Alcatel·Lucent

# ALCATEL-LUCENT SUBMISSION

***Senate Select Committee on the National Broadband Network***

**July 3rd 2009**

# 1. Introduction

Alcatel-Lucent is pleased to provide the following document in response to the Senate Select Committee's call for submissions based on the Committee's revised Terms Of Reference dated 14 May 2009.

As the world's leading provider of fibre-based access systems, we are able to observe first-hand the benefits that these networks bring, as well as the engineering, logistical and structural issues that need to be resolved during implementation. In this paper, we will provide insights that we have gained by working with regulators, policy makers, and telecommunications operators around the world and consider those insights in the context of the Australian environment and its unique challenges and opportunities.

In the short time since the Federal Government's announcement on 7th April, there has already been extensive discussion and commentary concerning the FTTP-based NBN and what it will mean for Australia. Alcatel-Lucent has had significant engagement with key stakeholders and has reached a number of conclusions concerning critical success factors required to create a well-balanced and viable network. In summary, we must:

**Emphasize that this is *the* national network.** The NBN is a national asset and must remain secure, well managed and resilient.

**Encourage Applications.** The network must encourage and maintain compelling consumer and business applications.

**Make it Australia centric.** The network must enable Australia to take full advantage of the digital economy by placing focus on locally developed services and applications. The opportunity to provide these services and apps on a global stage needs to be grasped quickly and decisively.

**Reduce customer complexity.** A connection to the NBN by a consumer or a business needs to be user friendly. Installation should be straightforward, and complexity should be minimised when a subscriber changes from one operator to the other.

**Streamline service provider connectivity.** This will be achieved by maintaining interconnection simplicity and standardization through a common Layer 2 Open Access Bitstream Service standard across all Australia.

**Promote competition**. Competition will be created at a retail level through novel and innovative service and application investment based on ease of open access to the ubiquitous "NBN Co" at agreed wholesale pricing.

## 2. Alcatel-Lucent's response to the Committee's Terms Of Reference

As the world's leading supplier of FTTx solutions, Alcatel-Lucent has global experience in the operating, regulatory and technical aspects of building such networks. Since the Government announcement, Alcatel-Lucent has focused on providing education relating to fibre access networks for the benefit of various industry groups in Australia. Using the experience gained through more than 90 fibre deployments worldwide, we have published a number of papers covering various aspects of community-wide optical networking, in addition to specific contributions made to the various submissions called for by the Government.

We commended the following papers to the Committee (see appendices and typeset versions supplied separately)

**FTTP- Our Digital Future at the Speed Of Light.** This paper provides an overview of Fibre To The Premise technology aimed at informing stakeholders especially in light of the previous focus on Fibre To The Node proposals and discussions.

**NBN- a new framework for 21st century networks in Australia.** This paper provides an overview of the key architectural issues that need to be addressed to cost effectively build a true nationwide open access network. It also discusses some of the issues that need to be addressed as the NBN replaces the copper access network as we know it today and the essential services it provides to the nation.

**Providing Systems Capability For Open Access.** This paper reminds readers that the operational construct, performance and complexity will largely be dependant on how well the NBN's operational and business support systems are architected.

**Living With FTTP.** This paper describes the practical implications of a FTTP deployment in our streets and homes.

## 3. Conclusions

Defining the right framework for NBN is an extremely complex task, especially if it needs to accommodate the requirements of multiple industry sectors (e.g. Telco, Entertainment, Education, Utility and Health Services).

Achieving the balance of reusing existing network assets versus an optimal FTTP topology is critical. Other network assets such copper will be eventually retired and it will be necessary to address the issues arising from USO, Lifeline and Special Services.

Wireless will be essential to provide NBN coverage to the 10% of the population outside the coverage provided by fibre. This wireless network needs to be well-engineered in order to avoid rural/regional/remote citizens being disadvantaged compared to their FTTP-connected fellows. However, it is a fact that today faster

access speeds can be achieved on fibre compared to wireless techniques. In the future, both will evolve, but basic physics dictates that fibre will continue to offer significantly faster access than wireless. This has implications for the service mix targeted for wireless customers, as well as a possible requirement for mixed delivery methods (e.g. wireless and satellite combined)

There is a trade off to be considered: additional engineering complexity to give the most flexible structure for enabling competition, versus simplicity for optimised cost, speed and robustness.

All of the above require very careful consideration to ensure the delivery of the right network, with true customer choice, and ubiquitous service availability, at prices affordable by all parts of society.

Alcatel-Lucent would welcome the opportunity to further elaborate on the above as the Committee sees fit.

## 4. About Alcatel-Lucent

Alcatel-Lucent (Euronext Paris and NYSE: ALU) provides solutions that enable service providers, enterprises and governments worldwide, to deliver voice, data and video communication services to consumers. It:

- has provided equipment and technology underpinning 90+ FTTx deployments in 90% of the top broadband economies including 20+ nationwide operators and 60+ municipalities and utilities,
- is the world's leading supplier of xDSL technologies, a position it has held since 1997,
- is the world's leading supplier of GPON FTTH technologies,
- is engaged with 25+ major telecommunications incumbents and competitors in IP end to end network transformations and in many more non end to end transformation projects,
- Everyday, more than 300 TeraBytes of data equivalent to around 3 billion web pages or 60 million songs, is delivered across our DSL technology platforms in Australia and New Zealand,
- Daily, more than 25 million calls are made across our technology platforms in Australia.

Alcatel-Lucent is proud to supply equipment and services to Australia's leading telecommunications incumbents and competitors. It has supplied the infrastructure for a significant portion of Australia's residential DSL community, making it a leader in helping Australians access the advantages of a digital lifestyle. Its solutions achieve advances in DSL, fibre optics, wireless and satellite access that help companies and individuals get maximum benefit from fast Internet services.

Alcatel-Lucent's commitment to Australia is not new. It has been part of the Australian telecommunications fabric since 1895. Its leadership in the development of Australia's communications infrastructure has included the country's first undersea cable network, the introduction of broadband Internet, the country's first 3G mobile network (m-Net) and the world's longest optical link, between Adelaide and Darwin.

As a leader in fixed, mobile and converged broadband networking, IP technologies, applications, and services, Alcatel-Lucent offers the end-to-end solutions that enable compelling communications services for people at home, at work and on the move. With operations in more than 130 countries, Alcatel-Lucent is a local partner with global reach. The company has the most experienced global services team in the industry, and one of the largest research, technology and innovation organizations in the telecommunications industry. Alcatel-Lucent achieved revenues of Euro 17 billion in 2008 and is incorporated in France, with executive offices located in Paris.

Alcatel-Lucent wishes to continue to play a leading role in improving Australia's economic outlook and standard of living by ensuring that the community has access to a rich variety of broadband services, wherever they live.

For more information, visit Alcatel-Lucent on the Internet: http://www.alcatel-lucent.com.au

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# Appendices

(Text versions of the papers referenced in section 2 are attached for completeness in the submission. More 'readable' typeset PDF versions have been supplied as separate files.)

# FTTP – Our digital future at the Speed of Light

At this exciting moment in Australia's history, people nationwide are talking about the government's "21st Century Broadband" announcement – and wondering what it actually means to build a national broadband network and deliver fibre into the homes and businesses of 90 percent of Australians.

*What is 'fibre to the premise' technology? How is it different to the broadband we have today? What can it do? How will it be installed? And what are these exciting new services?*

These are just a few of the questions Australians are wondering.

With more than a hundred years helping to build and shape this country's telecommunications environment – and as the global leader in delivering fibre-based broadband technologies to people around the world – Alcatel-Lucent is proud to help Australians understand a bit more about what all of this means.

Equipping Australian homes with fibre broadband connections will have a profound effect on people's lives and change the way we interact with technology and information – and each other. This paper takes a look at some of the details behind how this will be achieved – including a simple look at the underlying technology and a glimpse into the exciting digitally enabled future our country has to look forward to.

*Please note: the information presented here is general in nature and is not intended to portray in any way specific plans the Australian Government may have.*

## ADSL – FTTN – FTTP. What is the difference?

Until recently, discussions about a national broadband infrastructure for Australia have focused around the deployment of a "Fibre to the Node" (FTTN) network.

FTTN is the next generation up ADSL broadband services common today. ADSL works by:

- Delivering broadband via specialised modems situated in the telephone exchange
- Mixing Internet data and voice signals at the exchange onto the consumer's copper telephone line and delivering these signals all the way out to the home (or workplace)
- At the home, splitters are used to separate voice and data, and a similar modem is used to give the consumer access to the data, generally over their internet access.

The problem with ADSL broadband is that the maximum speed the data can reach the home is limited by the home's distance from the exchange – so, the further away the home is from the exchange, the slower the speed.

ADSL will not run effectively beyond certain distances, which can lead to people being disappointed with speeds, or with no service at all. So:

- Beyond 4.5 km, services faster than 1 Mbit/s cannot be reliably offered
- To reliably and confidently reach speeds like 12 Mbit/s consumers need to be as close as 1.5 km to the exchange.

FTTN solves this problem:

- It places mini-exchanges, or 'nodes' close to the consumer's home – typically within 800m from the node – and uses the last part of the consumer's copper line to complete the connection
- It uses modern VDSL2 technology (instead of ADSL or ADSL2+) with shorter line lengths that deliver speeds of up to 50 Mbit/s (speeds diminish the further away the consumer gets from the node)
- The node connects back to a central exchange using a high-capacity optical fibre, hence the name "Fibre To The Node".

