service. This cost also includes all field staff, supervision and all management costs (but not the exchange building costs).

Although these seem rather fuzzy figures, they do provide a good basis to get a broad costing of the proposed backhaul infrastructure. These costings are broken up into geographic links, and the timing can be worked out at a later date.

Currently there are telecommunication links to businesses in rural areas that severely compromise the availability of Backhaul to many other consumers in those areas – purely because of commercial funding. The installation of this proposed grid of core Backhaul would considerably reduce the 'network transmission congestion' caused by having too little throughput, and little if any geographic path diversity. My proposed Backhaul Network grid would very economically provide a geographically very diverse Backhaul network so that all those businesses could be economically provided with much faster connection speeds.

Detailed Backhaul Accounting

Appendix 9 contains several Backhaul Network structures that include most detail on optical fibre paths and the location of regenerator / switch / router (or amplifier) locations. Although these network structures are first estimates, they do show where the Backhaul can be best positioned to link in with other optical fibre telecommunications networks in Australia and form a very economical Backhaul core that will be capable of considerable growth over many decades with a minimum of expense.

The following table is a totalled summary of the detail provided in **Appendix 9**, covering vast areas of Australia that has a limited or nil Backhaul infrastructure. Here is the sum of these first estimates.

Eastern Inland Backhaul Backbone	$ M	km
Darwin - Three Ways Roadhouse	$30.93	951
Three Ways Roadhouse – Cloncurry	$23.99	753
Cloncurry – Longreach	$16.83	521
Longreach – Charleville	$16.65	515

Charleville – Cunnamulla	$6.39	193
Cunnamulla – Bourke	$8.48	256
Bourke – Griffith	$15.30	470
Griffith – Shepparton	$9.04	268
Shepparton – Ouyen	$12.62	374
Ouyen - Port Pirie	$20.42	614
Port Pirie - Port Lincoln	$14.35	445
Estimate	**$175.00**	**5360**

Eastern Inland Backhaul Crescent

Cairns - Charters Towers	$22.99	713
Pentland – Emerald	$19.06	582
Emerald – Roma	$13.30	390
Roma – Walgett	$15.74	478
Walgett – Dubbo	$9.08	276
Dubbo - Wagga Wagga	$14.60	440
Estimate	**$94.77**	**2879**

Eastern Inland Backbone to Coast Spurs

Cloncurry – Woodstock	$26.15	785
Clermont – Mackay	$9.70	290
Barcaldine – Rockhampton	$21.37	639
Charleville – Gympie	$21.73	651
Cunnamulla – Toowoomba	$27.34	838
St George – Lismore	$18.50	550
Bourke – Grafton	$25.33	791
Walgett - Port Macquarie	$20.08	616
Cobar – Maitland	$23.16	692
Hillston - Batemans Bay	$19.50	570
Wagga Wagga - Eden	$13.73	411
Corowa - Lakes Entrance	$12.70	370
Ouyen - Mount Gambier	$24.29	723
Estimate	**$263.58**	**7926**

Tasmania Backhaul and Spurs

Bairnsdale – Sorell	$24.10	750
Sorell - Eaglehawk Neck	$2.60	80
Sorell – Southport	$4.00	120
Sorell - St Marys	$8.90	270
Campbell Town – Gladstone	$14.40	420
Bridgewater – Wynyard	$15.80	480
Queenstown – Strahan	$1.70	50
Bridgewater – Longford	$7.05	215
Apollo Bay – Beaconsfield	$16.10	490
Estimate	**$94.65**	**2875**

West Australia Backhaul

Esperance – Meekatharra	$40.15	1225
Meekatharra – Albany	$40.50	1230
Albany – Geraldton	$30.60	920
Geraldton - Tenindewa	$4.80	140
Geraldton - Port Denison	$5.80	180
Estimate	**$121.85**	**3695**

Total Estimate ($M, km)	**$749.85**	**22,735**

So, before the CAN is rolled out in any large quantity, a considerable amount of Backhaul needs to be put in place, at a first estimate investment cost of about $750 M, and spanning almost 23,000 km

Timing the NBN Rollout

The big problem with Broadband is that without a substantial Backhaul network the Broadband CAN will connect with nothing – and nothing will be the result! The similarity is like providing computers for all schools without having any Local Area Network, CAN and Backhaul connected – because no matter what computers are provided if they can't connect with Broadband then their uses are rather limited! The Digital Economy cannot get a pulse until the Backhaul is in place and integrated with the existing Backhaul Networks in Australia

Creating the Backbones

With this understanding about the need for Backhaul first, it is imperative that the Backhaul precedes the CAN, and that means the core Backhaul Inland Backbone has to be installed within the first two years, the spurs within the third year and the remainder in years 4 and 5.

As pair copper has to be replaced – because it really has ended its MTTF lifecycle, then this means that all premises must be connected with FTTP as an essential service (just like water, sewerage, and electricity). Commercially 'passing' homes like the debacle with the dual rollout of HFC in the early 1990s is not connecting the premises, and as noted then, the HFC CAN was downsize engineered to minimise the costs, and it was proven (see **Appendix 8** Submission 45b to the Select Senate Inquiry on the NBN2 July 2009) that the competitive rollout by Optus and Telstra was extraordinarily expensive to all Australians, and it proved the "***Theory of the Second Best***" (see **Appendix 8**) which explains in economic terms that competition is a very poor second choice compared to business and community cooperation.

Integrating Non-Metropolitan Networks

Telstra's highly unprofitable non-metropolitan network is 'capital city centric' and the sooner that Telstra spins-off this infrastructure burden the better it will be for all Australians and the ASX! The NBN core Backhaul Backbone that I have proposed (see **Appendix 3**) is inland-based on purpose so that it picks up the tails of the capital city to country spurs and makes these spurs high capacity

With this inexpensive high throughput capacity in the inland, this Backhaul grid-mesh will then have several hundred minor 'spurs' from regional cities and country towns to Small Country Automatic Exchange (SCAX) hut sites that are typically anything from six to 80 km from the main Backhaul grid. As described above there are three options that will inexpensively provide FTTP to literally every premises in Australia – because virtually all of these SCAX huts are connected with optical fibre that can be used as either Backhaul and/or FTTP

Training the Field Staff

What has to be realised is that there is a large amount of physical trenching, splicing and equipment installing and commissioning, and a virtual army of people need to be trained up as soon as possible, and this training takes several months (if not years to learn Quality techniques). Much of this detail is covered in **Appendix 7** as the Supplementary answer to Senator Nick Minchin on giving evidence to the Select Senate Committee July 2009).

To get an understanding of the man-hours required, consider that every drum of optical fibre cable is 240 strands and that they are 10 km long. There is 19815 km of optical fibre, or about 1982 spliced cables with a total of 475,680 splices or terminations. If there are 250 workdays in a year, then over eight years there is 2000 workdays, and in that time there will be 23,784 splices per day.

Considering a good splicing team of two people can splice about 120 splices per day (and record the test results for each splice), then almost 4,000 qualified splicers are required right now and for the next eight years – and that is just for the Backhaul.

For the CAN, there will be in the order of 10 M premises where teams of two people (for efficiency) will take in the order of 1.5 hours per premises – plus the design teams to work out the street layout, the rodding and roping staff and the supervisory staff; and the staff to install and equip the OLT s in the local exchanges. In round figures it will take about 6.5 man-hours per premises including the local exchange (and that is just the metro areas). In the non-metro areas (regional, rural and remote) the man-hours can take some days per premises.

Consider there are 10 M premises in 2000 workdays at 6.5 man-hours per premises, then this works out at least 5000 premises per work day which is about 4000 field staff to do the CAN work alone.

We are up to at least 8,000 field staff and on top of that there are field and project supervisors, managers and office staff. Many of these will have to be experienced designers – and we simply do not have more than about 200 practicing telecommunications engineers in Australia – and importing them is not the answer – we need to in-house train them.

In round figures we need about 10,000 staff on average wages + superannuation of about $120,000 each yearly, which works out at a yearly wage bill of about $1.2 Bn annually, or about $9.6 Bn over eight years. Staff requires offices and transport and rather expensive equipment for splicing and measuring the Quality of every splice (before moving on and possibly leaving defects). These overhead costs (including supervision, management and office support / IT etc.) must be included.

Grooming the Backhaul

One of the rather well hidden expenses will be the development of engineering facilities to manage the total network and optimise the traffic throughput. At this stage large organisations in Australia like Telstra (which has a Global Operations Centre (GOC) in Clayton, Victoria) and Optus (which has a Global Operations Centre (GOC) in Macquarie Park, NSW), manage their network operations from these sites.

Serious consideration has to be given to establishing yet another GOC or using the services of established telecommunications businesses – or taking over the services of the GOC with the absorption of Telstra's wholesale network (and/or Optus and others like the Australian Academic and Research Network (AARNet)) infrastructure into the NBN.

Further consideration should be taken about existing optical fibre networks that may be 'under-utilised' like the Queensland Coal, Queensland Rail, etc that also have substantial fibre networks with relatively slow and/or relatively low capacity terminal equipment connected – compared to what is now standard as 10 Gb/s IP.

Earlier generation optical systems would have run STM-1 which is a 155 Mb/s arrangement of which only 126 Mb/s is available for 'transport payload' (the rest is for system management overhead), and this works out as 12.6% of a 1 Gb/s transmission system or a mere 1.26% of the available 10 Gb/s optical bandwidth capacity that is currently available. Currently most new transmission systems are running 10 Gb/s which is 10 times what was common several years ago being 1 Gb/s.

With improvements in technology, I believe that CWDM will become the standard for PON and direct FTTP within a few years, and this will facilitate economic FTA TV, and Pay TV, radio and datacasting as standard services alongside Broadband Internet.

Conclusion

This document was produced in good faith to try to get the NBN off the ground and into service for all Australians.

This inland Backhaul backbone with spurs to form a Backhaul Network grid was conceived by me in 2002 and put to document form in the past five years. In relative terms (satellite / radio) this backbone grid is reasonably inexpensive and a first estimate costing for that part of the project has been provided with the assumption that all Telstra's non-metropolitan exchange sites will become available to the NBN for augmentation and merging.

The backhaul network proposed here is about 22,750 km long and is first estimated to cost about $750 M to install and commission (using Telstra exchange sites). The non-metropolitan FTTP CAN may cost somewhat more than the Backhaul, but I doubt it because much of the non-metro CAN could be in the same cable sheath as the Backhaul and most of this FTTP CAN will be aerial.

The strong preference is that all premises are 100% connected (not just passed) with FTTP technology, and this document has provided three basic scenarios that will connect to just about every premises within 45 km of a Backhaul backbone or an optical fibre Backhaul spur.

The 10 km limit for FTTP is highly artificial and in non-metropolitan areas such a distance limit is unnecessarily short and this ‘urban centric’ strategy needs to be thoroughly and seriously reviewed. Suggestions on useful lengths are included in this document.

In the consideration that radio, TV and datacasting broadcast transmission can be performed very effectively with fibre – it stands to reason that FTTP should be expanded with CWDM techniques to download FTA TV, Pay TV, radio as well as datacasting and Broadband Internet. The synergies here will create considerable savings in other areas such as radio and broadcasting transmitters and the associated geographic spectrum space.

The labour force for this Backhaul network work will have to be trained as an urgent priority as there will need to be at least 4,000 splicers for the backhaul alone, to work for at least eight years. Likewise for the CAN, another 4,000 field staff (including about 1,400 splicers) will be needed over the next eight years. These staff need supervision, management and support staff, vehicles, test equipment, offices and vehicles as a priority and these estimated costs are inclusive.

The thick inland backhaul networks will promote digital business well outside the capital cities and this will cause the inland wealth to increase, and for people to be more distributed and less urbanised. Advanced mobile facilities and services in regional, rural and remote areas will then become closely aligned with what is available in the metropolitan areas, and the geographic ‘Digital Divide’ will to a large degree be eliminated. A large range of business opportunities that were once only ‘capital city’ based, will then be open to non-metropolitan areas and transport will become more ‘electronic’ than physical, greatly reducing our dependency on the oil economy.

If Telstra is to ‘see the light’ it will transform from a vertically integrated telecommunications business where it’s two arms (infrastructure and reselling) can be separated and each focus on their strengths. Currently each Telstra arm is crippling the other and that is covered in **Appendix 5** (Submission 45 to the Select Senate Inquiry on the NBN2 July 2009). When Telstra’s infrastructure is re-positioned under the NBN Co, then Telstra as a primary retail reseller will become the highly profitable telecommunications reseller in Australia.

The Return on Investment (ROI) has not been specifically covered here, but **Appendix 7** (as a Supplementary answer to Senator Nick Minchin on giving evidence to the Select Senate Inquiry on the NBN 2 July 2009) shows very clearly that even with a CAN connection cost of about $10,000 in remote areas, this cost can be returned in nine months in saved social support costs, improved education facilities, improved work prospects and reduced medical issues (like mental depression).

The Bandwidth advantages of FTTP significantly outweigh the use of radio (wireless) / satellite CAN technologies and considering this understanding that CWDM can be used as standard, then many other service contents like FTA TV, Pay TV, radio and datacasting can be included together with FTTP in all areas – not just metropolitan areas.

We have all learned the lessons and failures of privatising what are essential services, and the lessons here need to be enforced; and the NBN must never be allowed to be put into private hands – or be floated on the share market, or indeed operate as a profit-making organisation. The prime focus of the NBN is to maximise the provision of Quality wholesale telecommunications services to its resellers at prices that allow the competitive resellers to maximise their profits in what will be a very level playing field.

Appendix 1

Extract of a Submission to the NBN Expert Committee March 2008

Decades of Technology Changes

The following Table is an update from "Australia's Converging Networks Technologies" [02] that shows the Australian Backhaul Network Switching and Transmission technologies in a table form, with the dates rounded [in five-year blocks]:

Backhaul Technology	Implemented	Effective	Matured	Obsolete
Crossbar Mechanical Switching	1960	1965	1970	1995
10C Analogue Switching SPC	1970	1975	1980	1985
AXE Digital Switching	1980	1985	1993	2005
DMS Digital Switching	1985	1990	1995	2000
S12 Digital Switching	1990	1995	2000	2010
IP Switching / Routing	1995	2000	2005	2040
FDM on pair/quad cable	1935	1940	1950	1980
FDM on Coax Cable	1950	1955	1960	1985
FDM on Point-to-Point Radio	1960	1975	1985	1990
PDH on Pair Cable	1980	1985	1990	2005
PDH on Coax Cable	1980	1985	1990	1995
PDH on Point-to-Point Radio	1985	1990	1990	1995
PDH on Optical Fibre	1985	1990	2000	2005
SDH on Point-to-Point Radio	1990	1995	2005	2015
SDH on Optical Fibre	1990	1995	2005	2040
ATM on Point-to-Point Radio	1990	1995	2000	2005
ATM on Optical Fibre	1990	1995	2000	2005
MPLS on Point-to-Point Radio	1995	2000	2005	2040
MPLS on Optical Fibre	1995	2000	2005	2040
Optical Fibre – Single Mode	1985	1990	1995	2040
Optical Fibre – DWDM	2000	2005	2010	2040
Optical Fibre – CWDM	2000	2005	2010	2050

Table 1 Switching and Transmission Technologies in the IEN - Time

This table clearly shows that as from 2005, the only technologies in the IEN [Backhaul Network] that will not be obsolete or very near obsolescence will be IP switching; and for transmission; Optical Fibre and point-to-point Radio.

Note: I have not included the synergetic and necessary associated Network Management structures that are essential for the cost-effective and efficient operation, management, metering, maintenance, signalling and support of these various switching and transmission infrastructure technologies.

The table below follows on directly from the above table, but looks at the combination of Broadband IP with Pay TV (Multimedia) and Radio/TV Programme distribution networks. This table of particular significance as it links bearer physics to traffic utilisation to a lifetime.

