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Metropolitan telecommunications networks - The past, present and future

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Metropolitan Telecommunications Networks - The Past, Present and Future

Introduction

The structure of a city can be understood in terms of the connections that exist between the individuals, groups and institutions that exist within it. These many and varied connections include transportation links such as roads, rail and footpaths, and reticulated service networks for electricity, gas, sewerage and telecommunications. Although the telecommunications networks that exist in our cities may not have the physical presence of the other systems, they are nevertheless, an increasingly crucial component of a well functioning and, moreover, an efficient urban environment. While there have been many advances in telecommunications technologies in the past decade, the next real phase of development to occur in our cities is only just beginning. The rollout of very high capacity networks to the home – the so-called 'Next Generation Networks' (hereafter, NGNs) – will probably be the most significant advance in our telecommunications development since the original twisted copper pair network began to be rolled out in earnest at the turn of last Century. Indeed, those who design, build and maintain our cities should treat these NGNs like any other essential service, something to be actively encouraged in order to make our cities attractive places in which to live.

A Brief History of Telecommunications in Australia

To understand the present telecommunications networks in Australia, it will be useful to take a step backwards and consider what has gone before us, both in terms of Australian attitudes towards our communications systems and the technologies that were available.

In 1872, the mammoth task of building the Overland Telegraph between Adelaide and Darwin was completed and this thin wire, which stretched out nearly 3,000 kilometres, opened Australia to international telecommunications for the first time. It may well be claimed that the Overland Telegraph was the first great competition policy success in this country, in that, it is likely that the then Governor of South Australia, Sir Charles Todd, would never have committed the £120,000 he thought was required to build it without the imminent threat of Queensland building their own

overland line to the Northern Territory[1]. While the construction of the Overland Telegraph was a monumental task, it also became a monumental budget blowout. By the time the project was completed, the total cost was estimated to be four times the original budget allocation[2]. Despite the high financial price to be paid for building these networks, Australians had an insatiable appetite to be in contact with the outside world and consequently, quickly adopted the latest technologies. By the end of the 19th Century, Australians sent more telegraphs per capita than any other nation[3].

More evidence that Australians are quick adopters of telecommunications technology is that in the short space of five years after the telephone itself was invented by Alexander Graham Bell in 1876, Melbourne, Brisbane and Sydney had their own manually operated telephone exchanges. By 1901, there were nearly 25,000 telephone services spread over the country[4]. These networks were largely found in the larger metropolitan areas, with most customers being concentrated in Melbourne, Sydney, Adelaide, Perth and Brisbane. Over the course of the Twentieth Century, these networks gradually spread throughout the country. Now, around 97 per cent of residential houses are connected to a fixed telephone service.

Over the vast majority of our history, Australians have relied upon the Government (in some form or other) to provide telecommunications services. Before Federation, the various colonies built and maintained the networks. In the 19th Century, it was the separate Colonial Governments that largely paid for and controlled the electronic communications links within and between cities. To cut a long and interesting story short, from 1901 to 1975, this task was the Commonwealth Post Master General's Department's (PMG's) responsibility. In 1975, PMG was split into Australia Post and Telecom Australia. In 1993, Telecom was corporatised as Telstra, and market competition was introduced into the Australian telecommunications sector in the form of Optus. Since this time, two tranches of Telstra have been sold and after the present buy-back scheme, just under 49% of the company will be owned by householders and other investors. The present Government's policy is that the Commonwealth should divest itself of its remaining shares in Telstra. Therefore, it is

[1] Moyal, A., *Clear Across Australia: A History of Telecommunications, Thomas Nelson Australia, Melbourne, 1984, p.41*
[2] ibid, p.55
[3] ABS, 2001, *Special Article – History of Communications in Australia*, p.2

quite reasonable to anticipate that sometime in the not too distant future, all of the telecommunications companies in Australia will be in majority private and/or overseas ownership.

The Present Telecommunications Network

During the 20th Century, the Australian telecommunications system evolved from a simple copper line and manual switching arrangement to being a not insignificant part of what is arguably the most complex machine on the planet - the modern digital telecommunications network. Australia has around 5,000 automated switching units or exchanges. The vast majority of these exchanges are smaller units that aggregate both voice and data and send it to the core of the network, where the information is either switched or re-routed to its appropriate destination. The volume of information that is being exchanged is increasing in a compounding rate. The social impact of this change has been to dramatically the ease of access to information and to produce a more interconnected society. This has revolutionised several aspects of our modern lives, particularly with regard to education, work practices and social organisation.