## If FTTN solves the problem – why do we need FTTP?

FTTN is a significant step forward but is ultimately limited because it uses copper for transmitting the internet data. To note:

- The most ambitious future schemes for increasing the capability of copper are limited to about 100 Mbit/s (over distance ranges we might see with FTTN), and;
- These speeds will require very detailed engineering and the copper to be in perfect condition – these factors make services over 50 Mbit/s operationally prohibitive for most network operators.

Fibre to the Premise (FTTP), also known as Fibre to the Home (FTTH), is the *ultimate technology* for fixed broadband access.

It is a big step forward, moving broadband into a whole new league by completely abandoning old-fashioned, slow and unreliable copper telephone lines.

FTTP creates an incredible economy-transforming opportunity for creation of services far beyond what consumers today call 'The Internet'.

Every home or business will have its own fibre-optical cable coming in from the street. This length of fibre will connect to a new kind of modem at the home which will convert optical signals back into Ethernet – which is how computers normally connect to networks.

Data is literally delivered at the speed of light all the way to people's homes, enabling a new generation of services and all kinds of applications that will be limited only by human imagination. And because the data is transmitted using digital pulses of light, performance is largely unaffected by distance. A home that is 30km from the exchange will get exactly the same speed as one located next door to the exchange.

## What is GPON and how does it relate to FTTP?

GPON is an abbreviation for “Gigabit Passive Optical Networks” and is the global technology of choice for delivering super-fast broadband services via FTTP.

Key points to note are:

- GPON is super fast: data comes from the exchange at 2.5 Gbit/s – a thousand times faster than today’s 1 to 10 Mbit/s speeds
- Consumers will be able to experience burst speeds of 1 Gbit/s, and maintain speeds of up to 100 Mbit/s indefinitely, even when many people are active simultaneously.
- GPON is a shared network: meaning that a single fibre-optic cable provides service to a group of houses. Somewhere close to those homes, a passive splitter divides the signal from the exchange and fans it out to the group, normally in the range of 32 to 64 individual houses and businesses.
- The shared network greatly reduces cost and complexity as only a single fibre-optic cable is required to support a whole neighbourhood, plus there are many fewer end points in the exchange to manage, simplifying things tremendously.
- GPON can increase geographical coverage and reach more houses in lightly populated areas, as the shared fibre can be sub-divided at multiple locations before its final destination
- The Greenhouse footprint is dramatically reduced in a shared GPON network (compared to the greenhouse footprint of non-shared FTTP alternatives and traditional ADSL and FTTN broadband).
- GPON is future proof – many signals can be sent down the fibre at once, meaning that future upgrades will be possible by illuminating additional “colours” of light down the strand of fibre as and when required. The FTTH standards industry is planning these capabilities now.

## New services

GPON supports the delivery of many different media-rich, bandwidth-hungry services, all able to be delivered at the same time with reliable and dependable service quality, over a single fibre optic cable into the home.

The services are all combined together at the exchange and then separated out via an Optical Network Termination (ONT) box – that is an FTTP ‘modem’ - located in the home. A typical ONT box may have up to four Ethernet ports and one or more sockets for a Plain Old Telephone Service, or POTS for short.

The GPON operator will be able to manage and control how much internet bandwidth is available to each household, meaning that consumers will be able to choose services purely based on their individual needs and budget. No longer will they be restricted by their access speed.

For example, with bandwidth hungry High Definition IPTV, GPON can guarantee a picture perfect viewing experience while ensuring that at the same time, all telephony, medical, security, educational and internet services operate reliably and with high performance.

This far exceeds the capabilities of today's ADSL networks – the bandwidth required for HD IPTV is around 20 Mbit/s, but even this high rate will consume only a small fraction of the total bandwidth available over GPON to any single household.

## Old services – what about the phone line?

GPON doesn't use traditional copper telephone lines at all – but this doesn't mean the old copper telephone services won't be around for a while yet. In the medium term it is likely that people will have a choice of telephony services, including:

- Traditional copper lines co-existing with the fibre connection, providing telephone services as normal
- The ONT (GPON modem) providing a telephone service closely matching today's copper based telephone network
- A high quality managed Voice over Internet Protocol (VoIP) service provided by anybody offering services on the wholesale FTTP National Broadcast Network (NBN).

Video calling is destined to become a standard option and all kinds of collaboration services will become possible so that people can work and learn from their homes just as easily as in the office or on campus. To ensure the voice quality matches – or exceeds – what is available to today, the quality of VoIP service will be assured by the sophisticated intelligence of the GPON network. It is important to note that the nature, quality and reliability of telephony services in an NBN world will depend heavily on what regulators deem to be a 'regular telephone service', as well as the engineering design of the government's proposed FTTP network and the broader regulatory environment. These issues will form the basis of important discussions which will need to take place in the coming months.

## Streetscape and community impacts of the NBN

Rolling out an NBN will be a significant undertaking with vast civil engineering and construction requirements needed to install the new fibre-optic cables and passive infrastructure, and to physically connect each home to the new network. On a nationwide basis, there will be community concern around the visual amenity of this construction, the physical impact on residential property and other community impacts.

To address these concerns, more detail about the construction requirements are below. To put the construction of an FTTP network into perspective, it is a very similar undertaking to constructing out the fibre to the node network, only with far more benefits.

With FTTN, cabinets full of electronics are required to deliver data and telephony over the local copper line. These require power, cooling, and make noise, especially on hot days. In contrast, a major benefit of GPON based FTTP, purely in terms of the technology, is that ***Passive Optical Networks are truly passive***.

In contrast:

- A GPON distribution point, or *splitter*, is perfectly silent. It literally joins the main fibre feed from the exchange to the local connections, and nothing else – it requires no power and will almost never need servicing.
- A GPON takes up much less space than a fully equipped node cabinet.
- In some cases, existing underground pits can be used to house the splitter – and when a street-side cabinet is required, its size will be smaller than today's common telephone and FTTN cabinets.

FTTP construction requirements:

- FTTP does require a new connection to be made into the home and probably requires adjustments to the existing in-home telephone, broadband and pay television wiring
- The main fibre from the exchange may arrive via aerial connections, or via underground ducts (in existing underground estates, i.e. telephone pole-free estates the establishment of a new, overhead distribution network is likely to be very unpopular)
- In many cases, rather than dig new ditches, fibre will be able to be successfully pulled through existing ducts from the street into people's homes
- ONTs – the FTTP modems – need to be installed in people's houses. These will likely be mounted on an external wall with a connection through to the inside, although in some countries, modems are installed inside homes and businesses
- Indoor ONTs (FTTP modems) are very similar in size to today's ADSL modems. Outdoor ONTs are around twice this size, because their enclosure needs to be protected from the elements
- Connection of a house or community to the FTTP network needs to be coordinated back at the exchange to transfer over telephony and data services - a major task that requires superb planning and execution to ensure that services are only disrupted for the minimum amount of time. For example, ensuring access to the emergency call service is available during the cutover is just one aspect that needs to be considered

- For new buildings and new housing estates, most of these logistical challenges disappear: easy cabling for FTTP and installation of the ONT will be a given. Just as with light switches and power outlets, it is easy to install these when a home is being built.

## What are the environmental benefits?

One great advantage of a GPON FTTP network is that no power is required to operate the passive distribution points. Consolidating the active components into the exchange provides significant can mean power savings of up to 66 per cent compared to an FTTN equivalent.

However, the real environmental benefits which are likely to achieve much greater carbon footprint savings, will accrue from the rich variety of services that will be delivered using the new network – such as reduced travel and the ability to remotely monitor/control power consumption in homes of the future.

## How long until FTTP needs replacement?

FTTP is a future-proof long term investment with a long life expectancy. The fibres in the ground are expected to have a serviceable life comparable to the old copper network when it was new. The fibre architecture is expected to see Australia through the coming century.

Transmission equipment in the exchange will be upgraded in the future, in line with increasing bandwidth usage. But with FTTP supporting more than a thousand times today's typical broadband speed, this is unlikely to be needed for more than a decade.

## Is FTTP safe?

- FTTP is probably one of the safest technologies available for distributing data and other forms of information
- Although it uses lasers to power the light transmission, its power level, by the time it passes through the optical fibre network and reaches the home, is very low.
- Fibre cables can not conduct lightning surges like traditional copper cables can. In this way, fibre is in much safer than copper.
- The energy that reaches people's eyes when they look directly at a light bulb is substantially greater than the energy arriving through the fibre that links their home or business to a FTTP exchange.

## Who will be providing service to consumers?

As already indicated, a national FTTP network implementation, is a very significant investment.

The government has directed that the NBN be a wholesale network available at regulated rates to all kinds of competitive service providers. These service providers will deliver services over the network based on an agreed open access 'bitstream' specification; the characteristics of which will need to be agreed by the industry and government.

Bitstream is a 'common' term used in the telecommunications industry to describe how appliances and software in our homes and businesses exchange information (content) with our chosen application and service providers across any access infrastructure – including fibre - and who is providing access.

Bitstream is very important for the roll out of a national broadband network. Not having an agreed bitstream standard is the broadband equivalent of returning to the days when Apple and Microsoft computers couldn't exchange files with one another. It is like having different rail gauges in different parts of the country. Or having PAL television in some parts of the country, NTSC in others and SECAM in others.

## What does the future hold? Where can this technology take us?

Just as telephones transformed people's lives more than 100 years ago, with the introduction of fibre direct to people's homes, we are on the verge of a new era. Even over the next 10-15 years we can expect to see enormous progress in the applications and services that can be delivered over super-fast broadband.