Backhaul (Tx) Application	Implemented	Effective	Matured	Obsolete
Programme Distribution Coax	1945	1950	1975	1985
Programme Distribution p-p Radio	1960	1965	1975	1990
Programme Distribution Satellite	1980	1985	1990	2000
Programme Distribution Optic Fibre	1990	1995	2000	2030
Programme Distribution OF Systems	2005	2010	2015	2040
Telephony – Open Wire	1850	1855	1920	1930
Telephony – Loaded Cable	1920	1925	1955	1985
Telephony – Coax Cable	1950	1955	1960	1985
Telephony – Point-to-point Radio FDM	1960	1975	1985	1990
Telephony – Optical Fibre PDH	1985	1990	2000	2005
Telephony – Point-to-point Radio PDH	1980	1985	1990	1995
Telephony – Optical Fibre SDH	1990	1995	2005	2040
Telephony – Point-to-point Radio SDH	1990	1995	2005	2040
Telephony – Optical Fibre IP/MPLS	1995	2000	2005	2040
Telephony – Point-to-point Radio IP/MPLS	1960	1975	1985	1990
DDN – Loaded Cable	1965	1970	1975	1985
DDN – Coax Cable	1965	1970	1975	1985
DDN – Point-to-point Radio FDM	1965	1970	1985	1990
DDN – Optical Fibre PDH	1985	1990	2000	2005
DDN – Point-to-point Radio PDH	1980	1985	1990	1995
DDN/Internet – Optical Fibre SDH	1990	1995	2005	2040
DDN/Internet – Point-to-point Radio SDH	1990	1995	2005	2040
Internet – Optical Fibre IP/MPLS	1995	2000	2005	2040
Internet – Point-to-point Radio IP/MPLS	1995	2000	2005	2040
Pay TV Centralised Optical Fibre	1992	1995	2000	2005
Broadband Multimedia Centralised OF	1995	2000	2005	2005
Broadband Multimedia Remote OF	2005	2010	2015	2030
Broadband Multimedia 10G+ OF Systems	2010	2015	2020	2040

Table 2 Backhaul Network Wholesale Applications over Time and Technology

All of these Backhaul Transmission Applications have high bandwidth requirements, but each network structure is significantly different – and each network structure is optimally engineered for efficient distance-related and capacity-related transport.

It is obvious that each incremental system grows on the backs of the previous technologies, and this is one of the integrated synergies that brings in higher speed networks at ‘competitive prices’

(Explanation: “Competitive Prices” in this text specifically means prices that are commensurate with existing prices for similar service standards, and costing proportionately more for increased service standards. “Competitive Prices” in this text <u>specifically does not mean</u> prices that are moved by marketing and advertising strategies to fight/battle/war for a larger portion of the available market.)

In just the same way that the Backhaul Network (BN) has technologically morphed over several decades, the Customer Access Network (CAN) has also technologically morphed over several decades, and this too was described in “Australia’s Converging Network Technologies” [02].

Again I have produced a rather simple table that takes the various CAN technologies through their life cycles, and this should set the scene for sensible CAN forward network planning / engineering.

Customer Access Technology	Implemented	Effective	Matured	Obsolete
Open Wire Line	<1900	1900	1900	1970
Twisted Pair Cable	1940	1950	1980	2000
PGS Loaded Pair Cable	1940	1950	1970	1990
PGS VFHA – Pair Cable	1985	1990	1995	2005
PGS Remote Line Mux	1985	1990	1995	2000
PGS Remote Int Mux	1990	1995	2000	2005
PGS DDN 64 kb/s	1980	1985	1990	2000
PGS MegaLink 2 Mb/s	1980	1985	1990	2005
PGS ISDN 2 Mb/s	1980	1985	1990	2005
PGS Frame Relay 2 Mb/s	1980	1985	1990	2005
PGS Frame Relay 155 Mb/s	2000	2005	2005	2010
PGS Analogue Radio Conc. Sys.	1975	1980	1985	1990
PGS Digital RCS	1980	1985	1990	1995
PGS HCRC	1985	1990	1995	2000
Hybrid Fibre Coax (HFC)	1992	1995	2000	2010
HFC Analogue TV	1992	1995	2000	2005
HFC Digital TV	2005	2010	2010	2010
HFC IP/Internet DOCSIS2	1995	2000	2005	2010
HFC IP/Internet DOCSIS3	2005	2010	2015	2020
PGS ADSL DSLAM (IP)	1995	2000	2005	2010
PGS ADSL 2 / 2+	2005	2010	2010	2010
PGS ADSL on p-p Radio	2005	2010	2010	2015
Mobile – Analogue	1980	1985	1990	1995
Mobile – Digital GSM	1990	1995	2000	2005
Mobile – CDMA	1995	2000	2005	2010
Mobile – WCDMA (3GSM / IP)	2000	2005	2010	2030
Broadband – FTTNode 2 Mb/s (**ADSL**)	1990	1995	2000	2000
Broadband – FTTN 155 Mb/s (**ADSL**)	1995	2000	2005	2010
Broadband – FTTPremises 30 Mb/s	2000	2005	2010	2040
Broadband – FTTP 155 Mb/s	2005	2010	2015	2040
Broadband – FTTP 1 Gb/s	2015	2020	2025	2040
Broadband – FTTBusiness 2 Mb/s	1990	1995	2000	2005
Broadband – FTTB 155 Mb/s	2000	2005	2010	2020
Broadband – FTTB 1 Gb/s	2010	2015	2020	2040
Broadband – CWDM	2000	2010	2015	2050

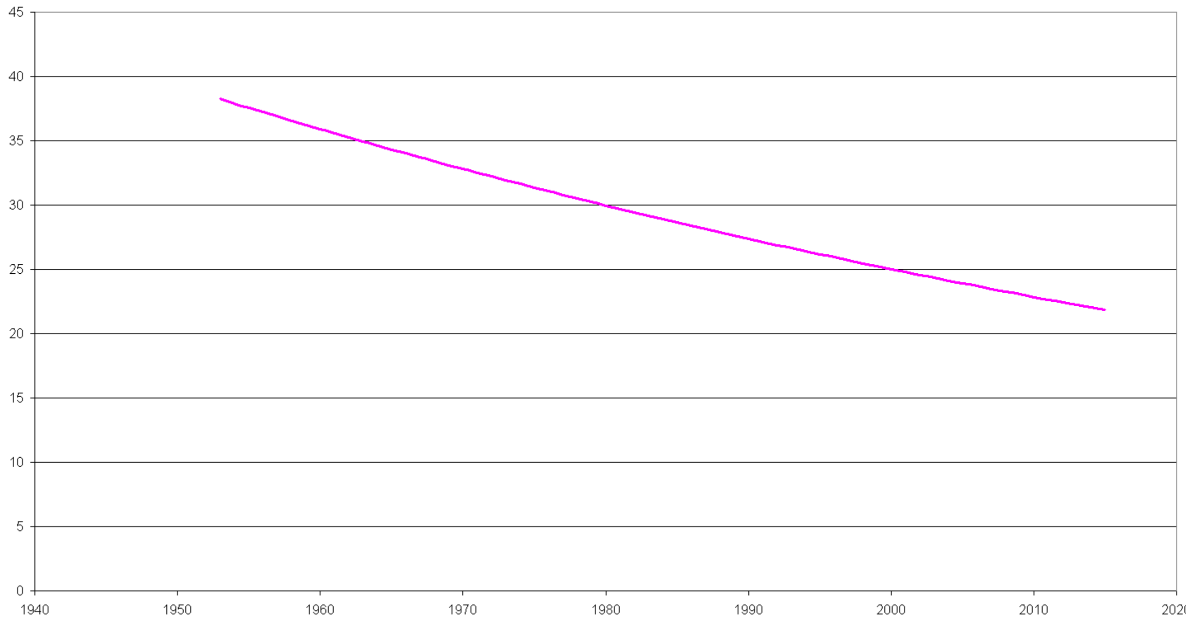
Table 3 CAN Technologies over Time

In general, the Australian Customer Access Network (CAN) [03] has trailed the transmission technologies used in the Backhaul Network [01] by several years, and in the more recent decades, these transmission technologies have considerably converged [02], faster with time (with the exception of Optical Fibre as a CAN transmission bearer, which is several years behind the general trend).

Appendix 2

Extracted from the RTR Submission October 2007, and updated in "[ ]" brackets.

Appendix B – Telecommunications Life Expectancy



This is a simple graph showing that the average life expectancy of [active] telecommunications equipment is dropping at a rate of about 0.90% per year/ per year. [Passive telecommunications equipment has between 15 to 20 years longer than active telecommunications equipment.] The markers were based on Crossbar [Switches], Optical Fibre [terminal equipment] and digital switching [equipment]. IP routers [are 'active and] fit this same curve!

When it comes to Technology, the term 'future-proof' is competitive business slick for the term 'Infrastructure Life Cycle Management ". Getting this into perspective, when Crossbar switching was introduced into Australia in 1960, the low maintenance life expectancy was about 36 years; AXE switching in 1980 – about 30 years; Optical Fibre in 1987 – about 25 to 30 years, Hybrid Fibre Coax 1992 – about 27 years. Industrial grade equipment used in telecommunications has low maintenance and useful life cycles that have been dropping at an exponential rate of about 0.90% per year every year and currently in 2007 the life cycle expectancy is about 23.5 years for industrial grade switches, routers etc equipment being installed now.

The term 'future-proof' really means that competitive businesses must not install commercial grade equipment, as the low-maintenance life span of this much cheaper equipment is much shorter than industrial grade equipment!

[May 2010: the current active equipment (IP switches/routers, Line Terminating Equipment etc) has a useful life cycle of about 22 years and 8 months in service, while passive equipment (like optical fibre) has a Mean Time To Failure (MTTF) of about 37 to 42 years.]

Appendix 3

Extracted from the RTR Submission October 2007

Appendix A – Savings due to Technology Life Cycle Replacement

Timeframe	Base Year	From Technology	To Technology	Service / Bandwidth Improvement Ratio	Technology Area	% Tech. Area Affected	Technology Cost Savings / Bandwidth Improvement (%)	Technology Accumulative Improvement Figure %
1995-1995	1995			1	All	100		120.12
1995-2000	1996	PDH	SDH	2	IEN	20	10.00	108.11
1995-2000	1997	Dial IP on Cu pair	ADSL IP on Cu	2	CAN	15	7.50	**100.00**
1995-2000	1998	HFC (Pay TV only)	HFC with Internet	1.8	CAN	20	8.89	91.11
1997-2002	1999	SDH STM-1	SDH STM-4	4	IEN	20	15.00	77.44
1999-2004	2000	SDH isolated	SDH with SCN	1.5	IEN	40	13.33	67.12
2000-2005	2001	ADSL isolated	ADSL with OOB	1.3	CAN	30	6.92	62.47
1998-2003	2002	ISDN (2 Mb/s)	VCTS (155 Mb/s)	50	CAN	5	4.90	59.41
2000-2005	2003	CCS7	CCS7 on IP	4	IEN	35	26.25	43.82
2000-2005	2004	Digital Switching	IP Routing / Switching	3	IEN	40	26.67	32.13
2002-2007	2005	GSM	CDMA	1.5	CAN	30	10.00	28.92
2003-2008	2006	ADSL	ADSL 2+	1.5	CAN	8	2.67	28.15
2005-2010	2007	HFC with Internet	HFC dig TV	1.4	CAN	20	5.71	**26.54**
2005-2010	2008	HFC with Internet	HFC with Broadband	4	CAN	20	15.00	22.56
2005-2010	2008	1 Gb/s OF	10 Gb/s OF	10	IEN	10	9.00	20.53
2005-2010	2009	STM-4	STM-64	16	IEN	10	9.38	18.60

The excerpt of the associated Excel Spreadsheet [Tech Advances] shows that over several years, replacement technologies have caused massive bandwidth improvements, and/or greatly reduced maintenance overheads in specific technology areas (simplified into Customer Access Network – (CAN) and Inter-Exchange Network (IEN)), together with a minimal extra purchase costs – and in some cases much cheaper. These savings / benefits have been calculated to give a percentage savings / bandwidth figure totally based on changed technologies and excluding competition.

With 1997 as the base date these savings have then been multiplied on each other to give an accumulative improvement figure like a golf score but starting at 100.

By 2007, the normalised technology accumulative improvement figure is 26.54. The means that due to replacing end of life cycle technology with new technology, the network utilisation gains and overhead cost reductions had reduced the end-user / overhead costs by 73.46%.

Hard-line economists who have been brainwashed into thinking that competition is the prime reason for improved business performance will remain highly sceptical of these figures as this philosophy does not sit comfortably with what they had been taught. The painful problem for these brainwashed economists is that these figures are reasonably traceable and these figures do therefore do have a solid basis to stand by themselves. That then brings into very serious question the validity of figures bandied about to praise competition.

The natural approach is to disbelieve the savings due to replacing end of life technologies with new technologies, and an easy way to do this is to ‘discount’ the technology figures so that they become far less significant. This is radical – but we are trying to save the faces of thousands of so-called eminent economists that have made their living through praising the unquestionable virtues of the Competitive Regime!

Let us assume that the gains through technology advances are double overstated and therefore the technology-based figures should be reduced by 50%. This would give the eminent economists some face:

Base Year	From Technology	To Technology	Technology Cost Savings / Bandwidth Improvement (%)	50% Discounted Savings	Technology Accumulative Swing
1995			0.00	0.00	109.36
1996	PDH	SDH	10.00	10.00	103.89
1997	Dial IP on Cu pair	ADSL IP on Cu	7.50	7.50	**100.00**
1998	HFC (Pay TV only)	HFC with Internet	8.89	8.89	95.55
1999	SDH STM-1	SDH STM-4	15.00	15.00	88.39
2000	SDH isolated	SDH with SCN	13.33	13.33	82.49
2001	ADSL isolated	ADSL with OOB	6.92	6.92	79.64
2002	ISDN (2 Mb/s)	VCTS (155 Mb/s)	4.90	4.90	77.69
2003	CCS7	CCS7 on IP	26.25	26.25	67.49
2004	Digital Switching	IP Routing/Switching	26.67	26.67	58.49
2005	GSM	CDMA	10.00	10.00	55.57
2006	ADSL	ADSL 2+	2.67	2.67	54.83
2007	HFC with Internet	HFC dig TV	5.71	5.71	**53.26**
2008	HFC with Internet	HFC with Broadband	15.00	15.00	49.27
2008	1 Gb/s OF	10 Gb/s OF	9.00	9.00	47.05
2009	STM-4	STM-64	9.38	9.38	44.84

But again the 50% technology discounted figures speak for themselves and they show that technology replacements still far exceed the gains made by competition and now this is getting embarrassing! *Can the truth come out?* So lets cut the 50% discounted figures by another 50% - to make the technology based cost reductions appear miniscule!

Base Year	From Technology	To Technology	Technology Cost Savings / Bandwidth Improvement (%)	75% Discounted Savings	Technology Accumulative Saving	Technology Accumulative Saving %	Claimed Competitive Saving %
1995	0	0	0.00	0.00	104.52	-4.52	
1996	PDH	SDH	10.00	2.50	101.91	-1.91	
1997	Dial IP on Cu pair	ADSL IP on Cu	7.50	1.88	**100.00**	**0.00**	**0.00**
1998	HFC (Pay TV only)	HFC with Internet	8.89	2.22	97.77	2.23	3.00
1999	SDH STM-1	SDH STM-4	15.00	3.75	94.11	5.89	5.91
2000	SDH isolated	SDH with SCN	13.33	3.33	90.97	9.03	8.73
2001	ADSL isolated	ADSL with OOB	6.92	1.73	89.40	10.60	11.47
2002	ISDN (2 Mb/s)	VCTS (155 Mb/s)	4.90	1.23	88.30	11.70	14.13
2003	CCS7	CCS7 on IP	26.25	6.56	82.51	17.49	16.70
2004	Digital Switching	IP Routing / Switching	26.67	6.67	77.01	22.99	19.20
2005	GSM	CDMA	10.00	2.50	75.08	24.92	21.63
2006	ADSL	ADSL 2+	2.67	0.67	74.58	25.42	23.98
2007	HFC with Internet	HFC dig TV	5.71	1.43	**73.51**	**26.49**	**26.26**
2008	HFC with Internet	HFC with Broadband	15.00	3.75	70.76	29.24	28.47
2008	1 Gb/s OF	10 Gb/s OF	9.00	2.25	69.17	30.83	30.62
2009	STM-4	STM-64	9.38	2.34	67.54	32.46	32.70

The bold numbers in the above table appear to tell the story that internationally a massive lie in economics has been promulgated for some decades. Even with discounting the technology based gains by an enormous 75% the result still comes in at about equal to that claimed by the competitive regime. In this bad-case scenario, the technology-based gains easily account for the apparent gains claimed by eminent economists who have praised the competitive regime.