In Australian cities, the pit and conduit system, supplemented in part by cables strung from poles, is almost ubiquitously used to feed twisted copper pair telephone lines to the customer. These lines not only carry the telephone services that they were originally designed to provide but also serve to originate and terminate dial-up data services for over 50% of Australian households[5]. Importantly, the Australian Consumer and Competition Commission (ACCC) has declared an open access regime for various parts of Telstra's network, facilitating what is known as 'line sharing'. The line sharing regime allows alternative carriers to pay for access to Telstra's copper lines and exchange buildings. This arrangement reduces the need to have the disruptive and inefficient duplication of network facilities.

The spread of mobile phone systems is hardly worth mentioning to the contemporary audience. These devices have had a large impact upon Australian society. Currently, the market penetration is more than 60% and rising. In order to cope with this demand, a vast number of mobile phone towers have been erected; this has of

[4] ibid, p.85
[5] Australian Bureau of Statistics (September 2003), *Internet Activity*, 8153.0, p.4

course an impact upon the modern metropolitan vista. Carriers are now making a concerted push to increase the data rates available via mobile phones through the use of more intelligent ways to utilise spectrum. While these devices will doubtless continue to find a place in most Australians pockets, handbags and glove boxes, it is unlikely that they will serve as a means to distribute and display the extremely high quality video images and other high bandwidth services that NGNs are capable of delivering.

The mobile phone market in Australia epitomises the effect of the regulatory changes that have occurred within Australian telecommunications since the early 1990s. These changes have transformed the industry from a State-owned monopoly into a competitive market with over one hundred licensed carriers. The market responses that this change has precipitated have been many and varied.

The construction of high performance alternative access networks occurred during the mid-1990s. The most significant example of this has been the Optus deployment of a Hybrid Fibre Coaxial (HFC) network past 2.2 million premises. Until this infrastructure rollout, Telstra provided the 'last mile' connection to virtually every fixed telephone service in Australia. HFC networks are capable of broadcasting television (ie., Optus Vision and Foxtel), and also interactive products such as higher speed Internet and telephony. In other words, this is a full service network. Full service networks have the capacity to simultaneously offer several services and hence, can generate much more revenue. Of course, the consequence of this is that the carriers are able to more quickly recoup their deployment costs. Telstra's responded to Optus' initiative by deploying its own HFC network past 2.5 million premises. The reach of both these networks is limited to the major capital cities plus the Gold Coast.

The bulk of the Optus HFC network was strung on the existing overhead electricity infrastructure. And so, in most places where you see an Optus Cable strung on a power pole you can be almost certain that a Telstra cable will either be attached to the same pole or else have been pulled through the ducts under the nature strip. Telstra initially began taking advantage of the fact that it had already installed ducts for its twisted copper pair network, however, technical difficulties increased costs and consequently, it chose to deploy much of its distribution network via power poles. Multiple users, anywhere from 500 to 2,000, share a single coaxial cable extending

from an optical network unit located on or under the street. The bandwidth available for interactive Internet services on any single cable is limited, and as the number of users of Internet services increases, the available capacity per user decreases. However, the demand for these kinds of services is currently quite limited and consequently, Internet data rates of well in excess of one Megabit per second (Mbps) are normally obtained.

In the past two to three years, several other geographically limited networks have been constructed. Further HFC networks have been built in the regional cities of Mildura, Ballarat and Geelong. The company responsible for these regional networks, Neighborhood [*sic*] Cable, has worked closely with local electricity companies in Victoria to gain access to houses via aerial cabling from powerlines. Perhaps of greatest note has been the emergence of the first NGN in the form of TransACT's Very fast Digital Subscriber Line (VDSL) network in Canberra.

The lack of rapid advanced network expansion may be explained away as a rational market response to the fact that alternative technologies are already able to provide the services that consumers are demanding. Instead of building further HFC networks to convey a video signal, Pay TV operators are now utilising satellite platforms to broadcast channels to households in the outer suburbs and to the less populous areas of Australia. Another recent development has been the rise of Asymmetric Digital Subscriber Line (ADSL). ADSL has enabled carriers, including Telstra, to utilise the existing twisted copper pair network to deliver Internet services at speeds up to 1.5 Mbps. While 1.5 Mbps is not sufficient capacity to carry television quality video, it is fast enough to satisfy the needs of most of today's broadband consumers by delivering a very fast Internet experience (at least relative to dial-up).