For example, Alcatel-Lucent believes that:

- The humble telephone will evolve into a multi-purpose communications device, supporting video, information delivery and entertainment
- A wide variety of community services, such as health care and education, will be delivered using high-definition video, transforming the way these services are provided
- Beyond HD TV, 3D TV will become the norm
- Information and entertainment will be delivered by smart appliances that do not resemble computers at all and automatically adjust to suit the preferences of the user.
- Total-immersion gaming will entirely change the way people spend leisure time
- Computers will not need to have applications installed and will be less vulnerable to viruses because network-based services will be cheaper and easier to use

- Unlimited network storage will make personal music and video collections redundant.

All of these things are already starting to happen, even with today's internet. But with fibre to our homes and businesses, the end-points are limited only by human imagination and how we want to spend our lives in the future.

## Is GPON the new NBN – or NBI? What is an NBI?

The original NBN, National Broadband Network, was a project launched by the government in 2008, and intended to provide FTTN services to 98% of the population. That project has been cancelled in favour of a new NBN, based on FTTP technology that will deliver broadband services with speeds up to 100 Mbit/s to 90% of Australians, and supplemented by next generation wireless technologies.

Beyond the idea of an NBN, Alcatel-Lucent has introduced a slightly different term – the National Broadband *Infrastructure*, or NBI.

The NBI takes the NBN beyond just fast broadband speeds and looks at the broader, more holistic approach that needs to be taken next to truly meet Australia's broadband needs.

The NBI will be like a sports car – to have a superb driving experience the car needs to be finely tuned and have all working parts in peak condition.

In the same way that a sports car needs to be carefully designed, engineered and maintained, *all* of the different parts of the NBI will need to work in harmony to provide a true 'end-to-end' experience for all Australians. There's no point in having a great looking sports car if its engine is underpowered, or if its tyres don't perform, or its brakes don't work.

In the same way, Australia requires an adequately engineered NBI that takes all factors into account.

As a critical piece of national infrastructure, the NBI will need to be finely-tuned to deliver essential services to consumers, business, government and emergency organisations. It must be dependable under all conditions, including times of national crisis. It must be resilient against natural disaster and secure against sabotage and attack.

The NBI Australians are looking forward to goes far beyond simply delivering fast internet to home users. A GPON network covering much of the country will be a tremendous first step towards implementing a true NBI for all Australians.

## Glossary

ADSL – Asymmetric Digital Subscriber Line

ADSL2+

NBN – National Broadband Network

NBI – National Broadband Infrastructure

FTTN – Fibre to the Node

FTTP – Fibre to the Premises

FTTH – Fibre to the Home

GPON – Gigabit Passive Optical Network

ONT – Optical Network Termination (box)

ISP – Internet Service Provider

IPTV - Internet Protocol Television

VDSL2 – Very High Speed Digital Subscriber Line 2

## Top 10 Fast Facts on Fibre

- GPON = "Gigabit Passive Optical Networks" – the most cost effective, environmental, latest and most up to date standard with the highest throughput, to deliver fibre to people's homes and workplaces
- Uses pulses of infra-red laser light – not electricity – to transmit information
- Already runs at 2.5 Gbit/s (2500 Mbit/s) and will soon support 10 Gbit/s, with evolution towards 40 Gbit/s
- Users can connect at up to 1 Gbit/s - 1000 times faster than basic broadband and 700,000 times faster than dial-up
- A fibre-optic strand is the thickness of a human hair and can serve up to 64 homes. Fibre optic cables generally contain many strands and are come in a range of thicknesses from millimetres up to around a centimetre
- Fibre-optics are extremely secure against snooping. They do not generate any electromagnetic interference themselves and are not affected by nearby electrical equipment
- Consumers located at the furthest distance from a fibre exchange get the same broadband speed as those next door to the exchange
- GPON generates only about a third of the carbon footprint of an FTTN system delivering similar services
- Alcatel-Lucent GPON is already deployed and in operation in more than 75 major networks around the world

- GPON uses a passive network that requires no power or electronics at any point between the exchange and consumers' premises

## Alcatel-Lucent as a supplier of GPON

In a rapidly-changing world, Alcatel-Lucent has stood strong and firm as the world's most trusted provider of broadband access equipment, and GPON in particular. At the end of 2008, Alcatel-Lucent held a 46% global GPON market share and was present in every country engaged in FTTP deployments. Alcatel-Lucent has more than 90 fibre rollouts across the globe, many of them based on the latest GPON technology.

# NBN – a new framework for 21st century networks in Australia

## Introduction

Architecture is critical in any construction. For the Australian government's planned Fibre To The Premise (FTTP) National Broadband, decisions made today around the design and architecture of the network will shape the future of broadband and the digital economy in Australia.

This paper is provided by Alcatel-Lucent as a contribution to the discussion around the National Broadband Network (NBN), providing a view on what an FTTP network and services architecture looks like - and how that might be impacted by regulatory and policy decisions.

## Background

As announced by the government, the objective of the FTTP NBN is to provide fibre connectivity to 90 per cent of Australian homes, capable of delivering internet and other services up to a total of at least 100 Mbit/s. For the remaining 10 per cent of Australian homes and businesses, complementary high-speed access methods, including wireless and satellite, will be developed. The network is expected to take eight years to build.

The government revealed the creation of a new NBN company (**NBN Co**), required to offer open access wholesale services yet not permitted to offer retail services. Regulation will be applied to ensure that customers receive the benefits of competition at the retail layer. The government has suggested that this company will be responsible for the entire access network, including fibre, optical termination at exchange level, backhaul, and aggregation where interconnection to service providers is provided.

## Types of service provider

The following table shows the functional layers that could exist in an open access NBN environment:

| | |
|---|---|
| **NBN Co** | This is the Public-Private Partnership (PPP) established to build and operate the NBN. Returns are assumed to be regulated and the company is excluded from providing retail services. This company purely provides wholesale access services to the Network Service Providers. |
| **Network Services Provider (NSP)** | Network Services Providers have a retail relationship with customers and provide Internet protocol (IP) access to applications. They may optionally develop and provide |

| | |
|---|---|
| | applications themselves (refer to ASP below). |
| **Applications Services Provider (ASP)** | These companies provide the applications such as those we know today: Television and video, Voice Telephony and Internet access. New kinds of applications and services are expected to emerge from non-telecom areas such as Health, Education, Home Automation and Power Management. |

To provide context, a typical Internet Service Provider (ISP) today fulfils the role of an integrated NSP/ASP. They provide the retail relationship with customers, as well as access to a standard internet service. Some of today's ISPs also offer telephony and paid video services.

## Reference architecture

## From the Service Provider To The Home

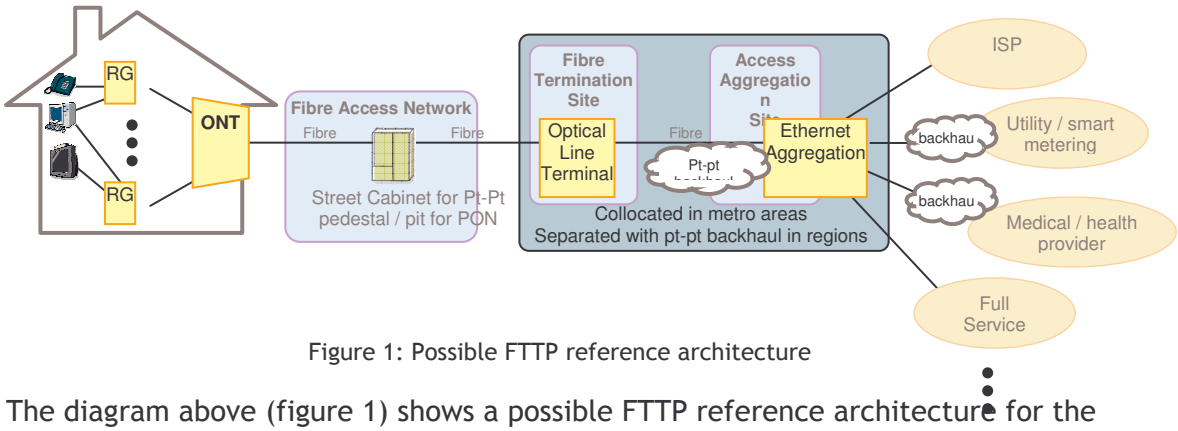


Figure 1: Possible FTTP reference architecture

The diagram above (figure 1) shows a possible FTTP reference architecture for the new NBN Co network, including the connections to future providers of information and services. Its context is a residential installation, but at a network level, there is a high degree of commonality between residential and business usage.

In order to accommodate residential customers and businesses with a single architecture, careful engineering decisions need to be made concerning the number of fibres in each cable and the location and capabilities of the pedestals. It is important to get this right at the outset as remedial engineering can be difficult and expensive.

## How it fits together

### a) Inside the home

Each premise is connected to the network by means of an Optical Network Termination (ONT) device which is then connected to one or more Residential Gateways (RG) inside the home.

An ONT:

- Is installed either inside the home or outside on an external wall
- Provides a termination and demarcation point for the Gigabit Passive Optical Network (GPON) service
- Can be thought of as being similar to a DSL modem today.

An RG:

- Connects to the ONT inside the home.
- Can be thought of as similar to today's router, although RGs are likely to be more sophisticated so that NSPs can configure and support next generation services like multimedia, security, and health.

To note, customers who only require basic internet connectivity may not need the additional functionality an RG provides – in this case, they could continue to use their existing router connected directly to the ONT. However to be able to receive the full benefit an FTTP NBN can provide, we expect that most customers will need an RG as part of their installation.