With the situation now clearly showing that technology-based service gains are real and very substantial, and are reasonably accountable (and this is a short list), then the Technology Accumulative Improvement Figure of 100:26.54 as given in the first table is highly realistic. In direct contrast, the Competitive Accumulative Improvement Figure is (100 – 26) or 100:74. In other words, the Competitive Regime can claim a mere 26% while the Technology / Infrastructure Regime can claim 73.46% reduction in end-user costs and/or improved network capability over the same timeframe.

It is now very clear that through using the Infrastructure Regime, the overhead costs would have dropped by 73.46%, but the Competitive Regime have let the overhead costs drop by only 26%, and we know that all of this and more is entirely due to technology replacement. So in other words there is direct inflationary pressure caused by the Competitive Regime in the order of 185% over the 10-year period, or at least 10.8 % per year/ per year inflation – not negative 3% per year / per year inflation as claimed. The difference is almost 14% per year/per year and this is huge, and cannot be ignored – no matter how embarrassing it is.

It is now very clear to me that the Productivity Commission may need to completely revise its philosophy to factor in technology changes as the major reason for telecommunications productivity and not competition. The Productivity Commission will have to comprehend that telecommunications infrastructure operating in a Competitive Regime is extremely inefficient and not highly efficient as taught in schools and universities.

This revision in philosophy could radically change the direction of the Productivity Commission to drop the Competitive Regime in relation to telecommunication infrastructures and quickly adopt the Infrastructure Regime. This dramatic backflip in Government policy that would have direct implications to the Trade Practices Act; particularly with those sections involving telecommunications infrastructure – and competing infrastructure businesses like Optus, Orange/Hutchison, Soul, Vodafone, Macquarie, Opel etc.

Telstra would have to be split into two separate bodies Telstra (infrastructure) and Bigpond (retail reselling), and competing telecommunications businesses with infrastructure could be then coerced by the ACCC to sell their infrastructures over to Telstra and become competitive resellers (on a level playing field)! I believe that is the school definition for competition.

The simple results from my brief calculations will I believe have a knock-on effect that puts the ACCC in step with infrastructure business, so it should then protect Telstra (infrastructure) from national and international competitive predators, while fostering robust competition between wholesale resellers /retailers.

This strategy suggested above would be excellent for all Australians and Australian business, including the equities markets.

Appendix 4

Extracted from the Submission to the NBN Expert Committee March 2008

Suggested Recommendations

Move on from the Competitive Regime

The Davidson Report (1982) heralded massive changes to the Australian Telecommunications industry to move it out of very constrictive Federal Government control into a competitive (and privatised) free market – and in hindsight any form of freedom from the then extremely conservative restraints would have been a positive move. Irrespective of this Report, the Australian telecommunications industry has paced with the globe until about 2000, when FTTH technology was not taken up to replace ageing pair copper CAN technologies – but shareholders were paid considerable dividends, and recent full-privatisation moves have aggravated the situation.

Since about 2000, competitive forces have actually hindered telecommunications infrastructure growth, and instead of moving towards FTTH as a priority (because Regional, Rural and Remote areas have a high proportion of their CAN technologies exceeding 4 km), Australia opted for ADSL on the existing pair copper, which I have demonstrated was a very short-sighted solution to partially solve urban situations.

The inefficiencies in competition then begs the question of how much Federal Government funding is required to foster competition in the Australian non-metropolitan telecommunications market, as that market cannot self-support competition? To date USO funding has been in place for over 20 years and there really has been no discernable closure in the differential service standards between Metropolitan and non-Metropolitan areas in this same time period.

I have absolutely no doubt that implementing FTTH [26] CAN in non-metropolitan areas will make an immense improvement to the customer service standards, but before FTTH becomes effective, the capacity of the IEN [Backhaul Network] in non-metropolitan areas needs to be increased by several 100% as warned in the 2008 ATUG Conference [11] so a radically different approach to providing enough IEN infrastructure engineering in non-metropolitan areas needs to be immediately applied.

If an alternatively different approach to IEN [Backhaul Network] infrastructure provisioning, then there would be an abundance of Broadband carriage capacity to more than match the future requirements of Broadband Internet requirements in these areas with FTTH as the future standard CAN technology. In this situation, non-metropolitan areas would then use Broadband Internet far more frequently, and this would self-generate business prosperity, which would in turn create a somewhat competitive market, and the outshot is that the USO package could be considerably reduced or could be immediately terminated – if there was a radical change in the way the telecommunications infrastructure was managed in Australia.

Appendix 1 demonstrated very clearly that introducing new and more effective telecommunication technologies is far more effective than competitive forces to lower end-user prices, and it demonstrates with reasonably easily traceable figures that the ***Competitive Regime is responsible for at least a 10.8% per year increase in end-user costs - not a 3% decrease, and this is a immense 13.8% per annum accumulative differential!***

With these facts now facing the Government of the day,

- **it is high time that the telecommunications Competitive Regime is immediately scrapped, and**
- **be replaced by a infrastructure regime to synergetically coordinate the maximum use of telecomms infrastructure in Australia, and**
- **provide this wholesale to competitive telecomms resellers that can onsell the services to the public at comparable retail prices.**

The competitive regime would then have its rightful place out of telecommunications infrastructure, and only in competitive telecommunications wholesale reselling/retailing.

Correct the ACCC Telecommunications Report

It is embarrassing that the ACCC have had to resort to an external consultancy group to initiate a telecommunications industry report when the then Department of Communications and the Arts did not appear to have the internal expertise to do this themselves. It is astounding that this report seems to have not correlated the physical demarcation points between major wholesale product lines, and consequently has almost totally missed reporting on the Inter-Exchange [Backhaul] Network (IEN), which is a major infrastructure component for all telecommunications products. It is confounding to see these mistakes being perpetuated in successive years without the Dept of Communications stepping in and aligning the report to reality. It is hoped that the Expert Panel can identify this issue and resolve it through the Department of Broadband and Digital Economy in the very near future.

- In this light, the ACCC Telecommunications Reports need an entire and rigorous restructuring so that the terminology topics are firstly aligned with reality, then the terminology is aligned with the physically existing technologies and that will in turn align with actual and practical divisions in management, sales and marketing.

- It would even make sense to go back several years in this process and get it right so that trends can be much better understood in a light of reality. All competitive telecomms businesses would be in a much safer position to provide more complete and relevant information as the report would not then produce 'distorted' results.

Align Customer Perception surveys with Infrastructure Technologies

Traditionally, telecommunication infrastructure product reporting is done by product over relatively large geographic areas, and it has always been done this way because the Marketing based Accountants behind the data gathering simply do not have the long-term Engineering experience and expertise to identify the prime factors that determine differential product performance in the telecommunications infrastructure industry in Australia.

The data needs to be correlated with 'telecom-ese' mapped areas – then the results would have a very high correlation of the service standards performance relating to the installed equipment, in telecom-ese locations, and then this can be correlated with meaningful knowledge with their overall ABS geographic area locations – not the other way around!

This submission contains the basic information so that meaningful analysis can take place, through understanding the physical limitations of both CAN and IEN technologies and where they are used, and it explains why data; that is grouped by ABS specified geographic areas, is almost useless.

Build the Inland High Capacity Transmission Ring

My first proposal is to turn this capital city-based thinking upside down and inside out so that the big communication links are country based as a national ring – but this ring is not costal – it is to be about 400 to 1500 km inland and has spurs that feed to the coast, picking up all the major routes towards the coast. If all major intercity routes would use this infrastructure as their first (or second) choice, then this inland high capacity ring would have extensive and inexpensive Regional, Rural and Remote wayside access points that would make business in the bush part of the profit-centres enjoyed with the capital cities.

In essence, install a multi SMOF cable transmission ring, capable of initially 100 Gb/s, and later 4,000 Gb/s (on multiple fibres) that links between: ***Mt Isa – Cloncurry – Winton – Longreach – Barcaldine – Blackall – Charleville – Cunnamulla – Bourke – Nyngan – Cobar – Hillston – Griffith – Hay – Mildura – Broken Hill – Port Augusta – Woomera – Coober Pedy – Alice Springs – Tennant Creek – Camooweal – Mount Isa.***

A second loop could take in the western half of Australia, although this link would not run inland like the one proposed for the eastern half of Australia, but it could also be rather high capacity for example 100 Gb/s to start and have enough dark fibre in place to allow it to grow to about 4,000 Gb/s also. This loop would basically pass through: ***Tennant Creek – Katherine – Kununurra – Halls Creek – Fitzroy Crossing – Derby – Broome – Port Headland – Newman – Meekatharra – Mt Magnet – Leinster – Kalgoorlie/Boulder – Cook – Glendambo – Coober Pedy – Agnes Creek – Alice Springs – Tennant Creek.***

There are several towns and villages not mentioned in this path but this is the first overview, and wherever possible wayside stations should be set up to provide local Customer access facilities for ample high capacity Broadband Internet.

This ring will provide transport between country centres, and a major bypass for inter-capital city traffic. The following sites could be ideal locations for major spurs to connect with nearby major cities and further outback locations: ***Tennant Creek*** – Darwin; ***Cloncurry*** – Normanton; ***Cloncurry*** – Hughenden, Charters Towers; ***Winton*** – Boulia; ***Longreach*** – Stone Henge, Galway Downs, Quilpie, ***Charleville***; ***Barcaldine*** – Emerald; ***Charleville*** – Roma; ***Cunnamulla*** – St George; ***Cunnamulla*** – Nockatunga, Tibooburra, ***Broken Hill***; ***Bourke*** – Brewarrina, Walgett; ***Nyngan*** – Dubbo; ***Griffith*** – Leeton, Narrandera; ***Mildura*** – Ouyen, Hopetoun, Warracknabeal; ***Mildura*** – Renmark, Burra; ***Port Augusta*** – Whyalla, Port Lincoln, ***Kalgoorlie/Boulder*** – Esperance, ***Kalgoorlie/Boulder*** – Albany, ***Mt Magnet*** – Perth, ***Mt Magnet*** – Geraldton, ***Wittenoom*** – Carnarvon.

The further outback locations should be capable of at least 10 Gb/s, considering the low density of customers in these regions.

Build the Inland Eastern Transmission Crescent

Because the Inland High Capacity Transmission Ring misses out on much of the higher density population in the eastern Australian states, this second proposal is to position a high capacity transmission crescent on the western side of the Great Dividing Range, roughly about 200 km inland, to support proposed high-density traffic between many regional areas. In essence the proposed transmission system would be a SMOF cable carrying at least 200 Gb/s initially and later 8,000 Gb/s (on multiple fibres) that links between: ***Cloncurry – Hughenden – Charters Towers – Clermont – Emerald – Roma – St George – Walgett – Dubbo – Orange – Cowra – Young – Cootamundra – Wagga Wagga – Narrandera – Finley – Deniliquin – Echuca – Kerang – Wycheproof – Beulah – Warracknabeal – Horsham – Hamilton – Casterton – Mt Gambier***.

Major nodes would then have multiple wayside spurs that feed off to rural and remote Customer Access Networks to provide high capacity Broadband Internet services.

The following locations could be ideal branch points to major costal cities: ***Charters Towers*** – Townsville; ***Charters Towers*** – The Lynd Junction, Atherton, Mareeba, Cairns; ***Clermont*** – Moranbah, Mackay; Emerald – Blackwater, Rockhampton; Roma – Miles, Chinchilla, Kingaroy, Gympie; ***St George*** – Moonie, Dalby, Toowoomba; ***St George*** – Goondiwindi, Texas, Tenterfield, Lismore; ***Walgett*** – Moree, Inverell, Glen Innes, Grafton; ***Walgett*** – Narrabri, Gunnedah, Tamworth, Port Macquarie; ***Gilgandra*** – Merriwa, Dunedoo, Denman, Singleton, Maitland; ***Orange*** – Bathurst, Lithgow, Bell, Richmond, Windsor, Dural; ***Young*** – Boorowa, Harden, Yass, Canberra, Queanbeyan, Braidwood, Bateman's Bay; ***Wagga Wagga*** – Tumbarumba, Adaminaby, Cooma, Nimmitabel, Bega; ***Finley*** – Corowa, Wangaratta, Bright, Swifts' Creek, Bairnsdale; ***Horsham*** – St Arnaud, Bendigo, Heathcote, Seymour; ***Horsham*** – Hamilton, Lismore, Geelong.

Many of these links may well exist, but it is the capacity that needs to be considerable bolstered, as (according to the ATUG Conference 2008 [11]) Broadband Internet will be using at least 300% more IEN capacity in the very near future than it is now. Ideally these SDH transmission circuits should be engineered to be open rings and carry at least 10 Gb/s per system, that way these systems can carry MPLS as the support bearers for high capacity IP in the IEN.

Build Inland Internationally Mirrored Servers

With the large high capacity inland transmission ring and the inland transmission crescent being put in place, it is necessary to load this network, and unload the more congested capital city and international routes. As a large proportion of our Broadband Internet traffic comes in from outside Australia, it makes strong business sense to install very large mirrored servers of internationally based servers and locate these well inland at locations like: ***Charleville, Bourke, Cobar, Griffith, Mildura, Walgett, St George, Roma, Emerald, Kalgoorlie/Boulder***.

The premise would be that as a customer calls an international server, the gateway router first calls to the inland server to provide the page. The inland server downloads the page data directly from itself to the customer. The inland server may check to see if there is an update of more recent data. If there is more recent data, then the international server downloads into the inland server and then the inland server downloads on request into the customers' computer.

I am sure that this process is more complex than I have described, but the Server Access Network (SAN) described here has several distinct advantages for Australia:

- Only when the page is 'refreshed' is it necessary to download internationally, radically reducing Australia's load on importing Internet data.
- The Inland server can respond very quickly because the travel distance is typically about one tenth that of downloads from the USA and Europe, Asia.
- The Inland servers' upload speed can really be maximised as the Servers will be virtually sitting on at least 1 Gb/s feeds into the high capacity inland IEN.
- Australian Federal Police (AFP) can really get their teeth into financial scams and other highly illegal activities (eg child porn) as the server images would be locally located, giving the AFP staff unprecedented access to search and annihilate the predators.
- Because inland servers mirror international servers, this would present a highly competitive scenario where the cost of server hosting in Australia would drop to comparative lows to compete with internationally mirrored servers.
- Other nearby countries would look as a first choice to utilise the Australian mirrored servers instead of the more distant direct servers with severely restricted upload speeds. Differential costing based on now greater traffic flows out of Australia would make Australia a premium sever site and this moves Australian Internet into a profit centre.

There are many inland cities that have trained IT personnel that are looking for work in those areas in favour of working in major coastal cities. This inland industry would be financial boom for many inland cities and set them on the path to financial recovery and a general redistribution of the population out of major capital cities into regional cities and towns. This will bring other professional Engineers, Doctors, Lawyers and Accountants back into Regional and Rural Australia.