Because it utilises existing telephone lines, ADSL is already available to around 7 million premises. Almost all Australian cities are serviced by ADSL, as are almost all regional centres down to a population of 4,000 and even many smaller towns. The ADSL market is very competitive, in that, there are a large number of suppliers vying for customers. Most of these suppliers resell a Telstra wholesale product, which utilises the incumbent's multiplexing equipment in over 1,000 exchanges, and install their own servers to authenticate and monitor the customer sessions. Over 300

Internet Service Providers take advantage of line-sharing to deliver Digital Subscriber Line services to customers[6]. The competition for ADSL customers is an important development because it demonstrates that telecommunications services can be provided to consumers without the need for each carrier to build alternative last mile facilities. Unfortunately, because of ADSL's limited bandwidth capabilities, it can not provide the full service network that consumers are likely to demand in the coming years.

Next Generation Networks

TransACT's VDSL network in Canberra has already been briefly mentioned. This is the first commercial application of a city-sized NGN in Australia, and one of the first of its scale in the world. TransACT's network is capable of delivering up to 54Mbps to the household and 3Mbps from the household back to the network core. With this capacity, a household could simultaneously receive a High Definition Television (HDTV) service, multiple high throughput games services, telephone services and still have plenty of room for a multi-Megabit per second Internet service. This equates to a much higher quality full service network, which ought to be able to cater for the demands of Canberrans for decades to come.

Although TransACT's network is similar to Telstra's copper-line product, in that, it is fundamentally a twisted copper pair connection to the home, the physical condition of the cable required to carry a VDSL signal has to be manufactured to a more exacting standard. And while Telstra's copper wire cable-runs can be over four kilometres in length in the metropolitan environment, TransACT's cable-runs do not extend beyond 300 meters from an optical fibre node. The high data transfer rates are achieved because shorter, higher quality copper-runs equate to less signal loss between the copper's origination and termination points. Of interest is the fact that one of the company's original and major backers is ActewAGL - an electricity and natural gas supply company that is half owned by the ACT Government. The involvement of ActewAGL has been crucial because the ingress to and egress from the household that TransACT utilises is the city's existing overhead powerlines. This has meant that TransACT has been able to install the network at a much lower per household cost than could have be achieved with an underground cable deployment. While the total

[6] Australian Bureau of Statistics (September 2003), *Internet Activity*, 8153.0, p.12

cost is estimated to be in the vicinity of $200 million, a long service life ought to allow TransACT to recoup their costs and after a period, generate ongoing profits.

VDSL is just one of many technology types available to builders of NGNs. Fibre To The Home (FTTH) is the technology that is most often touted as the future of telecommunications. FTTH networks can offer data rates much greater than even VDSL. The type of FTTH network that has typically been used in some smaller cities in Europe is the Passive Optic Network (PON). TransACT and the HFC networks uses PONs to concentrate data after the copper lines are terminated in the street cabinets. The TransACT trunk route PONs have enormous capacity by today's standards, they offer a downstream capacity of 1Gbps and an upstream capacity of 52Mbps. The impact of supplying such data rates to the household would be profound. Even many large companies and government departments would find this kind of capacity beyond their needs. With FTTH, it is difficult to imagine what digital applications could not be delivered.

Although FTTH may sound like an exotic technology, from a practical point of view there are no great challenges associated with making such networks operational. In fact, at least one has already been deployed in Australia, at least in a limited sense. Another electricity company, Western Power, is currently implementing a FTTH network in Perth. Western Power's wholly owned subsidiary, Bright communications is trialing this technology in the Suburbs of South Perth, Como and Victoria Park. It intends to use two deployment methods; the first is via existing power poles *a la* TransACT and the second is through the underground ducts being deployed as the above ground electricity supply is shifted below ground. If the pilot is successful then Bright Communications intends to greatly expand its network into metropolitan Perth. Because it is technically feasible to build NGNs, it can be concluded that other factors are impeding their advancement. These impediments will be considered in later sections.