Regarding multiple dwelling units ("MDUs"):

- New MDUs - an optical splitter could be placed in the basement and fibre laid to each apartment
- Existing MDUs - likely to use fibre to the basement and then either Ethernet or VDSL2 technology over the building's internal phone wiring, as a first step - still fulfilling the government's objective of delivering services of at least 100 Mbit/s. Refurbishment of the in-building cables with optical fibre will enable even faster services.

**b) Fibre Access Network**

The fibre which leaves each home (lead-in) and runs down the street (distribution fibre) is always dedicated to the home and it is not shared with other homes. Usually within a few hundred metres of the premise, the individual distribution fibres come together at a splitter/combiner (probably in a streetside pit or pedestal), serving up to 64 customers. A single shared fibre then runs from the splitter back to a fibre termination site which can be up to 20-30km away.

The actual number of homes that share a fibre can vary according to the usage requirements of the customers and customer density:

- Heavy usage - less than 64 customers can be connected
- Low density areas - may not be feasible to 'fill' a fibre with 64 users from the same community, due to insufficient dwellings. In this case, one or more additional stages of splitting along the main fibre can be used to reach different communities, making deployment economically feasible even in sparsely populated areas. To note, this line of fibre would still only reach a maximum of 64 users.

**c) Fibre Termination and Aggregation**

The next stage of concentration happens at the fibre termination site using an Optical Line Termination or "OLT".

At the “fibre termination exchange”, the OLT terminates many fibre connections serving thousands of users and consolidates them into a much higher speed optical link. This link is the first proper stage of “backhaul” and it is the critical link that connects the clusters of neighbourhoods served by an OLT to the wider world. At the other end of the backhaul link is a data switch that provides connectivity for all the wholesale access seekers.

In a metropolitan context, this “backhaul” link may be only a few tens of metres long. The NBN Co will be able to serve hundreds of thousands of households and businesses from metropolitan fibre termination facilities spanning a radius of 20km to 30km. Separating the fibre termination site and access aggregation site with a longer “backhaul” link spanning distances up to 80km or 120km allows the GPON architecture to be economically deployed in rural and regional areas.

**What is GPON?**
GPON taps a single optical fibre for multiple homes, sharing the bandwidth available on the fibre. An alternative to this technology is to provide point to point fibre connectivity, where each residence is connected by a dedicated fibre.

The advantage of the shared GPON approach is that for metropolitan and rural / regional distances (1km up to 30km), the cost of deploying the fibre network is lower than for a point to point architecture. Savings accrue because of reduced fibre management and splicing / jointing costs.

This is based on the assumption that:
• GPON is the chosen candidate for supporting FTTP
• A combined fibre and operating company is the chosen structural model. This means the reference architecture can be expanded by adding some definitions of interfaces that would be candidates for standardisation and/or regulation.

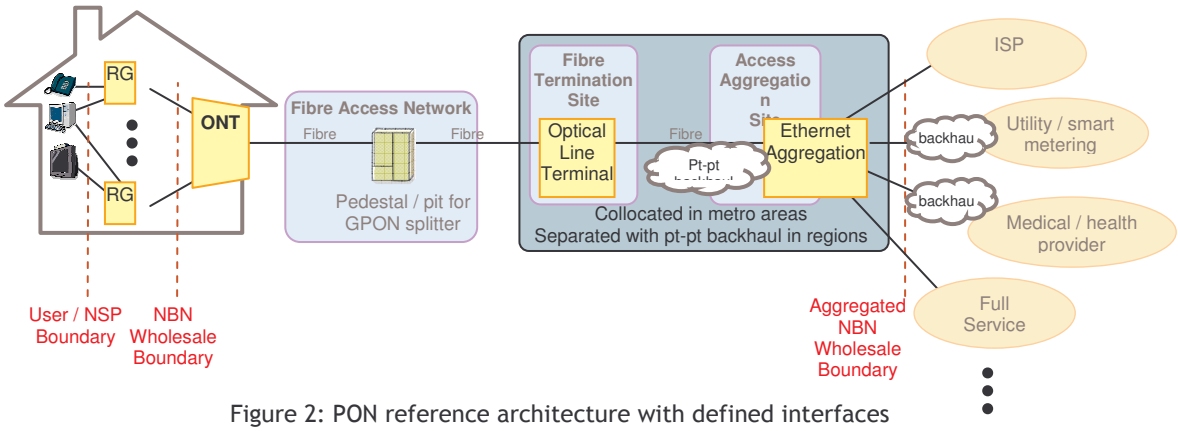


Figure 2: PON reference architecture with defined interfaces

Figure 2: Description of interfaces
User/NSP boundary: where the user connects his/her home appliances. Interface type depends on the service.

NBN Wholesale boundary: where Residential Gateways supplied by NSPs connect into the ONT supplied by NBN Co. Ethernet based.

Aggregated NBN Wholesale boundary: The data interface where NSPs can connect their service platform to serve many users. Ethernet based.

Note: this document does not define whether any of the above are the regulated "network boundary".

## Questions arising relating to Wholesale Open Access

With this architecture and structural model defined, the following questions become apparent:

1) **What degree of flexibility for service bundling should be made available?**

A fundamental decision that needs to be taken concerns the service packaging options that will be made available to customers. There are two basic options:

1. Customers only being allowed to connect to a single NSP:
   - Choice of service bundles is limited to that provided by the chosen NSP
   - However, NSPs may be regulated to allow open access to all other ASPs - which would mean that choosing an NSP would be based on the particular benefits they bring in their bundle, rather than the customer requiring access to a specific application or content.

2. Allow customers to have supply arrangements with multiple NSPs simultaneously:
   - Customers can pick and mix the services they require from the providers they wish to do business with
   - Removes the potential requirement for NSP bundles to be regulated for open ASP access, but at the expense of greater network complexity
   - Multiple physical or virtual RGs are required.

**2) Who will own, control, and support the various devices in people's homes?**

An important aspect of FTTP is that, unlike today's DSL environment, the concept of "BYO modems" is not yet feasible. Some aspects of the ONT's operation need to be centrally managed to ensure that network performance is maintained and that customers and access seekers are assured the bandwidth they have contracted for. The wholesale provider (NBN Co) will therefore be responsible for configuring and managing the ONT in accordance with the services they provide to the access seeking NSPs.

A key question is: ***could or should the ONT support an integrated RG or should the RG be separated from the ONT?***

Recall that the RG provides direct connectivity to the in-home devices. There are two alternatives here:

> a) In an **integrated RG scenario**, remote management access to the ONT/RG would be required by the NSP to fine-tune bandwidth and capabilities for IPTV, video telephony, and other services like security and health and internet access. The NBN Co will be responsible for managing all aspects relating to the fibre network itself.

With both NBN Co and NSP managing the same ONT/RG device (albeit for different purposes) this may complicate fault diagnosis and testing. A multi-NSP environment complicates this further, not least due to operational and billing systems support implications as well as security issues. In addition, in this scenario, how will the customer know which NSP to contact for support if various NSP services are misbehaving?

b) In a **non-integrated RG scenario,** each NSP provides and manages a separate RG, independently from the ONT - for example one RG for an IPTV service, another for general internet access, another for home security.

A lot of the management problems disappear in the non-integrated RG scenario, but at the cost of additional hardware.

Another key issue is the location of the various components: ONTs may be fitted externally or internally, and customers will need additional space for RGs which may be in addition to their existing home networking equipment. Where telephony is provided by an analogue terminal adaptor port on the ONT or RG, customers will also need to ensure this has connectivity to a cordless base station, or even their in-building telephone wiring.

**3) IP networking aspects**

If NBN Co supports only a single NSP per customer, that single NSP will be responsible for assigning the customer IP addresses. Applications providers (ASPs) will have to set up relationships with the NSPs that offer services on the NBN in order to reach customers. If an ASP wishes to partner with more than one NSP, they will have to separately interwork with each individual NSP's IP address space and Quality of Service scheme.

If the NBN Co allows customers to choose more than one NSP, then IP address complications arise. For example, each NSP will need to define its own IP address space within the same customer's network. This is especially challenging in the case where the RGs are virtualised inside a combined ONT/RG.

**4) How many bills should the customer receive, and how should tariffing be determined?**

In the single NSP case, tarriffing and billing is reasonably straightforward. The NSP charges the customer based on costs incurred from NBN Co as well as the applications provided. It can be assumed that NBN Co will include a charge that relates to maintenance of the fibre to the customer's premises

In a multi-NSP environment, it will be more difficult for the NBN Co to equitably incorporate operations and maintenance costs into its wholesale tariffs so that each customer pays a fair amount for the maintenance of their line, regardless of the number of NSPs they choose.

The next important tariffing question is determining how Quality of Service (QoS) will be charged. Today's 'best effort' access doesn't support QoS and the nation's service providers are yet to gain experience in tariffing it. The problem of fairly setting prices for QoS access exists equally for either the single NSP or multiple simultaneous NSP models.

**5) What will be the strategy for Fixed Telephony? (Below is a brief introduction to a complex topic!)**

Success of the NBN will result in churn away from copper based services until the utilisation of the copper does not support the cost of maintenance. At this time the copper will be retired with NBN fibre as the only access in many areas.

Presently the government has imposed a Universal Service Obligation (USO) levy on all carriers as part of the licensing requirements. This is used to subsidise POTS services in remote areas, generally over copper.

Given that the NBN (including FTTP, and potentially Wireless/Satellite) can support voice telephony services using Voice over IP (VoIP), will the USO be discontinued given the government's intent to provide NBN access to all Australians?