Appendix 5

Extracted from Submission 45 to the Select Senate Committee on the NBN 2, June 2009

Sparring Agendas: Bigpond v Telstra

There are several economic agendas and political views that make it seem rather difficult to structurally separate Telstra, or functionally split Telstra, because no matter how it is seen, the Telstra Board will naturally see that their business position will be compromised.

What has to be understood is that Telecom Australia grew out of the Department of Transport and Communications as a Commission from the then Post Master General's Department. Telecom Australia was then moved onto being a Corporation and rebadged as Telstra.

In this transfer from PMG to Telstra, there were several genetic errors that were deliberately sidestepped by economic Monetarists (economics that strongly favour privatisation of almost all government departments), whom I believe had hijacked the World Trade Organisation's agenda (circa 1970) on free trade between countries, and globally forced many governments to privatise their infrastructures or face financial exclusion from free trade. I believe that the Monetarists economic intention was to totally command all the globes infrastructures and capitalise on these huge money velocities for themselves.

The recent USA (and now global) financial meltdown caused by a short supply of oil in the USA due to hurricane Katrina taking out most oil production in southern USA in 2007, resulted in a downturn in the USA economy while most USA-based large Banks had sold 'futures on futures', (in a similar fashion as the Enron debacle in 2002 and the GE debacle in 1928) is continuing proof beyond any doubt that Capitalist / Monetarist greed exceeds our wildest thoughts. Capitalism is entrenched in all human societies, but it needs a balance of Socialism to manage the infrastructure, and that balanced political and economic structure minimises the need for heavy-handed regulation as we have with our ACCC and ASIC.

Telstra is the combination of two businesses that have diametrically different business agendas. One part (I like to call 'Telstra') is the Network / Wholesale / Infrastructure component, and this has an inherently slow infrastructure turnover of about 30 years and is distributed with human civilisation all over Australia. The other part (I like to collectively call 'Bigpond'), which is the retail / reselling component, and this has an inherently much faster product turnover of about 2 to 10 years. This 'Bigpond' part is inherently much smaller, and with Internet, much of its business can now be done on-line.

No matter how the various business units in Telstra are sliced or diced, the same answers keep coming up in that there is one group that is focussed on providing infrastructure for services, and another group that is focussed making a profit with a confusing arrangement of products.

These two groups (or teams) are like two sets of Rugby forward packs vying for the ball and field position; while it makes an interesting spectacle, and an awful lot of energy is expended between the two teams in travelling the ball from one end of the field to the other – far less energy can be expended if the team packs are separated into two distinct areas on the field, and each team runs their ball from end to end of the field without any interference from the opposing team. One team might sprint in a virtually continuous relay arrangement (with a small and light ball probably shapes like a baton), while the other team may simply walk their medicine ball in a wheelbarrow. (There are no rules about the ball remaining the same size, shape and/or density!)

When the PMG was in its last stages (late 1960s) it was focussed on providing services, and it had a shopfront in the Post Offices. Further, as customer and network equipment was far more prone to maintenance, there was at least another order of magnitude more maintenance staff than there are currently in the total telecomms industry in Australia, and so it was common practice to talk directly with those field staff and technicians, and customer service / maintenance was done largely without senior management involvement.

With the splitting of Telecom Australia and the Post Office out of the PMG's Department, this left Telecom Australia with virtually no customer interface other than roaming field staff. As digital technologies were introduced from about 1980, and as globally manufactured equipment was introduced from about 1990, so the need for ongoing maintenance dramatically dropped and the 'family' interface of Telecom Australia was lost with a massive drop in maintenance staff numbers on the 1990's. In the early 1990's Telecom Australia / Telstra introduced shopfronts in an attempt to re-establish a connection with the general public who were by then largely alienated by advances in technology.

Telstra now has several public, on-line, commercial, enterprise, government, and big business retail interfaces that are all focussed on providing a range of retail products that in turn resell wholesale services as retail bundled products. Telstra also has a massive telecomms infrastructure that connects to virtually every human settlement in Australia, with connections to many other countries and some infrastructure in other countries (eg New Zealand).

Through no fault of its own, Telstra has grown these two business arms that unfortunately have diametrically different business charters, and consequently, the constant internal fight is not doing Telstra or Australia any good – so there has to be an entirely different frame of reference brought in to visualise and resolve this problem with an amicable solution.

The Unworkable Frame of Reference

The Telstra Board is naturally totally opposed to any form of separation within Telstra as from the Board's perspective, any change from their structural holding will lessen the share price, because the profitability will be compromised. Even functionally splitting Telstra would be viewed very seriously as this reflects badly on the Board on their professional-ability to optimally structure their own business.

I believe that Telstra is already functionally split, but Telstra is not split along IT and building lines, and I believe that these changes could be implemented with consummate ease so that Telstra could be operated as a building and IT functionally split business, and this would not affect the bottom line profitably. If Telstra is viewed along its business units then it becomes obvious that some are profitable and others are cost centres.

Although I have not forensically studied the accounting books on this I have a very strong intuition that the network / infrastructure business unit side is not as profitable as it shows. Consequently, telecommunication facilities (exchange sites, ducting, etc) artificially have very high rental rates in the knowledge that competitors will have a very big entry step and a limited funding budget – forcing competitors to pay the high rental price. The flow-on from this skewed accounting approach is that these prices are carried over to Telstra for its internal infrastructure accounting (or vice-versa), and consequently the wholesale pricing is artificially high, making entry as competition rather difficult and the profit margin from Wholesale to Retail is an unnaturally small.

With this frame of reference, it makes complete sense that the Telstra Board would be loathed to separate the Telstra business structures in any form because the retail price is set as a percentage over the wholesale price to more than cover for the retail reselling costs (marketing, advertising, sponsoring, shop fronts, management etc.) and so this area too, shows a healthy profit.

With this old frame of reference based on Competition Regime, every business unit must show a profit – and this is the core of the problem when using this frame of reference! Clearly then, if this core problem is to be resolved, then the Competition Regime mentality has to be put to one side, and the profitably problem has the be viewed through a radically different frame of reference that also includes the some of the Infrastructure Regime.

Unfortunately the Monetarists (Economists based primarily in the USA that have the philosophy that all businesses must be not in government hands as that is 'inefficient' and the only really efficient business structure is one that operates in 'robust competition' with other competitive businesses), have pedantically wiped all literature and teachings of infrastructure business from economics texts in the western world, and they have notoriously branded such teachings as Marxist / Socialist. (Note that Sweden is a socialist country that has operated exceedingly well over many decades, although many other socialist countries have been isolated from world trade and have had their economies deliberately ruined by 'financial sanctions', instigated by the WTO – which is now controlled by Monetarists!) Professor Sharon Beder (University of Wollongong) has several publications that detail the Monetarists' Competitive Regime strategies – along with the many associated functional flaws.

A Synergetic Frame of Reference

It is very clearly understood that the Competitive Regime has extremely serious structural flaws, and the fact that the Competitive Regime is only successful where there is an equally large Infrastructure Regime to support the extreme inefficiencies inherent with the Competitive Regime. With this in mind, it has to be realised that Telstra – operating under the Competitive Regime, is in a bind where it is trying to be 'efficient through competition' and in doing this, it is hurting the very foundation that it thrives on – customers!

This hurt comes in many forms – particularly through putting the Shareholders interests above the Customers. The Synergetic Frame of Reference needs to put Customers on the same footing as Shareholders and although neither side will always be happy, there will be far more common ground for win-win situations than there is currently.

If Australia's telecommunications industry (Telstra in particular) is to lose its dysfunctionality, then the Competitive Regime Board members have to identify which business units are naturally profitable, which business units are cost centres, which business units are customer focussed, which business units are infrastructure focussed, and which business units have no place in the telecomms arena. My brief synopsis of this is that: Enterprise and Government, Metro Consumer, and On-Line Services are the business units that are customer focussed and naturally make profits and are customer focussed, and all the rest lose profits (are cost centres).

Countrywide (Non Metro Consumer) is also customer focussed and would in my opinion make a loss, and this is substantiated by the USO (Universal Services Obligation) which the Federal government pays out about $150 M annually to keep this business operational. Personally I believe this figure to keep it operational is substantially higher (like about $300 M annually) because the wholesale /network pricing seems to be held artificially high, as described above.

Telstra Wholesale, Network Technology and Network Design and Construction (NDC) are not retail customer focussed – and would be seen as cost centres – but their rental user costs have been structured (as described above) so that they do not appear to be making a loss. These business units are in reality infrastructure focussed, and/or other wholesale industry focussed, and as such, does not have public customers as their prime focus.

Using this frame of reference in place, it clearly separates Telstra into two distinct areas that have radically different prime foci, radically different mission statements and radically different approaches to doing business. In fact, with this new frame of reference in place, it shows that the crack in business direction is so great that puts senior / executive management and the board in an untenable position where everything is compromised.

Whatever fits very comfortably with the Competitive Regime (the customer focussed business units) is totally unacceptable with the Infrastructure Regime (the infrastructure focussed business units) and vice versa.

This situation means that functional separation is a lose-lose situation, (because the warring Business Units and the warring Board will still be co-domesticated) structural separation is another lose-lose situation (because the warring Board would still be co-domesticated) and so the remaining choice is to spin Telstra apart so that the customer focussed Business Units and its Board are together in a friendly environment; and the infrastructure focussed Business Units and its new and separate Board are also together in their friendly environment.

Spinning Bigpond out of Telstra

With the synergetic frame of reference in place it becomes obvious that Telstra is a two-headed monster that has diametric business initiatives and that by spinning Telstra much further than a structural separation, a Win-Win situation is readily achievable and it does not in any way compromise the Board.

The Bigpond Brand Name

For about a decade, Telstra has grown a brand name in Bigpond, and with a little lateral thinking, this brand name can be used to advantage to be the brand name for all business units that are customer focussed and all On-Line business. There is very little difficulty in changing all the shop signs to be Bigpond instead of Telstra. Taking this scenario a little further, Telstra has many building sites that are business offices, so it is not that difficult to make a selection of buildings and dedicate these to either Telstra or Bigpond, and move the staff accordingly, and under that bring in another Website that is specifically customer based and have it re-labelled and addressed as Bigpond (not Telstra). In line with these changes, the IT structure can be marginally changed so that Bigpond works with its own servers that are not 'behind the Telstra firewall'.

While this IT and building/ shop relabelling and positioning is going on in Bigpond, Telstra Wholesale should be building its IT interfacing so that Bigpond (and other telecomms resellers) can interface with Wholesale. There are a number of big productivity gains here because the Wholesale side will have to pass customer faults through a service management centre (which is effectively part of the Global Operations Centre (GOC) in Melbourne), and metering will become substantially a wholesale product that is passed into Bigpond as a Retail Reselling process in product bundling.

Locating Head Offices and Buildings

Taking the spin-off a little further, as the GOC is already located in Melbourne (Clayton), and as the corporate centre is in Exhibition Street Melbourne, it makes sense to locate the head office of Telstra Infrastructure Wholesale in Melbourne with a number of satellite offices in other capital cities, along with all the exchange sites etc. With Telstra in as rather prominent positions in Sydney's CBD, one of these buildings could be nominated as the head office for Bigpond Retail Reselling, and the staff could be moved accordingly so that they are in a Telstra nominated building or a Bigpond nominated building.

The direct follow on from this physical repositioning is that the IT system can be openly split so that Telstra / Telstra Wholesale becomes Telstra, and that Bigpond has its own Website and mail server. Once the business units are decided, and the people moved to defined buildings with their own email accounts and files, this then leaves separate company security, pay sourcing and minor business protocol issues to be resolved in the background.

Stock Splits – TLS and BPD

As far as the Australian Securities Exchange (ASX) is concerned, a trading halt should happen and the TLS securities need to be split – probably on a 4 into 3 + 1 basis where every 4 TLS securities become 3 TLS securities and 1 BPD (Bigpond) security; all at equal values. So the total value of the securities will be equal after the share split, but all TLS share holders will now have a 25% holding in BPD and a 75% holding ion TLS.

Initially the TLS and BPD securities will hold their value because the wholesale price has (I believe) been set artificially high. The Board of TLS being focussed on installing services and operating these at a minimum overhead and profit, will undoubtedly reduce the wholesale price and reduce their dividends, while concurrently, the Board of BPD will maintain their dividends yield, and as the wholesale price comes down, this will give more room for profit in the retail reselling business, so the dividend will increase – which will cause the security price of BPD to dramatically increase. The result is that the TLS security prices will not hold value and these prices will fall away and be sold off (probably back into Telstra itself), while the BPD security price will continue to rise as the wholesale prices are continually lowered.

Now, what has not been said is that Telstra will through this process become government owned, and therefore the infrastructure will become government owned, and run as a Commission and report to the DBCDE. This process takes away the competitive nature of the infrastructure and therefore moves Telstra Infrastructure Wholesale into a position where its critical mass makes it very cost efficient to manage telecomms infrastructure. In fact, this infrastructure will be come so cost efficient that competitive telecomms businesses will find it not-profitable to compete and would probably call foul – but there is an escape clause for these competitive businesses 'get out of goal' (for free)!

Building Competitive Retail Businesses

Continuing the Win-Win

Taking this development of splitting Telstra Corporate into Telstra Infrastructure Wholesale Commission and Bigpond Retail Reselling a step further, there will be several other telecomms businesses (for example Optus) that would be calling foul and looking for lawyers to fight their cause. To avoid this situation, it would be prudent to hold out big olive branch to these companies and let then sell off their infrastructure into Telstra, and here is another big Win-Win situation!

In competitive telecomms businesses selling off their telecomms infrastructures to Telstra, this frees these competitive telecomms businesses up in the same way as Bigpond to entirely focus on selling customer focussed products as services, while buying wholesale services agreements from Telstra.

The other very big win is that the infrastructure that is sold off to Telstra is no longer used in competition against Telstra, but used in synergy with the existing telecomms infrastructure, and this can result in a considerable grooming of the network structure on a national basis. In a grooming exercise that Telstra did at about 1992, Telstra was able to save several billion in otherwise new long-haul equipment. These savings amounted to more than a years' total budget in new equipment. That grooming was done about 18 years ago so merging say; Optus' infrastructure with the Telstra infrastructure would again save several billion in otherwise wasted infrastructure investments.

Starting with the NBN

The NBN Imperative

We know that inside a few decades the worlds oil reserves will have run out and our worlds will be very small except for the Internet, so we have to radically change our way of doing business – think globally and source locally. The cost of oil will rise significantly in the next few years and in that time globalisation, as we know it will start to die out because transport costs will be too high, and this is why we have to proactively re-learn to source locally. To compound this issue, we are now fully aware that the world's climate is changing – it is getting significantly warmer and we now know that this is being caused by the oil and coal that we have burned in the past couple of centuries to provide our energy and transport requirements. By far the lowest transport cost will be that using various electronic mediums particularly fibre optics and one of the main products that uses optical fibre is Broadband Internet. Australia is an isolated continent, and therefore we have to proactively position ourselves globally to take every advantage possible with electronic transport or we will be isolated from the other world economies to our disadvantage.

The Australian Government therefore has a time-constrained imperative that within about 5 years to get almost all of Australia connected with Broadband Internet such that business through teleconferencing is the norm everywhere. This is the imperative of the NBN.

A $42 Billion Question

Considering that the typical telecomms infrastructure spend (investment) in Australia is in the order of $5 Bn per year (1990 – 2008), then over eight years $42 Bn is in the ball park if all these funds were put into telecomms infrastructure, and this infrastructure was owned and managed by one business.

Take into account that Telstra needs to spin off Bigpond within say 24 months (as described above), then with Telstra as the body that is putting in the telecomms infrastructure, the investments of $5 Bn annually is probably a bit too low, but as I have shown earlier, telecomms equipment prices have fallen by about 10% annually (or in reverse you get an extra 10% bandwidth annually for the same investment), so over say 8 years the bandwidths are about 214% larger by then, meaning there will be technology breakthroughs that will substantially reduce the per capita investment requirement.