Another significant group of NGNs that are just now being deployed in Australia's cities are the various wireless technologies. Already in Australia, many 'Wi-Fi hotspots'[7] utilising the publicly available 2.4 GHz part of the spectrum have been

[7] 'Wi-Fi' is an abbreviation for 'Wireless Fidelity'. Wi-Fi networks are high frequency Wireless Local Area Networks (WLANs) that utilise a 802.11x protocol.

recently created. While not suitable for video, these signals offer Internet connection speeds of up to 11Mbps. A company called Unwired is overseeing what is perhaps the most significant wireless deployment occurring in Australia. For $95 million, Unwired have purchased its own exclusive spectrum licenses in the 3.4 GHz part of the spectrum, and is building towers in Sydney to offer a Wide Area Network (WAN) service. Although, this project is also currently in a pilot phase, Unwired has recently raised nearly $100m which they will use to construct 70 towers throughout Sydney. This will provide Unwired with a coverage footprint that encompasses 1.2 million homes and 240,000 businesses[8].

The higher range spectrum bands between 2 GHz and 6 GHz can provide data rates in the tens of Megabytes per second. While there are physical limitations on the amount of data that can be delivered from one wireless transmitter, this problem can largely be overcome by decreasing cell size, allowing the carrier to re-use any particular frequency that is available. The disadvantage of reducing cell size is that more mobile towers need to be erected. Given the number of towers that would be required when large concentrations of customers demand high bandwidth services, a wireless solution seems unable to provide a longer term solution to the problem of supplying urban customers with telecommunications services. Due to the limited bandwidth available from wireless solutions, it seems to offer another interim technology that will provide higher performance Internet but not the full suite of telecommunications services.

The engineering solutions described above seem to be the only viable technologies for Australian cities over the next 5 to 10 years. However, it should be noted that other more advanced technologies capable of delivering services such as HDTV have been tested and it is possible that a surprise solution could emerge. For example, the experimental 75-meter wingspan, solar/battery powered plane, Helios, offers just such a prospect. Such planes could circle cities 24 hours a day – serving as a telecommunications platform in the sky. This would conveniently avoid the costs of satellite launches and remove the costly and potentially unsightly infrastructure needed to individually access premises via cable. Unfortunately, as Helios' crash and total destruction in June this year demonstrates, these new platforms will require more research and capital outlay before the level of technical

[8]Breathe Group Limited release to the Australian Stock Exchange, 13 November 2003, p.6

development required for them to become a commercially viable option is reached. Consequently, the discussion following will be limited to the three options outlined above, VDSL, FTTH and Wireless. Specifically, the benefits that will flow from the widespread existence of NGNs in Australian cities will be presented and subsequently, the impediments that may prohibit those living in Australian cities from enjoying the benefits of the broadband in the short to medium term will be examined.

What Benefits Can Next Generation Networks Offer?

As we all know, ten years ago, the Internet was not much more than a research tool for academics, information technology workers and other miscellaneous specialists. Local Area Networks (LANs) existed in a limited sense but the generally used software applications were not specifically designed to take advantage of this interconnectedness. Today, Virtual Private Networks (VPNs) allow corporations to securely exchange files from one company office to another on the other side of the World via optic fibre at data rates of multiple Megabits per second. There are great economic benefits to be gained from utilising e-commerce. These benefits are derived from the making it easier and cheaper for businesses to find customers. Average cost savings and productivity increases for businesses that utilise modern telecommunications is obviously significant. Presumably, the benefits offered by NGNs will be even greater. It is quite difficult to estimate just how large these benefits will be but cost savings of up to 11 per cent have recently been proposed[9].

Besides the economic benefits, there are other social and cultural benefits to be enjoyed from living in a connected society. An example of how electronic connectivity can help relieve pressure from other metropolitan infrastructure is the rise of online banking. Around half of all bank transactions now occur in cyberspace and 7.26 million Australians have online banking accounts[10]. Another significant benefit is the advent of online shopping. In 2002, 23 per cent of Australians made at least one online purchase[11]. Over a third of these online shoppers spent $1,000 or more and the ABS estimate that total online spend in Australia was more than $4

[9] The Allen Consulting Group, *True Broadband: Exploring the Economic Impacts*, September 2003, p.36

[10] The Australian, 20 October 2003, "Online banking soars". The number of users quoted in this article is based upon research conducted by the Market Intelligence Strategy Centre, a research company which claims to monitor 92% of the Internet Banking facility providers in Australia.