*In houses where fixed telephony is the only NBN service desired, will the price reflect the costs of providing a national fibre network, or will existing guaranteed telephony price levels be maintained?*

How will the transition be handled, given the economics around retiring copper?

**Lifeline Requirements**

The existing PSTN service is often described to be a "lifeline" service, the chief characteristic is that it continues to operate under power failure conditions. This is possible because today's telephone copper network provides power from the telephone exchange – something that is clearly not possible with a fibre network.

In order for an NBN customer's telephone service to continue to operate during a power outage, the customer needs to have a battery backed supply. At minimum, this battery would need to power the ONT, plus the RG if that is how telephony is delivered. Of course, if the customer is using cordless phones, he/she would have to make separate arrangements to maintain service under power failure conditions.

In the future will it be a requirement of the NBN Co to deliver and support a lifeline option, and with what scope? Or, will the widespread adoption of mobile phones be seen as making this requirement outdated and redundant?

**6) What arrangements should be put in place for non-commercial and public interest ("special") access seekers?**

It is acknowledged that NBN will be used for much more than just internet access or IPTV.

Utilities are expected to start to use the network for remote monitoring of gas/power/water meters, and community service/healthcare organisations are anticipated to develop real-time communications and monitoring applications to help reduce the cost of outpatient and community care.

Given Utility providers may not trust connectivity to the meter through equipment within the customer's control, it is likely they will seek to become a special class of NSP, providing their own RG functionality, with dedicated, secure connectivity to the ONT

*How should utilities be charged for using NBN? What would be the arrangements for houses where no NBN services are required (e.g. houses where only mobile-based services are used)?*

**7) To what extent should the topology and design of the network be mandated at a national level?**

In designing a network as huge and diverse as NBN, it will be difficult or impossible to define a "one size fits all" approach. Issues such as housing density, future building or sub-division prospects, local terrain, availability of ducting/poles, proximity to major business centres and even risk of vandalism or terrorist attack may all have significance on the network design.

Guidelines for the design and deployment of solutions, based around a common reference architecture, but with options to suit differing situations found within Australia, need to be developed as soon as possible. This is especially urgent if quotes from vendors are expected to align with the guidelines as they emerge.

**8) How will the interfaces to service providers be defined?**

Effectively and efficiently allowing all types of service provider - ISPs, IPTV companies, health companies, security services, utilities and the like - to connect into the network and offer services is the most critical step to ensure robust retail competition.

A brief sample of the issues to be considered follows:

- How will the interfaces to access seekers be specified and tariffed? Interface speed? Total throughput – peak, average, or sustained?

- How many remote customers will an access seeker be able to reach through its point of interconnection pipes and will this allow smaller scale providers to efficiently enter the market or will it constrain the NBN environment to large national players only?

- How will today's wholesale access seekers make the transition to the new NBN points of interconnect, and how will existing customers be migrated? How many different classes of service will be provided per user, and/or in total?

- What latency and/or packet loss guarantees will be offered and supported and how will this be engineered and assured?

- Will Multicast be available? Will a compulsory migration path to IPv6 be specified ?

- Very importantly, how will an application and service divide be avoided between the 90% of Australia served by FTTH and the 10% served by other next generation access? Will access seekers be easily able to offer services to both community segments on both access options?

**9) How will existing network assets be incorporated into NBN?**

There is a substantial existing investment in transmission links and facilities that could be re-used in an NBN environment. This includes exchange buildings, trenches, ducts and poles, backhaul and core network transport, and already-laid fibre.

Some of these assets could be transitioned from existing use to NBN, others might be either 100% utilised or even made unviable as part of the process. Some of these assets will be owned by companies that wish to participate in NBN Co, others may wish to just continue as service providers, and some may even use NBN as a market exit strategy.

Some questions arising from this:

- To what extent will existing physical "Central Office" and competitive fibre backhaul assets, optimised for today's copper ULL, be used, versus a new network topology engineered 'purely' to take advantage of the reach and flexibility of GPON?

- Will NBN Co be allowed to lease backhaul facilities (e.g. to connect OLTs through to Ethernet aggregation points), or must all those assets be owned by NBN Co?. If NBN Co is leasing backhaul, what will be the privacy and lawful interception requirements on the lessor?

- Will NBN Co be allowed to lease other critical network components, such as the OLT and Ethernet aggregation points?

- Will NBN Co be obliged to incorporate cable TV simulation over fibre to protect the investment in cable TV set top boxes? Should this be provided directly on the ONT? Additionally, should free-to-air TV be included automatically as part of the national plan to discontinue analogue TV transmission (e.g. to cover DTV black spots)?

**10) How will special services be tested for compatibility and certified, or retired and replaced?**

Today, in both consumer and business markets, there is an array of copper-based services in existence, many of them stretching back decades. Examples include modem-based house security systems, telemetry applications in utilities, traffic control systems and primitive point to point analogue voice lines (e.g. “hoot’n’holler”).

All of these services can be migrated to modern equivalents; however a sudden disconnection would cause serious disruption, and public safety issues. Additionally, in a business environment, ISDN continues to be widely used, especially in Call Centres

A key question: *Who will be responsible for assessing all the “special services” currently running over copper, and ensuring that migration strategies are in place and executed prior to copper being discontinued in a specific neighbourhood?*

## Conclusions

Defining the right framework for NBN is an extremely complex task, especially when you need to accommodate the needs of multiple industry sectors (e.g. Telco, Entertainment, Utility and Health Services).

Achieving the balance of reusing existing network assets versus an optimal FTTP topology is critical. Other network assets such copper will be eventually retired and it will be necessary to address the issues arising from USO, Lifeline and Special Services.

There is a trade off to be considered: additional engineering complexity to give the most flexible structure for enabling competition, versus simplicity for optimised cost, speed and robustness.

All of the above require very careful consideration to ensure the delivery of the right network, with true customer choice, and ubiquitous service availability, at prices affordable by all parts of society.

# Providing the Systems Capability for Open Access

## Introduction

This paper is provided by Alcatel-Lucent as a contribution to the discussion around the proposed Fibre To The Premise (FTTP) National Broadband Network (NBN) announced by the Federal Government on 7th April 2009. It primarily focuses on the operational architecture and the challenge of ensuring that industry and end-users experience a level of service at least comparable to that found in today's networks. This operational architecture is implemented by management systems commonly known as Operational Support System/Business Support System, or "OSS/BSS" for short.

One of the basic precepts of the new network is that it will offer open access wholesale services. These wholesale services will be sold by a wholly independent NBN Company ("NBN Co") to network service providers (NSPs), who will use them as a building block for providing retail services to end-users. NBN Co will not provide retail services itself, just wholesale access to the fibre distribution network and local backhaul.

While the concept of wholesale services is well understood, the concept of Open Access is a new area for telecoms in Australia. Yet the definition of how Open Access will operate is absolutely critical to the success of the proposed national broadband network. At a basic level, Australia's definition of Open Access will likely mean that each end-user has the freedom to choose from one, or multiple, providers to receive services. NSPs will connect at an aggregated level at major switching centres. However, there is a multitude of issues to be considered and addressed before technical/commercial relationships can be set up and deployment can commence.

## Open Access: a new model – with new challenges

The term "Open Access" implies that the goods and services provided by the NBN Co will be universally available to a wide range of NSPs, but exactly how this will be achieved is yet to be determined. By what means will access be granted and how will policies be defined and implemented? Will non-Telecommunications companies such as utilities be able to gain direct access to the network or will they need to partner with a NSP? What will be the technical requirements imposed on NSPs in order to allow them to purchase, configure, maintain, bill and lifecycle-manage their end-users in an efficient and reliable way? Will the systems and processes used in today's Unbundled Local Loop (ULL) environment be adaptable to a virtualised ecosystem? Will alternative arrangements be available for smaller NSPs – if so, will there be pricing implications? What types of security will be implemented to ensure end-user privacy and, if appropriate, partition the end-user across several providers?

In the following sections, we'll look at some of the questions faced by NBN Co and NSPs across various stages of a customer's lifecycle. In any type of shared network

environment, questions like these will require careful consideration if the NBN Co is to achieve its target of making high-speed broadband available to the full breadth of Australian consumers and the business community.

## Customer Lifecycle

**A) Defining the offer**
Tariffing, billing and mediation will be a key issue for NSPs as they plan the launch of their own retail products and bundles. The end-user connection, virtual pipe across the Passive Optical Network (PON), and capacity at the point of interconnection are all candidates for wholesale pricing. Some of these may be fixed, others may vary according to chosen performance, usage and network topology. The OSS/BSS systems used by NSPs will need to cater for the entire suite of tariffs that apply to NBN in all their variants. Plus, NBN Co must be able to report detailed charging and usage information to its NSP customers in order to allow them to bill their own end-users and monitor their profitability. Differing service level agreements with their potential adjustments and fiscal impacts will also need to be delivered.

**B) Connecting the customer**
It should be noted that even with today's vertically integrated models, customer connection is one of the most challenging parts of the customer service equation. In an Open Access model, it will be vital to ensure the efficient use of all resources to ensure the highest level of customer experience along the value chain. A sample of the issues to be resolved here are:

- When an NSP wins a new end-user, how will they place an order on to NBN Co? How can they check that service is available in that area prior to accepting the order?
- Who will be responsible for ensuring that the customer records for a particular address are accurate? NBN Co? NSP? Or both?
- When a home is being connected for the first time, will representatives from several organisations need to be present simultaneously to ensure that basic services are interrupted for the shortest possible time? How will that be managed? How are multiple truck rolls avoided?
- How will the NSP be able to check the integrity of the PON link during a new service installation? Will there be troubleshooting interfaces?
- In the event that a new service is including telephony, how will the NSP arrange cutover from existing services?