Appendix 6

Extracted from the Submission to the NBN Expert Committee March 2008.

In this text, FTTEN refers to "**F**ibre **T**o **T**he **E**xchange **N**ode", where the Backhaul Network transmission fibre is extended from the Regional or District Switch / Router to a Switch / Router in the District or Local exchange site, and then fibre is then connected from this Switch / Router to the DSLAM (Digital Services Line Access Multiplexer) that is in the Local Exchange site.

Because in the DSLAM, the signalling radically changes from Backhaul signalling to Customer signalling in the DSLAM then effectively part of the DSLAM is in the Backhaul Network and the other part is in the CAN.

Engineering Problems with FTTEN

The following short table was produced to provide a better understanding of the ADSL performance over various length pair copper cable, where the DSLAM is located in an exchange site.

Understanding that the 'average' urban cable length is about 3.2 km, and the maximum urban specification is about 4.1 km, and it typically uses 0.40 mm pair copper cable. The following table based on ASDSL2+ shows where copper fails over length:

Total Length (km)	0.64 mm Dia, Length (km)	0.40 mm Dia, Length (km)	Attenuation dB @ 820 Hz	Attenuation dB @ 300 kHz	Max. Download Speed Mb/s
1.0	0	1	1.6	13.7	23.86
2.0	0	2	3.2	27.3	17.73
2.6	**0**	**2.6**	**4.1**	**35.5**	**12.39**
3.0	**0**	**3**	**4.8**	**41.0**	**9.31**
4.0	**0**	**4**	**6.3**	**54.6**	**4.30**
2.0	2	0	1.2	14.5	23.74
3.0	2	1	2.8	28.1	17.20
4.0	**2**	**2**	**4.4**	**41.8**	**8.91**
5.0	**2**	**3**	**6.0**	**55.5**	**4.11**
3.5	2	1.5	3.6	35.0	12.74
4.0	3	1	3.4	35.4	12.48
4.0	4	0	2.5	28.6	16.65
4.9	4.9	0	3.0	35.5	12.42

In all urban cases where the cable is 0.40 mm and is less than 2.6 km (including the wiring from the DSLAM through the MDF and to the cable entrance – to the premises equipment), the ADSL modem can operate above 12 Mb/s download. This accounts for about ~~25~~ 40% of the total customers; so ~~75~~ 60% of the customers ADSL equipment will not be working to minimum speed [of above 12 Mb/s download].

For all outer CAN runs [beyond 4.1 km typically in non-urban areas], if a 0.64 mm pair copper cable is used in place of the 0.40 mm pair copper cable for the first 2 km, if the total length is less than 3.6 km, then the ADSL modem can operate above 12 Mb/s download. This is a likely scenario in small country exchanges, and this would satisfy all the urban customers, but chances are that most of the customers will be further than 5 km away; the exchange has a RIM but no DSLAM!

In other words this table shows that: ***wherever possible all CAN cabling should be done with 0.64 mm pair copper and 0.40 mm pair copper should be phased out as a mater of urgency.***

If there are any more customer pair copper cables to be run from any exchange then it is imperative that 0.64 mm pair copper is used for at least the first 2 km from the exchange as a minimum.

The above grouped solutions use 0.64 mm pair copper cable in place of the standard metro / urban 0.40 mm pair copper cable, and this scenario removes the need for Fibre to the Neighbourhood Node (FTTNN) in virtually all urban situations, while providing the environment for greater than 12 Mb/s download speeds, using ADSL2+ DSLAMs.

Appendix 7

Extract of a supplementary answer (Submission 45a Select Senate Inquiry on the NBN July 2009) provided on notice to Senator Ian MacDonald (Liberal, Qld) on a supposedly rhetoric question of connecting Birdsville (far south west Queensland) with Broadband.

Senator Ian MacDonald – Birdsville Broadband

In my initial response at the Select Senate Hearing on the 20th July 2009 about connecting Broadband to Birdsville, I suggested that a mix of optical fibre and radio would be connected from Longreach as the nearest position to Birdsville, and I was guessing on the position of Longreach in Central Queensland as the nearest regional centre to Birdsville.

Having checked my Gregory's Map 149 "Australia", it became obvious to me that there would be a communication link along the road from Charleville using point-to-point radio as a main bearer going west via Quilpie, Galway Downs, Betoota to Birdsville and this probably is based on 2.4 GHz and probably runs a 34 MB/s PDH link. I am also guessing that this equipment is possibly running near full capacity for voice traffic (0.064 Mb/s per voice channel or a total system availability of less than 500 voice channels, or directionally 250 voice channels each way), shared between more than 33 communities.

[2010-05-25 *in hindsight, this longhaul radio link is probably an STM-1 (a 155 Mb/s bandwidth link bi-directionally carrying the equivalent of 63 * 2 Mb/s streams. This realisation could reduce the rebuild costs by about $200,000 or more than double the Broadband capability towards and at Birdsville.*]

As Broadband has a substantially larger bandwidth requirement (say 750 Mb/s per 1000 customers in a wholesale sense) then this link would be running in total network congestion if Broadband were to be offered to Birdsville from Charleville, because the available backhaul network bandwidth simply would not be there, as it would be a "tiered star" from Charleville, with many wayside stations on the route and this is probably a good reason why Birdsville may not have high capacity Broadband capability in the immediate future.

In light of that probable network congestion issue west of Charleville towards Birdsville, I would reconsider the option of upgrading the existing optical fibre spur off Longreach (as I had suggested to you in the Select Senate Hearing). As far as I know, currently there is no backhaul connection directly between Longreach and Birdsville, but I believe that there would be an optical fibre from Longreach to Stonehenge, and possibly on to Jundah (as there is a good road there). Jundah is not all that far from Galway Downs (probably about 60 km (or about 107 km from Stonehenge) as the crow flies, depending on where the current optical fibre ends).

It would make very good engineering sense to me to extend the optical fibre from Stonehenge / Jundah through to Galway Downs, and replace the associated existing transmission equipment (probably 150 MB/s SDH) with a much higher capacity for example say 1 Gb/s (1,000 Mb/s) so that the link from Longreach to Galway Downs (and its wayside stations of about 15 communities) would be able to share the backhaul 1 Gb/s capacity, for without getting anywhere near network congestion for intense Broadband Internet uses.

If this optical fibre system was then to cross connect at Galway Downs with the existing 34 Mb/s radio system between Charleville and Birdsville, then this much higher capacity (1 Gb/s) optical link will provide geographic network diversity for the Birdsville link via Galway Downs to both Longreach and Charleville, so that it could be dual parented (which means greatly increased network reliability for the customers).

The extended and upgraded (1 Gb/s) optical fibre link will radically change the backhaul network structure and (as I had originally alluded to in my response), the extended higher capacity optical fibre link with a much shortened tiered star structure will provide a much high network bandwidth per connection, so that Birdsville could have high bandwidth Broadband, with a comparatively small outlay (***commercially, in a competitive regime frame of reference, this infrastructure expenditure would never be financially justified***).

The nominal 34 MB/s radio link from Birdsville to Galway Downs (back towards Charleville) would, in my opinion, be too a low capacity for Broadband, and a rethink here to upgrade this link from nominally 2.4 GHz to a nominally 5.7 GHz system that has a maximum throughput of about 60 Mb/s which is a substantial increase on 34 MB/s. By translating the telephony voice to VOIP at the terminal exchanges, there are substantial bandwidth savings that make Broadband Internet at shared say 40 Mb/s for say 720 locations considerably faster than dial-up Internet over dedicated telephony channels (that would probably be in continual network congestion because dial-up Internet connections are usually on for about 25 minutes where voice telephony is usually just under 3 minutes).

Because of the bursty nature of Internet, Broadband end user speeds could peak over 12 Mb/s, and average about 4 Mb/s, which is considerably faster than say 0.056 Mb/s in optimal dial-up Internet. This is assuming that the physical pair cable CAN between exchange sites and premises is less than nominally 1.5 km and ADSL 2+ would be used (at this stage).

The backhaul 34 Mb/s radio system from Galway Downs could also be reconfigured so that some of the locations towards Charleville (for example Tenham and Thylungra) could be primarily parented towards Longreach via the 1 Gb/s optical fibre tail and this would give them very good Broadband backhaul availability (if their pair cable CAN is short enough).

From the Charleville end, the extended optical fibre from Longreach to Galway Downs will dramatically increase their opportunities for Broadband use, as the number of wayside communities towards Birdsville from Charleville is dropped from say 35, to about 8 back to Charleville on the 34 Mb/s radio system, where the rest would go to Longreach via Galway Downs on the 1000 Mb/s optical system.

The missing high capacity backhaul link that I proposed in my submission to the Expert Committee and referred to in this Select Senate Hearing would be the high capacity highway to connect these inland communities into the broader high capacity backhaul infrastructure ***via Darwin . . . Longreach, Blackall, Charleville, Cunnamulla, Bourke . . . Griffith . . . Broken Hill . . Port Lincoln***. And this backhaul Backbone will then be the inland frame to link the optical fibre grid towards the higher density populated east/south coastal areas, as I outlined in the third page of the supplementary graphics document depicting in light blue a nominal inland grid of high capacity optical fibre.

Here is a quick ball-park questimate of the proposed system:

Optical Fibre Longreach – Galway Downs

Engineering evaluation with a walk through and detailed designs	$50,000
107 km of Optical Fibre at $30,000/km	$3,210,000
5 *1 Gb/s Routers at $20,000	$100,000
4 * Power Packs and Batteries at $10,000	$40,000
Install and Commission Network Equipment	$15,000
Sub total	**$3,415,000**

Radio Galway Downs – Birdsville

Engineering evaluation with a walk through and detailed designs	$50,000
3 Routers and ancillary equipment $20,000	$60,000
8 *5.7 GHZ point-point radio systems $20,000	$160,000
8 * Power Packs and Batteries at $10,000	$80,000
Install and Commission Network Equipment	$65,000
Sub total	**$415,000**

My first guess for the total backhaul work is in the order of $3.9 M, but this is only half the solution as it is not any use having backhaul that cannot connect with the CAN, especially when that backhaul goes through / over these customers properties!

Assuming that these locations do not have ADSL, but do now have the capability for Broadband, with a broad-brush approach, wire all physicals (direct pair copper) through mini-DSLAMs and connect the DSLAM backhaul side to the upgraded backhaul via the routers positioned as regenerators / amplifiers:

Install DSLAMs at regenerator sites to all physical CAN circuits Birdsville – Longreach / Charleville (west sides)

Engineering evaluation with a walk through and detailed designs	$70,000
15 * 48 Channel DSLAMS ancillary equipment $50,000	$720,000
15 * Power Packs and Batteries at $10,000	$150,000
Install and Commission Network	$144,000
Sub total	**$1,084,000**

So this would connect about 720 premises with Broadband using ADSL for a very rough guess totalling about $4.9 M (or about say $6,800 per premises). The fact is the take-up will really be about 70% because the first guess will not align with the premises so the more real cost is towards $10,000 per premises. And this CAN needs to connect with solid backhaul:

*In one of the Superman movies there is classic scene, when Superman swooped down so save Lois as she was falling from a helicopter to her certain death. Superman caught her and they stopped in mid-air, and as he held her in his arms, he said, "It's alright Lois, I've got you!" to which a very surprised Lois responded to Superman, "**But who's got you**?"*

This classic scene encases the associated problem by connecting Longreach with an extended 1 Gb/s high capacity optical fibre link to Galway Downs, so that Birdsville can have Broadband. We may have solved the problem of getting a good backhaul network infrastructure from Birdsville to Longreach, but there is not enough backhaul network capacity to connect Longreach with the rest of the major backhaul which is in this case located along the eastern continental border. So the link from Longreach to Emerald would need to be upgraded, and probably the Emerald – Rockhampton link too! Hence my reasoning for the inland high capacity backhaul link in the first case…

I hope that this extended answer to your very difficult question about connecting Birdsville onto Broadband gives you and other Senators an insight into how one piece of well considered backhaul infrastructure with engineering know-how can positively affect the performance of more than 50 remote communities. In this case these communities are more than 600 km apart and covering an area of about 162,500 square km, without resorting to very expensive continued foreign debit by utilising satellites in a first instance.

Senator Nick Minchin – Infrastructure Regime

When I responded to your questions on competitive businesses, I did not have a concrete example that clearly showed why and how the competitive regime (competing businesses) is the wrong frame of reference to use with infrastructure, as the "Second Best" scenario always results. In this case there is the need for the $43 Bn NBN to correct the severe underspend in non-metro telecomms infrastructure that started in about 1983 after the Davidson Report (1982) initiated the 'commercialisation' of the telecomms infrastructure. Even then, that report got it wrong by instigating the universal services obligation (USO), which this year was about $145 M to make the non-metro areas look as though they are commercially viable.

During the Howard Government tenure there was the NTN fiasco, the DAB rollout, the HiBIS and a few other programs to inject telecomms funding on a commercial basis – when clearly this should have been on an infrastructure basis (and this is why they failed). As it turned out, the extended answer (above) that I provided to Senator Ian MacDonald is a classical case that shows the ballpark funding, as a concrete reference to use to show how external accounting P&L with infrastructures operates to the benefit of Australia's economy.

In the above extension of the answer provided to Senator Ian MacDonald, if the competitive regime frame of reference is used, then there is no way that this infrastructure would be installed as the internal P&L statements would show that the customers would never pay enough for the services at levelled commercial rates, and Telstra (in this case) would never amortise these costs and make enough profits over a short enough time frame to satisfy their 'competitive' business model.

The internal P&L accounting used with the competitive regime runs along the internal lines of "the retail users will pay a lot more than the whole infrastructure costs, and over a specified time frame of say three years, and the rest is almost straight profit, minus overheads."

If Telstra did put in this infrastructure, then they would have to answer to their shareholders, who would not be at all pleased because this funding would not be giving a financial return.

With the above scenario, the wholesale outlay will be in the order of $10,000 per premises, so if this was spread over three years then this is a monthly bill of about $277, before interest is considered, so the wholesale bill will be in the order of $300 per month, per premises.

The retail rate will be approximately 100% over the wholesale's unit rate, so this will be about $600 per month per premises, and considering that the going retail ADSL rate is nominally say $60 per month, the Birdsville case is simply not justifiable by internal accounting methods, as it is in the order of 10 times more expensive than the nominal rate.

What may not be obvious is that since about 1990, Telecom Australia / Telstra changed its accounting methods to use internal P&L accounting to match the needs of its shareholders, and maximise its profits. Consequently almost all new infrastructure from that date has gone onto telecomms facilities is equipment that has a high usage rate and a low per-premises cost, and that basically meant that Band 1 and Band 2 (major capital cities, their suburbs and major non-capital cities). The rest of Australia has basically missed out.

Taking the above case (Birdsville Broadband) that was raised by Senator Ian MacDonald. Assuming that this infrastructure cost came out as $10,000 per premises, then the external accounting P&L process would move in and look at many issues like:

Medical eHealth savings through customers using BB Internet	$500
Unemployment social service cost reductions	$2,000
Saving in Petrol and Oil products	$3,650
Improved Education	$5,000
Trading from the Farm	$3,000
Short List Sub-total (per premises, per year)	**$14,150**

So using the External Accounting P&L approach as used in the infrastructure regime, this infrastructure would have paid for itself in less than 9 months, and we have not even asked the shareholders about the profits (because the government and opposition are the shareholders), and the government overheads on Social Security and Health / Medical are significantly dropped, while these people will be paying bigger taxes!

The obvious argument is that these external accounting P&L figures are far too optimistic, so if these figures were heavily discounted by say 75% then we will get:

Medical eHealth savings through customers using BB Internet	$125
Unemployment social service cost reductions	$500
Saving in Petrol and Oil products	$912
Improved Education	$1,250
Trading from the Farm	$750
Short List Sub-total (per premises, per year)	**$3,537**

Keeping this external P&L accounting in line with a typical competitive business case, then it should break even over three years (neglecting interest). These heavily discounted figures clearly show that the payback to the government for putting in this infrastructure is more than $10,500 over three years making this infrastructure business case extremely compelling.