[11] ABS, *Household Use of Information Technology 2001-2002*, Catalogue Number: 8146, p.34

billion in 2002 up from $1.9 billion in 2001[12]. The positive impact of these recent developments such as decreasing car use and the associated pollution are almost impossible to measure, but these benefits will doubtless compound as the number and use of available online services increases.

The deployment of a Next Generation Network in Australian cities would vastly increase the number of services available online. With a high data link, such as one that could carry HDTV, there would be no reason why activities as diverse as seeing the doctor, talking to a group of clients, or checking up on elderly relatives could not be conducted from home or the office. Residential services such as video-on-demand already saves many Canberrans the task of going to the local video shop. However, perhaps be the most important development is that with a live video feed from the office to home, it is reasonable to expect that teleworking will become a very common activity. For a large number of people working in areas such as software development, help desk support, finance and government, increased productivity may well be the outcome while the negative externalities associated with using the transport system can be avoided.

Impediments to Next Generation Networks

As has been already mentioned, TransACT's VDSL network in Canberra and Bright Communication's pilot FTTH network in Perth are the only examples of fixed line networks currently being built with the capacity to handle the bandwidth demands consumers will require in the decades to come. Considering the financial cost of building roads, the environmental cost of producing vast amounts of greenhouse gases and other pollutants, the enormous time saving potential of NGNs, and given the fact that it is technically feasible to build them, it seems remarkable that such deployments remain rare in Australia and throughout the world. The short explanation for this is that most consumers of telecommunications services appear to be satisfied with the less mature service offering that is currently being provided by carriers. However, consumer expectations will almost inevitably grow beyond the current copper network's capability to deliver services. As this occurs, the Australian public will demand a network capable of providing very high bandwidth services. The impediments to developing such networks in the short to medium term will now be examined in more detail.

[12] ibid., p.35

The biggest barrier to the creation of NGNs is the cost of installing the cables to the home. According to preliminary CRU modelling, the cost of building a FTTH network in a city the size of Melbourne or Sydney is in the vicinity of $1-2 billion, even before a single customer is connected. To establish fibre in all major cities in Australia and refurbish the backbone network so that it could accommodate the inevitable increase in demand for data services would cost carriers a very substantial amount. The majority of this initial investment would consist of paying for the 'civil engineering' costs associated with fibre rollout and building the requisite street cabinets to serve as signal concentrators. Estimates of the costs of deploying HFC networks in the major cities of Australia were also made in 1994[13]. Interestingly, the overall cost estimates are still comparable with these more recent estimates of FTTH costs in the major cities of Australia. Pure inductive logic supports the claim that although the telecommunications technologies are improving, the cost of manually installing cable is unlikely to fall by any significant amount in coming decade. In addition, there customer connection costs are also high. To drop a line from the street cable to the house and to install the necessary customer premises equipment such as a optic fibre termination unit and set-top box is likely to cost in the vicinity of $1,500 per customer.

Considering the high costs associated with entering the NGN market, investors would need to expect significant revenues in order to recoup their outlay. Recent CRU estimates have indicated that a minimum of 25 per cent of available customers would need to subscribe to at least one service offered on a NGN for a carrier is to break even in less than ten years[14]. The uncertainties associated with whether these levels of market penetration can be obtained make investment in NGNs a somewhat risky business proposition. Given the recognised costs, it will only be when investors can be confident that the services offered by NGNs are to be widely demanded that the building of such networks become an attractive proposition. Given that the Australian public has been slow to take up the services offered by HFC and ADSL, it seems unlikely, at least in the short term, that a telecommunications carrier would deploy superior FTTH networks in each of Australia's major cities. However, as the demand

[13] Bureau of Transport and Comminations Economics, *Communications Futures Project Work in Progress Paper No.5: Costing New Residential Communications Networks*, September 1994, pp.38-39

[14] Communications Research Unit, Brown, R., 'Modelling the Cost of Broadband Rollout', *Proceedings of Communications Research Forum 2002*, October 2002, p.10

for services such as video-conferencing and video on demand increase, the era of the NGNs draws closer.