**C) Managing performance in a multi-provider environment**
Although Gigabit Passive Optical Networking (GPON) has the capability of providing very high bandwidth to all users, it's important to note that these systems are bandwidth-managed. This means that each user – and potentially each NSP for each user, needs to work within a managed framework. Imagine for a moment a scenario where multiple consumers in a single dwelling want to concurrently access high definition streaming movies from several different supply sources as well as enjoy access to voice products supplied from another, Internet access from another and smart metering or home energy management from yet another.

- Who holds the master inventory on what resource is available for consumption? How will the individual services offered be resource managed to prevent conflict and disruption?
- What real-time and post-event information will be provided to NSPs if Quality of Service (QoS) thresholds are being exceeded? Will this provide sufficient detail to enable the enforcement of Service Level Agreement (SLA) contracts?
- How will NSPs be able to check that any one of their customers is actually getting the bandwidth and performance that was contracted?

To do this properly in a shared infrastructure will require capability at the network layer, dealing primarily with QoS and bandwidth allocation, but it also places significant demands at the management and operational layer, not just to create and enforce policy, but more importantly, to have the ability to share key operational information with external customers. Creating, offering and managing shared services in an Open Access wholesale environment will be a crucial task for the NBN Co, especially in view of the scale and scope of the operation planned.

**D) Fault management and resolution**

By definition, services provided to consumers through NBN Co involve more than one party – at a minimum, NBN Co and the consumer's NSP, but possibly other Application Service Providers (ASPs) also. This multiplies the risk of incorrect data provisioning and mis-communication under fault conditions. In particular, logistical steps such as actioning customer care call centre staff or dispatching field technicians can only work if all parties are in perfect synchronisation. Remedial actions executed by one party may cause a failure at a different part of the chain if not properly orchestrated through shared OSS/BSS facilities.

In most cases, consumers experiencing issues will call their NSP, who will need up to date network status from NBN Co in order process the call appropriately. In particular, NSPs will want to know when faults are affecting multiple users simultaneously so that they avoid wasting time attempting to debug user-specific issues. The following types of system could be considered.

- Outage maps – under conditions of a fibre break or failure of active equipment owned by NBN Co, information on service availability and impacts could be managed in one place and provide a single point of reporting for all NSP customers.
- Automated notification of system alarms or activation of back-up routing, perhaps even filtered so that NSPs only receive alarms pertinent to their own operation
- Central appointment booking service – this would allow coordination across parties to support synchronisation of field staff to attend to customer appointments where there were suspected cross-domain assurance issues.

**E) Churn at retail level**

In today's telecoms environment, retail churn is a fact of life, and that is unlikely to change with the introduction of NBN. Unlike today's environment, the connection between service providers and end-users is purely virtual – no wires require jumpering to move a customer from one retail provider to another (although it is possible that residential gateways would need replacement). In

theory, then, retail churn should be simpler under NBN, thereby increasing competition.

- How should NBN Co administer retail churn transactions? Should an on-line system be provided for churn requests?
- Could churn requests be initiated solely by the gaining provider (implying mutual trust between retail operators), or would the donor provider have to confirm the move?
- If the donor NSP is partnering with an ASP, and the consumer wishes to continue with that ASP service after churning to a different NSP, how will the subscription details be transferred? (To give an example, imagine an internet provider partnering with an IPTV company: the consumer wishes to change internet provider but wants to keep the same subscription for the IPTV service)
- Should the requested changes be made effective immediately, or should there be a limited "cooling off" period in case the customer made a too-hasty decision?

**F) Service disconnection and/or transfer**

Services may be discontinued for many reasons, including people moving out, switching to alternatives (e.g. wireless), or even death. Each of these scenarios needs appropriate handling via OSS/BSS. Most complex is the "moving" case where the customer may require seamless service, available the same day, maybe in a different state. As there is no retail relationship between NBN Co and the consumer, it is almost certain that NBN Co will only become aware of service disconnection via its NSP customers. Apart from handling the request directly, it also needs to consider whether and/or how it should inform other NSPs of the likely requirement for their services to be discontinued also (e.g. moving house means cut off everything, but don't switch off the electricity if somebody goes wireless!)

In particular, if the NBN is going to support life-critical applications such as monitored health services, it will be very important to assure rigorous process for service disconnections and transfers and have tight and responsible SLAs.

In the next section, we will provide a glimpse of the strategies that can be deployed to ensure that an OSS/BSS architecture fit for purpose can be developed.

## Defining Objectives and Structure

Alcatel-Lucent has defined the following essential requirements for the NBN Company to successfully design a suitable OSS/BSS framework to support Australian business and consumers.

1) **Clear definition of the commercial and regulatory structure under which NBN will operate.** From this will flow the likely business interactions between NBN Co and NSPs, allowing OSS/BSS interfaces that will meet the operational objectives of the new network to be specified in detail.
2) **A statement of priorities and expectations regarding performance and functionality**. Metrics such as delivery times, mean time to repair, etc, will determine cost. Performance standards already exist in industry today and these can perhaps be used in the future. But more complex issues such as

the richness of external Application Programming Interfaces (API)s require very careful consideration.

3) **Adoption of a robust framework for the development of OSS/BSS systems**. In this respect, the following model is a useful visualisation, covering capacity planning, marketing, and product lifecycle management among others:

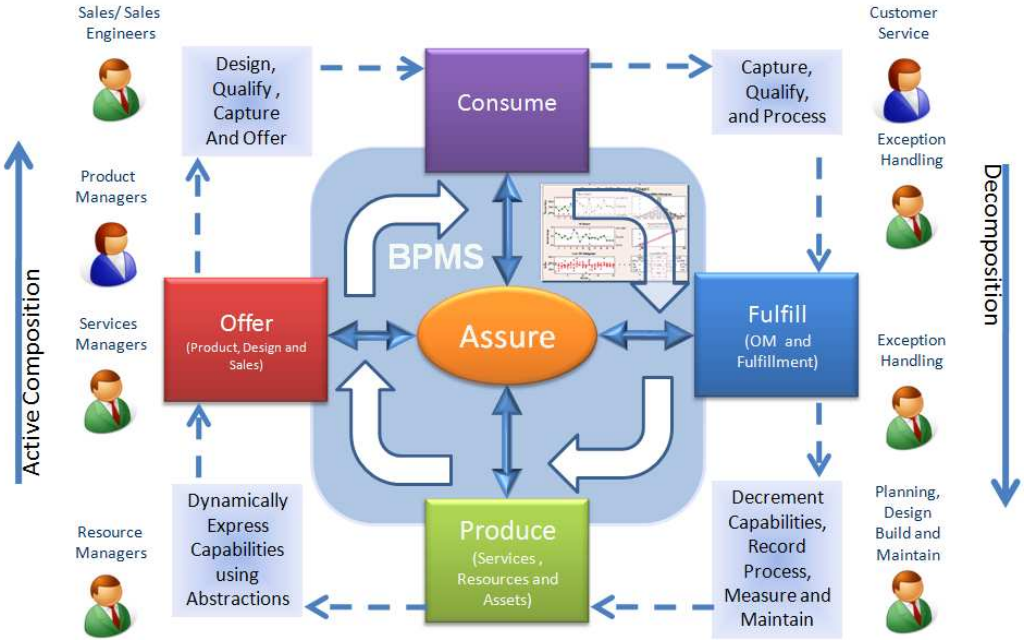


Figure 1: The Telco Model

In this model, business runs in a closed loop consisting of four key stages: Produce, Offer, Consume, Fulfill, all of which revolve around a pervasive Assurance function. In an NBN Co scenario, these can be defined as follows:

***Produce***: this represents the capabilities of NBN Co to create the underlying resources and services from the Fibre Optics, Passive Equipment, Active Equipment and all of their associated management systems.

***Offer***: building on the underlying technical capabilities, this layer represents the process and systems whereby the viable commercial offerings are defined and managed.

***Consume***: this represents the sales process, which for NBN Co would comprise selling a virtual pipe through to the aggregated interface where the NSP connects.

***Fulfil***: this represents the ability for NBN Co to accept and process and order, provision the necessary resources across the PON, and update its own databases to register the new user details and decrement the consumed assets from the relevant database.

***Assure*:** All stages of this process can experience problems, and require their own specific support processes. Intelligence is required to ensure that the various stages of this process do not become disjointed, or even inconsistent with each other.

The challenge for designing NBN Co's OSS/BSS architecture will be to take the concepts of this closed loop system, break it down into implementable pieces, analyse with respect to the business and environmental attributes existing in Australia, mix in the emerging regulatory requirements, and then start mapping those requirements to actual systems that are available in the market today.

## NBN OSS/BSS requirement in summary

The overall challenge for NBN OSS/BSS design can be summed up as follows:

***Enhanced products:*** NBN wholesale services must enable NSPs upstream to deliver a diverge range of enhanced products to their customers. The interfaces to do this should be simple to use, low cost and easy to access. The services offered by NBN Co must allow all types of provider to successfully deliver products and services across the NBN infrastructure. Mechanisms must be put in place to prevent conflict of access and to preserve the necessary quality and service levels required by NSPs and the consumers they serve.

***Service provisioning:*** NBN Co's OSS/BSS must enable efficient and integrated service provisioning. These mechanisms should be both simple and transparent through both an on-line web portal as well as business to business interfaces for the purpose of ordering, provisioning, change management, fault resolution and termination of services. The interface must be able to present full lifecycle management capabilities for the open access wholesale products on offer from NBN Co.