Typically the Australian telecomms spend (investment) on infrastructure would be in the order of $5 Bn per year, but if you go back to about 1990 and rationalise the telecomms investment by about 50% due to the competitive regime kicking in, (including considerable ACCC based costs for thousands of lawyers in Telstra) so the infrastructure investment is about say $2.0 Bn per year, then the underspend thanks to the competitive regime is about 19 * $2.0 Bn = $38 Bn, and looking backwards this is a bit under what the NBN is ($43 Bn)!

When I described the outline of the economic ***"Theory of the Second Best"***, in the Selective Senate Hearing it should have been very obvious that ***the competitive regime is clearly the "Second Best" strategy for the Australian economy*** – but we are naturally competitive, and the least disruptive placement for the competitive regime is in retail reselling. We have several very successful competitive businesses like David Jones, Myer, Woolworths, Coles, Harvey Norman, Bunnings to name a few; and all of these have focussed customer markets, with a minimum of infrastructure, and a minimum of involvement with the ACCC. Telstra as it is, has a maximum of infrastructure and a maximum of interaction with the ACCC!

If we really want the "First Best" for Australia, then it is a 'no-brainer' to utilise the infrastructure regime for telecomms infrastructure at a wholesale level (ie NBN and Telstra Infrastructure Wholesale working as one) and let the competitive regime retail this wholesale infrastructure products and services to the public, just like other major successful retail trading businesses in Australia.

So here is the problem: *We now know that by using the competitive regime's approach of utilising internal P&L statements to prioritise infrastructure on a biggest returns basis, this maximises infrastructure in the "metro" cities and minimises infrastructure everywhere elsewhere.*

We know that the NBN is being set up (as a company) funded by the government as an infrastructure regime business to put in infrastructure everywhere so that areas that have missed out in the last 20 or so years can be provided with Broadband Internet (and both sides of Government and Opposition have a general agreement with this strategy)!

Why would the Government and Opposition be so inept to put the NBN back into the competitive regime after any time frame at all, when they have the historical facts that prove this situation ends up with a "Second Best" economic situation for Australia?

Senator Nick Minchin – Staff and Training

The evidence that I presented in response to your questioning about staff ages was rather incomplete, so this short addendum addresses most of the areas that I did not cover.

Before I left Telstra in 1996 there was a concerted effort to bring in a younger work force particularly in the sales and marketing areas. In general I commended this competitive business approach as the shopfronts usually have younger clientele and this maximises their business profitability, and seniors are usually not high-revenue clientele.

In regards to the technical / field staff in the telecomms industry; the general (office-based) thinking is that with Intranet (behind the firewall), the Global Operations Control (GOC) via the telecomms equipment alarm monitoring system can connect to virtually every telecomms piece of equipment (both in the Backhaul and in the CAN), and most service issues can be either immediately resolved by a data table command change from the GOC, and/or later resolved by a field staff person when they next visit that site.

This computer screen realism mentality is endemic, and there really are field staff that are much like 'board jockeys' that travel from site to site (Backhaul and CAN) and replace faulty board assemblies, then commission the equipment back into service inside an agreed 'time window' in coordination with the staff in the GOC in Melbourne.

With first generation digital equipment of the early 1980s, this equipment had reliability Mean Time To Failure (MTTF) figures measured in decades, not weeks or days as it was with earlier mechanical and analogue equipment. Telstra was put in a very awkward position of having to put off thousands of highly trained technical staff. With the second generation digital equipment installed from about 1990 onwards, this 'globally manufactured' equipment had remote alarming and control such that it could be 'managed' from an operations centre, and Telstra was again in a very awkward position of offloading more than 90% of its remaining backhaul (core network and edge network) engineering and technical maintenance staff. This is the prime reason why Telstra now has a relatively young staff, and why contractors to Telstra are usually the older maintenance ex-staff! This is also the prime reason why Telstra's staff, have a generally short historical memory.

So in general, now most exchange sites are totally unmanned, but nationally there is another field staff team that is basically CAN and peripheral/edge backhaul based, that installs and commissions new equipment, and this is the area that really needs to be trained up and soon.

Optical fibre is not nearly as simple to splice as compared to join copper wire pairs using insulation displacement connectors (IDCs). The optical splicing equipment is expensive, and each splice has to be measured and recorded well before the optical fibre cables are put into service. Optical Fibre technology has come in since about 1986, and it is now used almost universally throughout the backhaul network, and business / enterprise CAN, to radio base stations (for mobile phones and mobile Internet), and the fibre component of HFC.

Australia has several hundred (if not a few thousand) trained field staff, but apart for some of those in the business / enterprise area, almost none of these staff have any background in optical fibre technology – particularly in splicing. When it comes to installing an optical fibre CAN, we are looking at say 10 M premises, and therefore about 30 M splices. If this were to be rolled out in say four years, then in round figures this is about 30,000 splices every weekday. Considering that a fast splicer will get through say 100 splices per day, then Australia will need at least 300 splicers working full time for four years, and these splicers will need the associated splicing and measuring equipment which costs about $25,000 each.

Unlike general rack installation work, training in optical fibre technology is a precision job (understand the centre of the fibre is typically about 9 um, not 0.4 mm as in urban pair copper cable). Learning the basics will only take a few days, but learning to do repetitive and precise splices, detailed field based measurements and accurate field recording takes months and a lot of patience; and these qualities do not suit the vast majority of the outside field staff.

I hope that this clarification explains to you how and why existing trained field and maintenance staff that have been displaced some decades ago may not be useful for the installation and commissioning of FTTP and the associated equipment interfacing into the augmented backhaul, and why Telstra had to make some rather unpalatable decisions about its own staff numbers. This addendum also shows that Australia will have to educate and train a small battalion of field staff that have Optical Fibre Splitter certifications (and experience), in the short term, together with the necessary and expensive splicing, testing and calibration tools and equipment.

Appendix 8

Extracted from Submission 45b as an addendum to the Select Senate Committee on the NBN July 2009, about the "Theory of the Second Best" and its practice in Australia which explained why the HFC rollout was extraordinarily expensive – including concrete figures.

Theory of the Second Best

In my opening address to the Select Senate Committee Hearing in Canberra on the 20th July 2009, I made reference to the "**Theory of the Second Best**", and it later became obvious to me that although the Senators were very well versed in the Competitive Regime and its benefits, they appeared totally unaware of the Theory of the Second Best, which I outlined as follows:

*"In 1956 two Economists, Australian-American Kevin Lancaster and Canadian Richard Lipsey came up with the "**Theory of the Second Best**" which in simple English states that **"when businesses work in synergy, then this will always give the most efficient outcome for the economy"**, or putting this in a more brutal form **"the privatised / competitive regime is clearly a very poor Second Best choice compared to any synergetic infrastructure regime".** The Cold War was in its throes when this theory came out and economics lecturers found this theory 'very difficult' to teach in this political climate, so this theory has sat quietly for several decades."*

During the giving of evidence, it became very clear to me that without a very simple worked example about a real situation, it was virtually impossible to demonstrate how this "Theory of the Second Best" works, and why this economic theory is so critical in light of the NBN infrastructure proposal and the consideration that the NBN is to be privatised (into the competitive regime) in about five years time.

This "Theory of the Second Best" needs to be understood in practice by the Senators and those that work with them and the Productivity Commission, because like all theories, they are rather vague until a real example shows what really goes on.

This short paper shows how the competitive regime is a very Second Best strategy compared to the infrastructure regime. Each of the headings below demonstrates with rather simplified accounting just how grossly inefficient the competitive regime really is. Australia can be far more productive if it uses the infrastructure regimes' synergetic approach for installing and operating infrastructure, while leaving the retail reselling to the competitive regime.

The Competitive HFC Rollout

Background

In about 1995, Telstra and Optus both installed Hybrid Fibre Coax (HFC) Customer Access Network (CAN) in robust competition with each other so as to get the lions' share of the metro Pay TV market. The competitive scoring was done on the basis of the 'number of homes passed', with the highly incorrect assumption that all these homes that were 'passed' could be 'connected', and so 'homes passed' therefore related back to the sales market potential for the take-up of Pay TV and the ongoing revenues from this product.

It is generally agreed that Telstra paid about $2.5 Bn and Optus paid about $2.2 Bn for this duplicated infrastructure to be installed and commissioned in the Australian metro areas, and that there was an 85% overlap in this geographic duplication. So thanks to the competition regime, we now have an 85% duplicated HFC Pay TV CAN with its associated exchange based equipment and the associated backhaul infrastructures, together with their duplicated headend equipment, and very conservatively this all cost $4.7 Bn in 1995.

Increased Project Costs

Both Telstra and Optus rushed their infrastructures into service in robust competition between each other, so engineering, technical and field staff worked six and seven days a week for extended overtime to get this infrastructure in before their infrastructure competitor.

What is not well publicised is that when project time is shortened, the overall costs escalate at a much faster than linear rate. It would be very conservative to assume that with the extended overtime and work days that the labour costs were increased by 1.2 times (6 days per week including overtime compared to 5 days per week without overtime), and that these costs rise at about the square of the labour costs or about 1.44 times in this case.

Similarly, when it comes to purchasing equipment with a shortened time frame, this situation loses much of the substantial discounts that can be arranged with large bulk sales. In this rushed scenario, telecomms equipment manufacturing companies (like Cisco, Magnavox, Ericsson, Alcatel, Siemens, Nortel, Pirelli, NEC, etc., have to operate their manufacturing lines under a far greater stress to provide the peak orders on a much tighter time schedule. In this environment equipment prices can easily be over 50% greater than the standard programmed purchasing discounted prices that would be normal by waiting a few months.

In round figures, these time-constrained extra costs due to competition easily put the project budget in the order of 50% over budget, and if this is factored into both the Telstra and Optus released project costs, then ***the project costs <u>without competition</u> would have been***:

Telstra = $2.5 Bn should have been $2.5 Bn / 1.5 = **$ 1.67 Bn**
Optus = $2.2 Bn should have been $2.2 Bn / 1.5 = **$ 1.47 Bn**

So if neither of these infrastructures were competitively rushed into service (as they were in reality), then the grouped total project costs **<u>without competition</u>** would have been about **$3.14 Bn and not $4.70 Bn a <u>saving of about $1.56 Bn</u>**, and the customers would have had a better service standard, but the project would have taken 18 months, not in 12 months.

The inefficiencies due to the competitive regime in this case cost Telstra about $833 M and cost Optus $733 M, a total of $1,566 M in getting the equipment installed, and commissioned under the competitive regime approach, which was clearly the Second Best strategy.

Geographic Overlap

Both the Telstra HFC and Optus HFC networks and their associated edge equipment and backhaul are 'competitive infrastructures', covering the same geographic metro areas with a nominal 85% overlap, so these HFC CANs are different in size by about 15%, where one is larger than the other – or looking at in another light; one covers an area of 15% where the other one does not.

Looking back at the overall costs, Telstra = $2.5 Bn and Optus = $2.2 Bn, and Telstra has the slightly larger footprint. In comparison Optus / Telstra = $2.2 Bn / $2.5 Bn = 0.88, and this comparison of project costs has a very close alignment to comparative geographic network coverage, proving that both projects were operated in virtually the same manner and 'efficiency'! But in reality how efficient was all this?

As a duplicated network is entirely unnecessary, this means that if the Telstra HFC network and associated backhaul were to be taken as the base requirement, then the Optus investment of $2.2 Bn is a wasted investment. Alternatively if the Optus HFC network and associated backhaul were to be taken as the base requirement, then the Telstra investment of $2.2 Bn is a wasted investment, and a further $300 M is required to bring this network up in size enough to cover the full metro coverage.

So no matter which way this is approached, the competitive regime is the prime cause for the network to be duplicated. The cost of the full duplication would be in the order of $2.5 Bn, but Optus stopped short of a full duplication at $2.2 Bn and so the effective wasted investment due to the ***competitive regime*** is $2.2 Bn, ie 22/47 = ***<u>47% wasted revenue</u>***.

With the infrastructure regime approach this HFC CAN and associated backhaul network is wholesale rented to both Telstra and Optus who in turn competitively retail this network to their customers, and the customers have the choice of their Pay TV provider from the same infrastructure.

In this case there would be HFC CAN infrastructure with associated backhaul costing only $1.67 Bn and considering that the competitive regime approach cost for the lesser HFC infrastructure cost $2.2 Bn, then the real wasted revenue is $2.2 Bn in a total of $3.87 Bn, which is ***<u>132% wasted revenue</u>*** thanks entirely to the much lower productivity of the ***<u>competitive regime</u>*** as a poor 'Second Best' strategy compared to the infrastructure [cooperative] regime.

In this 85% duplicated network case, the competitive regimes' productivity is a mere 36% that of the infrastructure regimes productivity figure.

If this competitive regime strategy were taken further so that both Telstra and Optus had 100% duplicated coverage, then the financial cost for either Telstra or Optus would have been $2.5 Bn each

– or $5.0 Bn in total from the telecomms industry for that period. The ***competitive regime business would have wasted $3.33 Bn*** as the infrastructure regime cost for the single network would have been only $1.67 Bn, showing that the competitive regime costs about 199% extra than the infrastructure regime, and this clearly shows that the competitive regime is really a very poor 'Second Best' strategy.

In this fully duplicated network case, the competitive regimes' productivity is a mere 33% that of the infrastructure regimes productivity figure.

Geographic Coverage Comparison

Assuming (for simplicity) the Telstra geographic footprint covers say 10,000 sq km, and as there is an 85% overlap, then by deduction, Optus has a 10,000 * 0.85 = 8,500 sq km equivalent geographic coverage.

With the competitive regime model, the total area covered is 10,000 sq km and the overall cost is $4.7 Bn, or approximately $470, 000 per sq km.

With the infrastructure model, because the two infrastructures are not in competition against each other, they cover different areas, so the total area will be 18,500 sq km, and the total cost will be $3.14 Bn (not $4.7 Bn as in the competitive regime), so the cost per unit area for the infrastructure regime model will be $3.14 Bn / 18,500 sq km = $170,000 per sq km

Competitive Regime model	**$470,000 /sq km**	**(276% base cost)**
Infrastructure Regime model	**$170,000 / sq km**	**(100% base cost)**

So the infrastructure [cooperative] regime model is 176% more economic (more productive) than the competitive regime model, or looking at this the other way around, the competitive regime model is at least 64% less economic (less productive) than the infrastructure [cooperative] regime model.

Both productivity figures mean the same, and the difference in productivity is no less than astounding – so where has the Productivity Commission been all these years? Why has the Productivity Commission not picked up on this glaring inefficiency scenario?

Competitive Mobile Phone Networks

Engineering Insight

Mobile phones all work on a set of common radio frequencies. Every mobile phone searches for a parent mobile base station, which then relays the phones' details to a common database for confirmation. The mobile phone is connected to the radio base station that provides the strongest reception, and is part of that mobile providers network. Mobile network providers can pass mobiles onto each other's base stations to provide virtual geographic network coverage by 'competitive' networks.

In a very similar fashion to the HFC example above, each mobile base station is also part of the CAN and has a radio or fibre optic point-to-point communication link back to the district telecomms facility, where the signalling is then relayed back to the common database, and where the nearby radio base stations poll the mobile and decide on the best radio link.

Competitive Regime Situation

It should be obvious from the above engineering insight that only one mobile phone radio network is necessary, and that this network is in effect 'open access' so that any (virtual) mobile phone network retailer could have their phones appear as though they are on this common network with their own logo etc.

Australia has a number of competitive infrastructure mobile radio networks working different parts of the electromagnetic spectrum to optimise on the population density in various geographic areas.

If we take the situation where there are two mobile radio networks with equal geographic coverage, and these networks were installed and commissioned on a schedule that did not involve overtime and shift work, then this is as near to a perfect arrangement for any competitive regime as possible.