The number of customers using greater than 0.2 Mbps connections more than doubled to 516,800 in the year to June 2003[15]. It is reasonable to expect that the carriers such as Optus and Telstra will attempt to recoup the money that they have already spent on their HFC Networks. Telstra has spent around $1 billion to upgrade its telephony network to carry an ADSL signal and will want an economic return on this investment. The company predicts that the demand for its ADSL and HFC services will continue to increase and that by the end of 2004, over 1 million customers will subscribe to the data services offered by their ADSL and HFC networks. In 2006, they predict that these networks will generate over $1 billion in high speed Internet revenue alone. When marketing and network maintenance expenses are taken into account, it is reasonable to assume that Telstra will not be getting a satisfactory economic return on their broadband investment for some years yet. The early construction of a FTTH network could undermine the market for what is already being offered to Australian higher bandwidth consumers and there is a danger that the original expenditure would never be recouped. Consequently, the economic reasoning for maintaining the status quo, at least for the time being, is understandable.

The Future of Telecommunications in Australia

When can Australians expect to have NGNs installed into their major cities? One way of addressing this question is to consider the circumstances surrounding the companies who are currently building NGNs in Australia and the demographic profile of their target customers.

In the TransACT case, the company is vertically integrated, in that, because it one of its principle investors is the local electricity company, it has a readily available distribution network, the power poles. Further, Canberra's socio-demographic profile combines relative high income and high average levels of education and as past studies have demonstrated[16], such a population profile is the most disposed to pay

[15] Australian Competition and Consumer Commission, *Snap Shot of Broadband Deployment as at 30 June 2003*, p.2

[16] National Centre for Social and Economic Modelling (Lloyd, R. and Hellwig, O.), *Barriers to the Take-Up of New Technology*, November 2000, pp.11-12; See also, Communications Research Unit, Brown,

for high speed Internet products. Another important factor to bear in mind is that ActewAGL is a utility company and, as such, is more likely to have a business plan with longer break-even periods. Also, with the onset of market contestability in the electricity and natural gas distribution, companies in these industries are becoming more disposed to diversifying their interests.

A similar explanation can be given for Western Power's entry into the NGN. This company is fundamentally a utility that is looking to diversify its asset base. Also, Western power has a program of putting electricity cables underground and consequently, is well positioned to use the same ducts for telecommunications infrastructure – a significant cost saving measure. Not surprisingly, the area being targeted has a socio-demographic profile that is not too dissimilar to that found in Canberra. The suburbs directly south of the Perth CBD have both high incomes and high levels of education – just the kind of people that carriers could anticipate extracting the most customers from.

There are two main conclusions that can be drawn from these observations. Firstly, because of the high costs and drawn out return on investment, broadband companies will require a longer outlook than those generally accepted in companies other than utilities providers. Secondly, when companies do begin to build NGNs in earnest they will most likely target more affluent and more highly educated regions first. Further, in order to minimise the cost of rollout, areas will be targeted where there is a readily available, affordable ingress and egress route. However, while the costs associated with building NGNs is not falling rapidly, the demand for the services offered by NGNs will inevitably rise – and probably rise quickly. As this occurs, pay-back periods are bound to shorten. As business cases improve, this will free the capital required to build NGNs in other Australian cities.

The time frames associated with the market predictions described above are far from certain. A small number of consumers are probably already demanding the services that can only be provided by NGNs. It can be speculated that as pent up demand increases towards 25 to 30 per cent, niche markets will develop and some less risk averse carriers (most likely smaller operators) will build NGNs on a limited scale in

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R. and Gilmour, G., *Developing a Broadband Access Model, Proceedings of the Communications Research Forum 2001*, October 2001

areas are likely to have a favourable disposition to consuming high bandwidth services. These competitive pressures may force the larger carriers to upgrade their service delivery capacities. When this network rollout occurs, it will represent a great transition in the Australian telecommunications network. The twisted copper pair networks that have served us so well over the 21st Century will have become obsolete and the fibre optic networks that should have the capacity to meet our needs for the 21st Century will have superseded them.

The message to take from this paper is that the Australian householders will come to demand for the full suite of telecommunications services in the coming decade. Consequently, activity reminiscent to the frenetic HFC network builds that occurred in the mid-1990s is likely to occur some time in the next ten years. City planners and maintainers need to be aware that this activity will soon occur. While using power poles for ingress to and egress from the household is currently the cheapest available way to deliver NGN cables, it is by no means the only method for achieving this purpose. While such issues have been relatively dormant for city planners over the last decade or so, they will certainly return in the next decade.

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