***Fault resolution:*** NBN wholesale services need to provide problem management and resolution capabilities and achieve this in an efficient and cost effective manner. Service delivery, fault reporting and network management will all be tightly coupled and integrated with the provisioning and activation processes.

***Reporting and KPI Management:*** End-user customer experience will be critical in terms of public acceptance and acclaim for the NBN. Reporting and Key Performance Indicator (KPI) management is a key area that deserves the same focus as 'service provisioning' and 'fault resolution' as it underpins the commercial arrangements between NBN Co and its NSP customers and will define the nature and the criticality of interactions. KPI reporting should be operational (was the service delivery within specifications), as well as network based (i.e. time to provision as well as bandwidth/usage).

## Preparing to Meet the Challenge

Clearly, the challenges for the Government and NBN Co management team are significant. Decisions made in the initial period will go on to have significant ramification and impact in the longer term. Full consideration must be given to the plethora of issues that arise from the new form of relationships that will need to be established for the proposed operating model. The knowledge, skills and experience required to arrive at the high level desired outcomes for both the nation and Australian business is significant.

Because these open access environments are a fairly recent construct, with limited examples even globally, learning from experience gained overseas will be extremely valuable during the planning phase.

Experience and skills will be required in many areas, stretching from initial design and policy considerations, operational design and systems implementation, through to the possibility for external service and operational management. Few, if any companies, are better positioned than Alcatel-Lucent. Our experience with BSS/OSS design and implementation for Open Access Wholesale operators is unmatched. Our experience of working into regulated environments of separation is also unparalleled.

Glossary

ASP – Application Service Provider
BSS – Business Support System
FTTP – Fibre to the Premise
GPON – Gigabit Passive Optical Networking
IPTV – Internet Protocol Television
KPI – Key Performance Indicator
NBN – National Broadband Network
NSP – Network Service Provider
OSS – Operational Support System
PON – Passive Optical Networking
QoS – Quality of Service
ULL – Unbundled Local Loop
SLA – Service Level Agreement

# Living with Fibre to the Premises

## Introduction

Many people in Australia are beginning to wonder about the environmental impact that NBN's Fibre To The Premises (FTTP) network will have, both on their local community and their individual homes. In particular, discussion is growing about the possibility of overhead distribution and what it might look like. This is in the context of the government's announcement that it will introduce "streamlined arrangements" in order to contain costs and facilitate rapid deployment of the National Broadband Network (NBN). In this paper, we will look at how deployment methods used elsewhere might be applied in Australia and what their impacts and advantages might be. In summary, we believe that a mixture of methods can be deployed to suit differing local environments in Australia, balancing cost against visual amenity and other considerations.

## Distribution at a neighbourhood level

### Point-to-point versus GPON

The environmental impact at a neighbourhood level will likely depend on the choice of technology for fibre distribution. Two main methods are currently under discussion: point to point (P2P) and Gigabit Passive Optical Networks (GPON). The key difference between these two systems is that P2P uses a single fibre per subscriber whereas GPON employs advanced techniques to use one fibre for up to 64 subscribers. Both techniques provide virtually unlimited bandwidth and can provide identical end-user services both today and into the future.

In a P2P environment, the fact that every customer is allocated a dedicated fibre effectively limits the distance that can be achieved between the consumer and the nearest Optical Line Termination (OLT), due to cost reasons. An OLT can be thought of as a next generation Digital Subscriber Line Access Multiplexer (DSLAM), the device that DSL modems connect to in the exchange. In fact, in a P2P environment, OLTs will probably need to be deployed on street corners, in cabinets, as the nearest main exchange facility could be up to 30 kilometres away and it would be uneconomical to lay a fibre of this length for every customer. For the long distance run between the OLT and central exchange, the customers' traffic uses a shared fibre, very similar to GPON. However, at the street corner these OLT cabinets will contain significant amounts of electronics and will require cooling during hot weather, causing inevitable noise pollution. The number of these cabinets will be determined by cost considerations – the longer the fibre runs to each home, the more fibre and fibre joins will be required, increasing the cost. Use of existing exchange buildings might eliminate the need for streetside OLTs, but still with additional fibre and splicing costs as well, as the lost opportunity for real estate savings.

In a GPON environment, a single fibre runs from a central OLT site serving up to 64 users. Consumers up to 30 kilometres away can be economically connected on this single fibre. Close to the consumers' premises, the cable is split inside a junction

box similar to those used in today's telephone network. For the whole link between the central exchange and consumers' premises, only light is used. No power is required at any point between the exchange and the home installation.

The discussion on P2P versus GPON is a significant topic, with local environmental impacts just one of the considerations. Alcatel-Lucent commonly installs both types of system. But it is probably fair to say that from a visual, noise and carbon footprint standpoint, GPON is preferable for residential fibre coverage.

## Overhead or buried?

At a neighbourhood level, the fundamental decision to be taken is "overhead" versus "buried". This discussion is largely unaffected by P2P versus GPON considerations. By "overhead", we mean that the main distribution fibre serving many homes is suspended above ground using existing or new infrastructure. "Buried" means that the fibre is entirely below ground, and invisible. While buried would be the obvious preference for most home-owners, it should be remembered that much of Australia is currently served by a network of power, telephone and cable TV overhead lines. Fibre-optic cables are very small in diameter, even when containing hundreds of individual fibres. So even a main cable carrying fibre for a whole district could be appended to existing overhead cables with relatively little visual impact. It is very likely that overhead distribution will be the default for neighbourhoods where other utilities (power, telephone, cable TV) are already provided using this method.

In areas where no distribution poles exist today, buried methods can be considered. Especially in residential areas, the erection of a pole/cable system purely to support the NBN would be very unpopular.

There are a number ways that fibre cable could be brought into a neighbourhood without the need for overhead distribution.

**Use of existing telephony ducting.** At first glance, this is the simplest option. The service being provided will enhance or replace existing telephony services. The construction of the ducts and pits is generally designed with telecommunication requirements in mind. And, further on, nearly every home in the country is connected. **However**, in many cases, the ducting is either full, or so near full, that installing a fibre cable alongside existing phone wiring would be either impossible, or very risky to existing services. Pulling cable through ducts introduces stresses and strain on the fibre, resulting in the need to use shorter fibre runs, and in turn more frequent fibre splicing (a very expensive job). The P2P architecture often means more cables, so duct space can be even more of a premium. There are also legal/commercial issues to be resolved before the use of existing telephony ducts could be confirmed. In addition, the topology of the existing telephony network may not be optimised for distributing fibre, given the much longer cable lengths that can be achieved with technologies such as GPON.

**Use of other utility ducting.** Use of electricity and/or gas ducting for distributing fibre cables is not normally considered feasible for safety reasons. However, a technique used in Japan and some other countries is to distribute fibre through the sewerage pipes. This method can be used both for neighbourhood distribution and

connecting individual homes. At some point after the pipe enters the property, the cable is brought out to a termination point where the Optical Network Termination (ONT) can be connected. This can be a very low cost way of installing fibre to individual premises. However, aesthetic considerations aside, there are problems with this approach, most notably the risk of the fibre being damaged when emergency maintenance is being carried out to clear blockages, etc.

**Trenching and micro-trenching.** As a fibre cable only two centimetres in thickness can carry up to 1,000 fibres (enough for up to 64,000 homes), trenching can be carried out quickly and with relatively little impact, even for main cable runs close to exchange buildings. Machines exist which can cut a 10 centimetres width trench down a one kilometre street in just a couple of hours. Closer to individual homes, unobtrusive "micro-trenches" about two centimetres wide can be quickly made with circular saws and even these can carry hundreds of individual fibres.

Decisions on the best way to distribute fibre from the central exchange will probably be taken on a case-by-case basis. Some will be 100 per cent overhead, others will be buried from the central exchange right to consumers' premises. Some may use overhead part-way from the exchange (e.g. along main roads) and then dive underground when entering pole-free estates. Other environmental issues, such as risk of extreme weather or bushfire damaging the distribution network, may also need to be considered.

## Distribution at street level

At the street level, buried distribution could again be achieved using existing telecommunications ducts, other utilities ducts, or micro-trenching. Any of these could be implemented with minimal visual impact. Overhead distribution is however very likely to be used in estates where utilities are already delivered via overhead lines.

***What would overhead distribution of a fibre network look like at street level?*** Most people are familiar with the sight of cable TV overhead networks – a support cable and the coax itself underneath, large amplifiers, sometimes mounted high up, and junction boxes splitting the signal out to individual houses. At a street level, an overhead-based GPON network would likely be less visually impactful than the equivalent cable TV network. For example, a small-diameter fibre cable could be strung next to the cable TV coax, and small boxes (tap boxes) stationed along the cable every four homes or so. From these tap boxes, individual fibre cables would run to each house using existing overhead connections. For each group of (up to) 64 homes on a single fibre, a splitter is required, probably contained within a compact ground-mounted pedestal. In a P2P network, the overhead cables would also need to "come to ground" wherever OLTs were implemented on street corners.

The bottom line is that home-owners already living with overhead delivery of utilities need not fear a significant additional impact from NBN fibre being added alongside existing overhead cables.

## Connection of individual homes

***What are the issues with overhead connection?***

An individual home with existing utility connections overhead can easily add an NBN fibre connection with virtually no visual impact to the premises overall. Connection will be quick and cheap with relatively little risk of other complications arising from the installation. Care may be required in homes *not* currently served by cable TV, as the NBN cable may place additional height restrictions on movement within the property in order to avoid entanglement.