Assuming that each network cost $1 Bn to install and commission then the total cost for the mobile networks will be $2 Bn. When competitive networks are commissioned, they operate at typically between 30% and 60% occupation, so their network occupation is typically 45%. So in this situation we have invested $2 Bn at 45% making the total investment worth about say $0.9 Bn. Keeping in mind there are two managements, two maintenance and two sets of overheads, and that is ***anything but high productivity or high overall business efficiency***.

If this network was commissioned under infrastructure guidelines, then there would be one network that cost $1 Bn, and its occupancy will be in the order of 90%, so the value of this investment will be $0.9 Bn. These customers would be none the wiser as they would have their personal logo on their mobile, and they would have network connection as before (but black spot areas would be a priority issue for the infrastructure regime, so the overall coverage would be far better, and the chance of network congestion would be far lower than if this infrastructure was operated by the competitive regime).

The table below extends this theory for more competition, and it is very easy to see that as the number of infrastructure competitors is increased, the Unit Access Network cost rises very quickly. Nominal Productivity quickly falls away in line with market share, proving that the competitive regime is a very poor 'Second Choice' strategy compared with the infrastructure regime strategy for providing mobile radio networks.

	Infrastructure Networks	Total Infrastructure Cost	Unit Access Network Cost	Nominal Productivity
Infrastructure Regime	1	$1 Bn	$50	100%
Competitive Regime	2	$2 Bn	$100	50%
Competitive Regime	3	$3 Bn	$150	33%
Competitive Regime	4	$4 Bn	$200	25%
Competitive Regime	5	$5 Bn	$250	20%

The obvious argument is that each competitive network will not have full geographic coverage, but will concentrate on say the high-density populated cities (because that is where the high revenue is). This strategy will bring the network cost down for some competitive providers, but the competitive regime productivity will only marginally improve.

Backhaul Infrastructure Networks

In the World Broadband Conference in February 2009 held in Sydney (where Senator Nick Minchin gave an opening address), at the end of the second day discussion forum of the there was talk between several major players in the telecomms industry about the failings of the competitive regime in long haul fibre networks.

The very strong general consensus was that if one long haul provider has a seemingly 'commercial' link (say for example between Brisbane and Rockhampton), then that provider, being the only competitive provider will charge as much as possible for the use of that link.

Another competitive long-haul provider will 'see' that this is a commercially viable place to put in a competitive long-haul link, but their customer user price will be very close to the same ball park price as the first provider (and they intend to amortise rather quickly). The problem is that the expected customers are not in numbers or use as their business case made out so they amortise over a much longer period in a Second Best scenario.

Now the problems begin! A third long-haul provider sees the commercial opportunity and establishes a third competitive long-haul link between these two locations and then finds out their are virtually no customers at the high price, so this third long-haul operator drops its customer rates to say 35% of the other two competitive providers, and gets some customers – but not really enough ROI to make this a financially successful venture, so now this is clearly a poor Second Best scenario.

The other two now drop their customer prices to keep their customers (and this is where the ACCC would become satisfied that they had done their job in that 'robust competition' had brought the end user prices down). Now, the first long-haul system was operating at say 70% usage, the second at say 30% usage and the third at say 20% usage, their respective managements are getting about 35 to 50% of the income they expected before the competitive regime have made all these three long-haul links very low ROIs.

So instead of having three long-haul links in robust competition with each other, we have three long-haul links with too little traffic to make sufficient ROIs for the three infrastructure providers, and this is now a very poor Second Best scenario, and legal issues arise.

Conclusion

This short addendum paper relates to the "Theory of the Second Best" which has a direct application in the efficient and productive economic strategic structuring of the NBN, and the whole telecommunications infrastructure in Australia (and elsewhere).

In the Select Senate Committee Hearing on the 20th July 2009, it was apparent that although Senators asked questions asking me to explain how the Theory of the Second Best worked, it was extremely difficult to explain without concrete financial examples to show how the infrastructure regime works and directly compare that to how the competitive regime works with respects to providing infrastructure.

The concrete financial examples that I have presented here clearly show that when the competitive regime is used to install and/or operate infrastructure, the economic productivity is very low in comparison with business practices that are common with the infrastructure regime.

When Pay TV was introduced into Australian metro areas, this was done in a competitive regime environment costing then about $4.7 Bn when if this had been rolled out under the infrastructure regime this equivalent infrastructure would have costed Australia about $1.67 Bn, so about $3.3 Bn was wasted. In productivity terms 137% of the infrastructure outlay was wasted through working in the competitive regime.

With mobile phone networks, these productivity figures are much worse than for the Pay TV infrastructure because the mobile phone networks have several infrastructure competitors.

The prime symptoms that show the productivity failings of the competitive regime approach of installing and operating telecomms infrastructures in Australia is that:

- Only the higher density populated areas (ie metro and regional) have adequate telecomms infrastructures,
- The lower density areas have a ($150 M/pa) USO subsidy to make them look commercially attractive,
- The HFC infrastructure and its associated backhaul are at least 85% geographically duplicated, and neither is near full network capacity,
- The HFC competitive infrastructure costs were far more than double (2.76 times) one well installed and operated network under the infrastructure regime,
- Competitive mobile networks have symptomatic black holes that continue for several years,
- Competitive long-haul networks very quickly become non-commercial when competition is introduced,
- Broadband Internet is installed and cannot provide Broadband standards – hence an ongoing black hole list in Broadband too,
- ADSL has being installed where Cable Internet already can provide better Broadband speeds, where FTTP should have been installed years ago
- The NBN will construct its network on a commercial basis as it is deemed to be sold to private equity by about 2014, and this self-defeats the purpose of the NBN.

It therefore follows that utilising the competitive regime frame of reference to provide infrastructure is a folly that will very quickly end up with large amounts of scarce revenue being unwisely invested into duplicated high ROI network infrastructures. Network infrastructures that commercially have a high ROI will be installed in high preference to infrastructures that have low ROIs – meaning that non-metro areas will again be deserted by commercial / competitive infrastructure businesses, and the NBN initiative will be lost again.

Appendix 9

Eastern Inland Backhaul Backbone

Here is a first pass breakdown of the Main **Eastern Inland Backhaul Backbone**

At Location	To Location	Distance	Fibres	Racks	Sub Total ($k)	Link Name	Link Total ($M)	Distance (km)
Darwin	Adelaide River	112	240	4	3760			
Adelaide River	Pine Creek	110	240	2	3500			
Pine Creek	Katherine	90	240	2	2900			
Katherine	Mataranka	113	240	2	3590			
Mataranka	Larrimar	90	240	2	2900			
Larrimar	Hi-Way Inn Roadhouse	72	240	2	2360			
Hi-Way Inn Roadhouse	Dunmurra	36	240	2	1280			
Dunmurra	Newcastle Waters	80	240	2	2600			
Newcastle Waters	Elliott	20	240	0	600			
Elliott	Powell Creek	60	240	0	1800			
Powell Creek	Renner Springs	31	240	2	1130			
Renner Springs	Banka Banka	80	240	2	2600			
Banka Banka	**Three Ways Roadhouse**	57	240	2	1910	Darwin - Three Ways Roadhouse	$30.93	951
Three Ways Roadhouse	Barkley Homestead	188	240	2	5840			
Barkley Homestead	Soundan	130	240	2	4100			
Soundan	Avon Downs	60	240	2	2000			
Avon Downs	Camooweal	70	240	2	2300			
Camooweal	Yelvertoft	90	240	2	2900			
Yelvertoft	Mount Isa	98	240	2	3140			
Mount Isa	**Cloncurry**	117	240	2	3710	Three Ways Roadhouse - Cloncurry	$23.99	753
Cloncurry	McKinlay	90	240	2	2900			
McKinlay	Kynuna	92	240	2	2960			
Kynuna	Werna	83	240	2	2690			
Werna	Winton	79	240	2	2570			
Winton	Eversham	88	240	2	2840			
Eversham	**Longreach**	89	240	2	2870	Cloncurry - Longreach	$16.83	521

Longreach	Ilfracombe	20	240	2	800			
Ilfracombe	Barcaldine	86	240	2	2780			
Barcaldine	Blackall	106	240	2	3380			
Blackall	Tambo	102	240	2	3260			
Tambo	Augathella	116	240	2	3680			
Augathella	**Charleville**	85	240	2	2750	Longreach - Charleville	$16.65	515
Charleville	Wyandra	95	240	2	3050			
Wyandra	Coongoo	48	240	2	1640			
Coongoo	**Cunnamulla**	50	240	2	1700	Charleville - Cunnamulla	$6.39	193
Cunnamulla	Tinnenburra	90	240	2	2900			
Tinnenburra	Barringun	31	240	2	1130			
Barringun	Enngonia	35	240	2	1250			
Enngonia	**Bourke**	100	240	2	3200	Cunnamulla - Bourke	$8.48	256
Bourke	Cobar	100	240	2	3200			
Cobar	Gilgunnia	80	240	2	2600			
Gilgunnia	Matakana	80	240	2	2600			
Matakana	Hillston	80	240	2	2600			
Hillston	Golgowi	80	240	2	2600			
Golgowi	**Griffith**	50	240	2	1700	Bourke - Griffith	$15.30	470
Griffith	Darlington Point	35	240	2	1250			
Darlington Point	Jerilderie	90	240	2	2900			
Jerilderie	Finley	41	240	2	1430			
Finley	Corowa	35	240	2	1250			
Corowa	**Shepparton**	67	240	2	2210	Griffith - Shepparton	$9.04	268
Shepparton	Echuca	90	240	2	2900			
Echuca	Cohuna	60	240	2	2000			
Cohuna	Barham	24	240	2	920			
Barham	Swan Hill	60	240	2	2000			
Swan Hill	Tooleybuc	40	240	2	1400			
Tooleybuc	Manangatang	45	240	2	1550			
Manangatang	**Ouyen**	55	240	2	1850	Shepparton - Ouyen	$12.62	374
Ouyen	Underbool	40	240	2	1400			
Underbool	Murrayville	70	240	2	2300			
Murrayville	Pinnaroo	30	240	2	1100			

Pinnaroo	Loxton	134	240	2	4220			
Loxton	Waikerie	80	240	2	2600			
Waikerie	Morgan	30	240	2	1100			
Morgan	Burra	70	240	2	2300			
Burra	Jamestown	60	240	2	2000			
Jamestown	Gladstone	60	240	2	2000			
Gladstone	**Port Pirie**	40	240	2	1400	Ouyen - Port Pirie	$20.42	614
Port Pirie	Port Augusta	82	240	2	2660			
Port Augusta	Iron Knob	73	240	2	2390			
Iron Knob	Kimba	80	240	1	2500			
Kimba	Cleve	80	240	1	2500			
Cleve	Arno Bay	20	240	1	700			
Arno Bay	Port Neill	30	240	1	1000			
Port Neill	Tumby Bay	40	240	1	1300			
Tumby Bay	**Port Lincoln**	40	240	1	1300	Port Pirie - Port Lincoln	$14.35	445
Port Lincoln			0	0	0			

Eastern Inland Backhaul Crescent

Here is a first pass breakdown of the **Eastern Inland Backhaul Crescent**

At Location	To Location	Distance (km)	Fibres	Racks	Sub Total ($k)	Link Name	Link Total ($M)	Distance (km)
	Cairns			0	0			
Cairns	Mareeba	64	240	1	2020			
Mareeba	Atherton	72	240	1	2260			
Atherton	Ravenshoe	70	240	1	2200			
Ravenshoe	Mount Garnet	65	240	1	2050			
Mount Garnet	Minnamoolka	7	240	1	310			
Minnamoolka	Valley of Lagoons	90	240	1	2800			
Valley of Lagoons	The Lynd Junction	90	240	2	2900			
The Lynd Junction	Greenvale	50	240	2	1700			
Greenvale	Clark River	60	240	2	2000			
Clark River	Blue Water Springs	30	240	2	1100			
Blue Water Springs	**Charters Towers**	115	240	2	3650	Cairns - Charters Towers	$22.99	713
Charters Towers			0	0	0			
	Pentland		0	0	0			
Pentland	Longton	80	240	2	2600			
Longton	Mirtna	60	240	2	2000			
Mirtna	Belyando Crossing	110	240	2	3500			
Belyando Crossing	Moray Downs	50	240	2	1700			
Moray Downs	Lagan	70	240	2	2300			
Lagan	Clermont	100	240	2	3200			
Clermont	Capella	60	240	2	2000			
Capella	**Emerald**	52	240	2	1760	Pentland - Emerald	$19.06	582
Emerald	Springsure	70	240	2	2300			
Springsure	Rolleston	70	240	2	2300			
Rolleston	Wyseby	40	240	2	1400			
Wyseby	Ridgelands	90	240	2	2900			
Ridgelands	Injune	20	240	2	800			
Injune	Gunnewin	20	240	2	800			

Gunnewin	Stirling	40	240	2	1400			
Stirling	**Roma**	40	240	2	1400	Emerald - Roma	$13.30	390
Roma	Surat	80	240	2	2600			
Surat	Glenmore	60	240	2	2000			
Glenmore	St George	60	240	2	2000			
St George	Dirranbandi	90	240	2	2900			
Dirranbandi	Hebel	55	240	2	1850			
Hebel	Lightning Ridge	62	240	2	2060			
Lightning Ridge	**Walgett**	71	240	2	2330	Roma - Walgett	$15.74	478
Walgett	Coonamble	110	240	2	3500			
Coonamble	Gulargambone	50	240	2	1700			
Gulargambone	Gilgandra	50	240	2	1700			
Gilgandra	**Dubbo**	66	240	2	2180	Walgett - Dubbo	$9.08	276
Dubbo	Peak Hill	65	240	2	2150			
Peak Hill	Parkes	50	240	2	1700			
Parkes	Forbes	45	240	2	1550			
Forbes	West Wyalong	95	240	2	3050			
West Wyalong	Temora	80	240	2	2600			
Temora	Junee	55	240	2	1850			
Junee	**Wagga Wagga**	50	240	2	1700	Dubbo - Wagga Wagga	$14.60	440
Wagga Wagga	Tumut	90	240	2	2900			
Tumut	Talbingo	30	240	2	1100			
Talbingo	Adaminaby	90	240	2	2900			
Adaminaby	Cooma	40	240	2	1400			
Cooma	Nimmitabel	45	240	2	1550			
Nimmitabel	Bega	58	240	2	1940			
Bega	**Eden**	58	240	2	1940	Wagga Wagga - Eden	$13.73	411

Eastern Inland Backbone to Coast Spurs

Here is a first pass estimation of the **Eastern Inland Backbone to Coast Spurs**

At Location	To Location	Distance	Fibres	Racks	Sub Total ($k)	Link Name	Link Total ($M)	Distance (km)
	Cloncurry		240	2	200			
Cloncurry	Gilliat	105	240	2	3350			
Gilliat	Julia Creek	35	240	2	1250			
Julia Creek	Nelia	50	240	2	1700			
Nelia	Maxwelton	50	240	2	1700			
Maxwelton	Richmond	50	240	2	1700			
Richmond	Hughenden	112	240	2	3560			
Hughenden	Torrens Creek	88	240	2	2840			
Torrens Creek	Pentland	40	240	2	1400			
Pentland	Homestead	50	240	2	1700			
Homestead	Charters Towers	70	240	2	2300			
Charters Towers	Mingela	50	240	2	1700			
Mingela	Woodstock	50	240	2	1700			
Woodstock	**Townsville**	35	240	2	1250	Cloncurry - Woodstock	$26.15	785
Townsville			240	2	200			
0	Clermont		240	2	200			
Clermont	Moranbah	93	240	2	2990			
Moranbah	Coppabella	58	240	2	1940			
Coppabella	Nebo	35	240	2	1250			
Nebo	Eton	84	240	2	2720			
Eton	**Mackay**	20	240	2	800	Clermont - Mackay	$9.70	290
Mackay			240	2	200			
0	Barcaldine		240	2	200			
Barcaldine	Jericho	90	240	2	2900			
Jericho	Alpha	49	240	2	1670			
Alpha	Capricorn	60	240	2	2000			
Capricorn	Bogantugan	60	240	2	2000			
Bogantungan	Anakie	40	240	2	1400			

Anakie	Emerald	80	240	2	2600			
Emerald	Blackwater	90	240	2	2900			
Blackwater	Duaringa	50	240	2	1700			
Duaringa	Gogango	40	240	2	1400			
Gogango	Stanwell	40	240	2	1400			
Stanwell	**Rockhampton**	40	240	2	1400	Barcaldine - Rockhampton	$21.37	639
Rockhampton			240	2	200			
0	Charleville		240	2	200			
Charleville	Morven	90	240	2	2900			
Morven	Mungallala	45	240	2	1550			
Mungallala	Mitchell	46	240	2	1580			
Mitchell	Roma	45	240	2	1550			
Roma	Jackson	45	240	2	1550			
Jackson	Miles	45	240	2	1550			
Miles	Chinchilla	60	240	2	2000			
Chinchilla	Durong South	90	240	2	2900			
Durong South	Wondai	80	240	2	2600			
Wondai	Goomeri	30	240	2	1100			
Goomeri	**Gympie**	75	240	2	2450	Charleville - Gympie	$21.73	651
Gympie			240	2	200			
0			240	2	200			
0	Cunnamulla		240	2	200			
Cunnamulla	Weelamurra	70	240	2	2300			
Weelamurra	Murra Murra	90	240	2	2900			
Murra Murra	Bollon	90	240	2	2900			
Bollon	Boolba	90	240	2	2900			
Boolba	St George	65	240	2	2150			
St George	Westmar	100	240	2	3200			
Westmar	Moonie	89	240	2	2870			
Moonie	Tare	70	240	2	2300			
Tare	Dalby	90	240	2	2900			
Dalby	Oakey	60	240	2	2000			
Oakey	**Toowoomba**	24	240	2	920	Cunnamulla - Toowoomba	$27.34	838
Toowoomba			240	2	200			

	0			240	2	200			
	0	St George		240	2	200			
St George		Nindigully	40	240	2	1400			
Nindigully		Nariel	90	240	2	2900			
Nariel		Bungunya	20	240	2	800			
Bungunya		Toobeah	20	240	0	600			
Toobeah		Goondiwindi	40	240	2	1400			
Goondiwindi		Yelarbon	40	240	2	1400			
Yelarbon		Texas	50	240	2	1700			
Texas		Bonshaw	30	240	2	1100			
Bonshaw		Tenterfield	80	240	2	2600			
Tenterfield		Casino	125	240	2	3950			
Casino		**Lismore**	15	240	2	650	St George - Lismore	$18.50	550
Lismore				240	2	200			
	0			240	2	200			
	0	Bourke		240	2	200			
Bourke		Brewarrina	96	240	2	3080			
Brewarrina		Walgett	134	240	2	4220			
Walgett		Collarenebri	70	240	2	2300			
Collarenebri		Moree	140	240	2	4400			
Moree		Warialda	30	240	2	1100			
Warialda		Delungra	33	240	0	990			
Delungra		Inverell	63	240	2	2090			
Inverell		Glen Innes	64	240	2	2120			
Glen Innes		**Grafton**	161	240	2	5030	Bourke - Grafton	$25.33	791
Grafton				240	2	200			
	0			240	2	200			
	0	Walgett		240	2	200			
Walgett		Burren Junction	90	240	2	2900			
Burren Junction		Wee Waa	80	240	0	2400			
Wee Waa		Narrabri	18	240	2	740			
Narrabri		Boggabri	60	240	2	2000			
Boggabri		Gunnedah	30	240	2	1100			
Gunnedah		Tamworth	73	240	2	2390			

Tamworth	Bendemeer	30	240	0	900			
Bendemeer	Walcha	50	240	2	1700			
Walcha	Mount Seaview	90	240	2	2900			
Mount Seaview	Wauchope	90	240	0	2700			
Wauchope	**Port Macquarie**	5	240	2	350	Walgett - Port Macquarie	$20.08	616
Port Macquarie			240	2	200			
0			240	2	200			
0	Cobar		240	2	200			
Cobar	Canbelego	40	240	2	1400			
Canbelego	Nyngan	92	240	2	2960			
Nyngan	Nevertire	80	240	2	2600			
Nevertire	Warren	20	240	2	800			
Warren	Gilgandra	80	240	2	2600			
Gilgandra	Mendooran	45	240	2	1550			
Mendooran	Dunedoo	45	240	2	1550			
Dunedoo	Coolah	40	240	2	1400			
Coolah	Merriwa	100	240	2	3200			
Merriwa	Denman	40	240	2	1400			
Denman	Singleton	60	240	2	2000			
Singleton	**Maitland**	50	240	2	1700	Cobar - Maitland	$23.16	692
Maitland			240	2	200			
0			240	2	200			
0	Hillston		240	2	200			
Hillston	Lake Cargelligo	90	240	2	2900			
Lake Cargelligo	Tullibigeal	40	240	2	1400			
Tullibigeal	Ungarie	40	240	0	1200			
Ungarie	West Wyalong	40	240	2	1400			
West Wyalong	Barmedman	30	240	0	900			
Barmedman	Temora	40	240	2	1400			
Temora	Cootamundra	50	240	2	1700			
Cootamundra	Harden	20	240	2	800			
Harden	Yass	60	240	2	2000			
Yass	Murrumbateman	20	240	0	600			
Murrumbateman	Canberra	30	240	2	1100			

Canberra	Queanbeyan	10	240	2	500			
Queanbeyan	Bungendore	20	240	0	600			
Bungendore	Braidwood	30	240	2	1100			
Braidwood	**Bateman's Bay**	50	240	2	1700	Hillston - Bateman's Bay	$19.30	570
Bateman's Bay			240	2	200			
0			240	2	200			
0	Corowa		240	2	200			
Corowa	Wangaratta	90	240	2	2900			
Wangaratta	Myrtleford	35	240	2	1250			
Myrtleford	Bright	35	240	0	1050			
Bright	Dinner Plain	45	240	2	1550			
Dinner Plain	Omeo	40	240	2	1400			
Omeo	Swifts Creek	25	240	2	950			
Swifts Creek	Bruthen	70	240	2	2300			
Bruthen	Bairnsdale	20	240	2	800			
Bairnsdale	**Lakes Entrance**	10	240	2	500	Corowa - Lakes Entrance	$12.70	370
Lakes Entrance			240	2	200			
0			240	2	200			
0	Ouyen		240	2	200			
Ouyen	Woomelang	100	240	2	3200			
Woomelang	Hopetoun	30	240	2	1100			
Hopetoun	Rainbow	40	240	2	1400			
Rainbow	Jeparit	35	240	2	1250			
Jeparit	Dimboola	50	240	2	1700			
Dimboola	Horsham	40	240	2	1400			
Horsham	Natimuk	20	240	2	800			
Natimuk	Edgehope	90	240	2	2900			
Edgehope	Naracoorte	60	240	2	2000			
Naracoorte	Kingston SE	90	240	2	2900			
Kingston SE	Robe	40	240	2	1400			
Robe	Beachport	50	240	2	1700			
Beachport	Millicent	30	240	2	1100			
Millicent	**Mount Gambier**	48	240	2	1640	Ouyen - Mount Gambier	$24.49	723

Tasmanian Backhaul and Spurs

Here is a first pass estimate of the Tasmanian Backhaul and a few Spurs

At Location	To Location	Distance	Fibres	Racks	Sub Total ($k)	Link Name	Link Total ($M)	Distance (km)
	Bairnsdale		240	2	200			
Bairnsdale	Yarram	80	240	2	2600			
Yarram	Palana	210	240	2	6500			
Palana	Menama	50	240	2	1700			
Menama	Gladstone	90	240	2	2900			
Gladstone	St Helens	80	240	2	2600			
St Helens	Bicheno	80	240	2	2600			
Bicheno	Ravensdale	80	240	2	2600			
Ravensdale	**Sorell**	80	240	2	2600	Bairnsdale - Sorell	$24.10	750
Sorell	**Eaglehawk Neck**	80	240	2	2600	Sorell - Eaglehawk Neck	$2.60	80
Sorell	Geeveston	80	240	2	2600			
Geeveston	**Southport**	40	240	2	1400	Sorell - Southport	$4.00	120
Southport			240	2	200			
0			240	2	200			
0	Sorell		240	2	200			
Sorell	Bridgewater	40	240	2	1400			
Bridgewater	Oatlands	70	240	2	2300			
Oatlands	Campbell Town	80	240	2	2600			
Campbell Town	**St Marys**	80	240	2	2600	Sorell - St Marys	$8.90	270
St Marys			240	2	200			
0			240	2	200			
0	Campbell Town		240	2	200			
Campbell Town	Longford	60	240	2	2000			
Longford	Beaconsfield	60	240	2	2000			
Beaconsfield	Bridport	70	240	2	2300			
Bridport	**Gladstone**	70	240	2	2300	Campbell Town - Gladstone	$14.40	420
Gladstone			240	2	200			
0			240	2	200			
0	Bridgewater		240	2	200			

Bridgewater	Ouse	80	240	2	2600			
Ouse	London Lakes	60	240	2	2000			
London Lakes	Derwent Bridge	30	240	2	1100			
Derwent Bridge	Queenstown	90	240	2	2900			
Queenstown	Roseberry	80	240	2	2600			
Roseberry	Parawee	90	240	2	2900			
Parawee	**Wynyard**	50	240	2	1700	Bridgewater - Wynyard	$15.80	480
Wynyard			240	2	200			
			240	2	200			
	Queenstown		240	2	200			
Queenstown	**Strahan**	50	240	2	1700	Queenstown - Strahan	$1.70	50
Strahan			240	2	200			
0			240	2	200			
0	Bridgewater		240	2	200			
Bridgewater	Bothwell	60	240	2	2000			
Bothwell	Miena	75	240	2	2450			
Miena	**Longford**	80	240	2	2600	Bridgewater - Longford	$7.05	215
Longford			240	2	200			
0			240	2	200			
0	Apollo Bay		240	2	200			
Apollo Bay	Wickham	130	240	2	4100			
Wickham	Surprise Bay	70	240	2	2300			
Surprise Bay	Woolnorth	80	240	2	2600			
Woolnorth	Smithton	20	240	2	800			
Smithton	Wynyard	60	240	2	2000			
Wynyard	Devonport	60	240	2	2000			
Devonport	**Beaconsfield**	70	240	2	2300	Apollo Bay - Beaconsfield	$16.10	490
Beaconsfield			240	2	200			

Western Australia – South West Backhaul

Here is a first pass estimate of the South / West of Western Australia

At Location	To Location	Distance	Fibres	Racks	Sub Total ($k)	Link Name	Link Total ($M)	Distance (km)
	Esperance		240	2	200			
Esperance	Scaddan	60	240	2	2000			
Scaddan	Salmon Gums	65	240	2	2150			
Salmon Gums	Dundas	60	240	2	2000			
Dundas	Norseman	45	240	2	1550			
Norseman	Higginsville	75	240	2	2450			
Higginsville	Kamalda West	80	240	2	2600			
Kamalda West	Kalgoorlie	60	240	2	2000			
Kalgoorlie	MidStation	80	240	2	2600			
MidStation	Menzies	70	240	2	2300			
Menzies	Leonora	90	240	2	2900			
Leonora	Mid Station	90	240	2	2900			
Mid Station	Leinster	80	240	2	2600			
Leinster	Sir Samuel	40	240	2	1400			
Sir Samuel	MidStation	70	240	2	2300			
MidStation	Wiluna	70	240	2	2300			
Wiluna	MidStation	95	240	2	3050			
MidStation	**Meekatharra**	95	240	2	3050	Esperance - Meekatharra	$40.15	1225
Meekatharra	Reedy	70	240	2	2300			
Reedy	Cue	60	240	2	2000			
Cue	Mount Magnet	80	240	2	2600			
Mount Magnet	MidStation	90	240	2	2900			
MidStation	Paynes Find	90	240	2	2900			
Paynes Find	Mount Gibson	70	240	2	2300			
Mount Gibson	Jibberding	80	240	2	2600			
Jibberding	Burakin	60	240	2	2000			
Burakin	Wyalkatchem	80	240	2	2600			
Wyalkatchem	Kellerberrin	75	240	2	2450			
Kellerberrin	Bruce Rock	60	240	2	2000			

Bruce Rock	South Kumminin	55	240	2	1850			
South Kumminin	Kulin	50	240	2	1700			
Kulin	Lake Grace	65	240	2	2150			
Lake Grace	Pingrup	50	240	2	1700			
Pingrup	Boden	70	240	2	2300			
Boden	Porongrup	80	240	2	2600			
Porongrup	**Albany**	45	240	2	1550	Meekatharra - Albany	$40.50	1230
Albany	Mount Barker	50	240	2	1700			
Mount Barker	Cranbrook	35	240	2	1250			
Cranbrook	Kattering	70	240	2	2300			
Kattering	Wagin	50	240	2	1700			
Wagin	Narrgin	50	240	2	1700			
Narrgin	Pingelly	50	240	2	1700			
Pingelly	Beverley	50	240	2	1700			
Beverley	Northam	65	240	2	2150			
Northam	Calaringi	75	240	2	2450			
Calaringi	Bindi Bindi	60	240	2	2000			
Bindi Bindi	Wilbin	70	240	2	2300			
Wilbin	Perenjori	75	240	2	2450			
Perenjori	Tardun	80	240	2	2600			
Tardun	Tenindewa	60	240	2	2000			
Tenindewa	**Geraldton**	80	240	2	2600	Albany - Geraldton	$30.60	920
Geraldton	Nabawa	40	240	2	1400			
Nabawa	Yuna	40	240	2	1400			
Yuna	**Tenindewa**	60	240	2	2000	Geraldton - Tenindewa	$4.80	140
Tenindewa			240	2	200			
0			240	2	200			
0	Geraldton		240	2	200			
Geraldton	Wongoondy	90	240	2	2900			
Wongoondy	**Port Denison**	90	240	2	2900	Geraldton - Port Denison	$5.80	180

Acronyms

ABS	Australian Bureau of Statistics
ACCC	Australian Consumer and Competition Commission
ACMA	Australian Communications and Media Authority
ADSL	Asynchronous (directional speed) Digital Service Line
CAN	Customer Access Network
CEO	Chief Executive Officer
CWDM	Coarse Wave Division Modulation
dB	decibel
DBCDE	Department of Communications and the Digital Economy
dBm	Power level as decibels in reference to 1 mill watt
DOCSIS	Data On Cable System Information Service
ESA	Exchange Switching Area
FTA	Free To Air
FTTC	Fibre to the Kerb
FTTP	Fibre to The Premises
GBE	Government Business Enterprise
GHz	Giga Hertz
GIS	Geospatial Information system
GPON	Gigabit Passive Optical Network
GPS	Global Positioning System
HCRC	High Capacity Radio System
HFC	Hybrid Fibre Coax
km	kilo-metres
Lib	Liberal Party
LTE	(Optical) Line Terminating Equipment
M	Million
Mb/s	Mega bits per second
MHz	Mega Hertz
mm	milli-metre
MTTF	Mean Time To Failure
NBN	National Broadband Network
NSW	New South Wales
NT	Northern Territory
ODF	Optical Distribution Frame
OLT	Optical Line Termination
PGS	Pair Gain System
PMG	Post Master General’s Department
PON	Passive Optical Network
QLD	Queensland
RIM	Remote Integrated Multiplexer
ROI	Return On Investment
SA	South Australia
SCAX	Small Country Automatic Exchange
TIO	Telecommunications Industry Ombudsman
TV	Television
USA	United States of America
Vic	Victoria
WTO	World Trade Organisation