***House to house daisy chain connection***

Another technique that is used in other countries leverages the close proximity of dwellings in modern estates to link fibre from house to house on an external wall. It's a method that can be used for apartment blocks as well as single family dwellings. The cable, although completely safe, is kept well out of normal reach, and encased in an armoured sheath to reduce the risk of accidental or malicious damage. No poles are required in the street and the main visual impact is where the cable crosses the empty space between houses. However, this requires a high degree of uniformity of design to work, and there are also legal issues to be considered.

***How could "buried" connections be achieved for individual homes?***

**Existing telephone ducting**: assuming that the distribution fibre is available in the street in, or near, existing telecommunications infrastructure, then utilising existing telephony ducting is tempting. There are however, issues to be considered:

- Is there room in the duct alongside the telephone wiring?
- Are there any tight corners beyond the bending capacity of the fibre?
- If it is impossible to 'push" the fibre through the duct, could the telephone wire be used to pull it through? How will that service then be reconnected? What happens if the telephone line is damaged in the process? Are there property considerations to bear in mind with respect to the telephone cable and duct?

**Microtrenching**: microtrenching could be achieved relatively quickly and cheaply if *no restrictions* were placed on the installer. But most people would not be happy with a cut right across a newly laid driveway, the loss of a favourite rosebush, or if part of a garden wall was demolished. With 20,000 homes per week to be installed, there may not be much room for negotiation with the installation teams. Alcatel-Lucent would prefer that consumers were provided the option to prepare for themselves, in advance of the NBN installation crews arriving in their communities. Once the upcoming NBN installation was confirmed, the homeowner could direct a contractor to cut a microtrench on the preferred route across the property. Very clear standards on bend radius, depth, and temporary covering would obviously need to be available.

**Underboring**: in this technique, a small pit is dug by the roadside and a special machine lowered in and used to tunnel towards the house. Some of these use water to carve a path through the soil. Achieving accurate direction can be a challenge.

Obviously, all of these techniques can be affected by terrain (soil, rock) and the design of the house and foundations/slab. A microtrench across three metres of

lawn is a different proposition to a trench through to a battleaxe block built on solid rock!

In summary, we believe that the government should publish guidelines that will inform consumers about their choices – whether to commission their own installation in advance, what the required standards are, how to choose an appropriate contractor, and what is the minimum installation standard they can expect if no action is proactively taken before the NBN install team arrives. Ideally, every house should be surveyed prior to installation and the owner informed on how connection would be made by default.

### What about homes that aren't connected using fibre?

As indicated by the Government announcement, around 10 per cent of homes won't be connected using fibre – they will be using wireless or satellite instead. Obviously, from a visual standpoint, the key difference is that neither of these approaches requires external wires to connect the home to the network, nor is there any requirement for a distribution network to reach street level. Around the home, the impacts will likely be very similar to FTTP-connected premises - a box mounted somewhere inside or outside, providing multiple services, and perhaps with connections to smart meters. But as these customers are likely to be in remote areas, those using wireless will probably need a professionally installed mast/antenna, and satellite customers will need a dish of appropriate size for their region, again professionally installed.

## Equipment in the home: Optical Network Termination

One common parameter for the 90 per cent of homes with a fibre-based NBN connection is that they will require an ONT device. This device converts the pulses of light into a data stream to be delivered over an ethernet connector and is the optical equivalent of a DSL modem. In addition to ethernet, it may also provide a telephone socket and even TV connections. All of these services originate from data delivered over the fibre-optic link. The ONT requires a 240 volt supply to operate.

There are a lot of options available for supplying ONTs to NBN consumers. The key decision point is whether the ONT should be inside or outside the house. Most network operators prefer the ONT to be external to the house in a secure box to prevent tampering and facilitate maintenance. If NBN is to be used for utilities monitoring, a secure environment (with a direct connection to the smart utility meter) is essential.

### Externally mounted ONTs

It's possible that some houses will already have external meter boxes with enough space to house an ONT; in others, a new external cabinet may be required. If aesthetics or close proximity between houses prevent this, the ONT could be mounted directly on an external wall, perhaps high up to minimise the risks of tampering.

In all cases where the ONT is mounted externally, out of reach from the consumer, the installer will need to provide a mains connection to power the ONT, as well as making any connections to smart metering devices. External ONTs also need to have connections for their services (potentially ethernet, telephony and TV) wired through to inside the house and terminated at an appropriate point. Typically this would be where the primary phone socket resides, but obvious questions arise about cable TV/standard TV connections. TV connections might have to be patched through to existing cable connections - and who would pay for this is an open question.

## Internally mounted ONTs

Internally mounted ONTs can be deployed with various options:

**Internal telecom closet box.** This could again be a secure meter box, but this time inside the home. It still prevents tampering and allows utilities connections. Power would be wired in by the installer. An advantage is that the ONT is protected from high temperatures; on the negative, it is harder for the service provider to maintain. Additionally, the service ports on the ONT (data, phone and TV) have to be made available external to the closet box.

**Wall mounted on the inside of an external wall.** The fibre is brought up against an external wall and a connection made through to an ONT mounted on the inside.

In this scenario, services sockets are all readily accessible to the consumer. A secure “behind the wall” connection could still be made to smart meters, including its own power connection if the ONT was intended to allow the supply of electricity to the household to be remotely controlled.

**Desktop**. In this scenario, the ONT is free-standing and the consumer can move it around.

This type of deployment is significantly different due to the fact that the fibre cable is now a patch lead from the wall to the ONT. This would probably be implemented by means of a wall plate/socket and a pluggable lead to connect the ONT. Note that the power level of the light signal is very low and is not a health hazard. The infra-red is invisible to human sight so it’s unlikely that children would want to play with the lead even if they could detach it from the ONT. Obviously, in this case, secure connections to smart meters are difficult to achieve.

## Power considerations

All of the ONTs mentioned above require a 240 volt supply to operate. Depending on the installation type, this would be directly wired, or from a domestic power socket. Unless battery backup is provided, the system will not function if the house loses power – just like DSL and cable internet today. However, there are some circumstances under which operation under power failure might be desired. For example, if fixed telephony is relied upon for emergencies, or if a consumer with a battery-powered laptop wanted to maintain internet access, even though all the house lights were out.

For directly-wired ONTs, a battery could perhaps be included in the installation - with cost, maintenance and environmental impacts. For devices powered from standard sockets, various capacity UPS systems could be included – again at additional cost. Depending on how telephony is provided in the future, and how broadband is viewed, battery backup may become covered by regulations - but this is a discussion still in its early stages. Alcatel-Lucent believes that battery backup should be optional, but the additional price should include the cost of recycling batteries in an environmentally responsible way.

It should be noted that the power consumption of ONTs is similar to that of a typical DSL modem, so even assuming that the power connection is on the customer side of the meter, consumer impact will be minimal.

## Equipment in the home: Residential Gateways

If the ONT is the modern equivalent of a DSL modem, then the Residential Gateway (RG) is the router. It will allow Network Service providers (NSPs) to effectively manage the services they sell to consumers. It's expected that most, if not all consumers will need at least one RG in their home. This functionality might be integrated into the ONT, but will more than likely require a separate box.

As most consumers are already familiar with having routers in their home installation, the addition of an RG will probably not be too dramatic. In some cases, they will no longer need their home router, so some simplification will be possible. At worst, the RG will require a bit of shelf space, a power socket, and an additional ethernet cable or two. Its therefore one of the lesser-impacting parts of the NBN equation. However, if a consumer has multiple NSPs, each providing their own RG, then cabling and space might become a bit more challenging.

## Conclusions

Any project the size of NBN inevitably carries with it impacts to communities and to individuals. In the case of NBN, these impacts could range from additional overhead wiring on poles, through to visual installation scars on an individual consumer's property. However, the end-goal is to catapult Australia to the very forefront of broadband technology and the benefits it brings. These benefits will fundamentally change the way Australians do business, communicate with each other, and enjoy their leisure time. New applications still to be uncovered will enrich our lives and make us more competitive as a nation. Our carbon footprint will be reduced due to reduced travel requirements and the ability to manage our energy resources more efficiently. That is the context in which the impacts should be judged.

## How Australia should be preparing itself for FTTP broadband

In order to maximise the opportunities that FTTP broadband will bring, there's much that people can do right now

**Renovators and new home builders:** Despite the recent advantages in wireless technology, it is *strongly recommended* that whenever the opportunity presents itself, ethernet cabling (CAT5 or CAT6) should be laid within the home. Ideally, a patch panel should be installed at a central location, adjacent to the main phone socket or where cable TV enters. Each room can then be connected. For some broadband applications, such as high-definition IPTV, a wired connection is almost essential.

**External landscapers, etc:** although standards have not been published, and there may be surprises, it is very cheap to lay plastic conduit when undertaking other landscaping or construction jobs outside. Laying a straight, three centimetre diameter plastic pipe from close to the street telephone connection to where the phone line enters the building would only cost tens of dollars and might save major headaches later on. Of course, laying such conduit does not guarantee that a home will be provided with an FTTP connection - or that the conduit will be used if a connection is subsequently made.

**Developers**: the Government has already announced that from July 2010, new estates must be fibre-equipped. Recent studies have shown that fibre-equipping a house during construction increases the value by a greater amount than the cost of providing this facility. With due regard to relevant standards, this is something all developers should already be doing today.

Glossary

DSLAM - Digital Subscriber Line Access Multiplexer
FTTP – Fibre to the Premises
GPON - Gigabit Passive Optical Networks
NBN - National Broadband Network
NSP – Network Service Provider
OLT - Optical Line Termination
ONT – Optical Network Termination
P2P – Point to Point
RG – Residential Gateway