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# Comparative Costs for Fibre to the Node and Fibre to the Home Rollouts in Australia

**Final Report to ACCC**

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# Contents

# Executive Summary

This project was commissioned by the ACCC as part of widening the debate in Australia on the options for large-scale broadband availability. The aim is to consider the comparative costs of rolling out Fibre to the Home (or Premises) (FTTH) as against Fibre to the Node (FTTN). The principle is that, while FTTH will cost more in initial installation, its continuing operations costs will be lower and hence may be justified in the medium term. An influential analyst report[1] from the US, for example, has promoted the need for fibre to the premises as a major competitive upgrade for the US RBOCs.

The geographic target for rolling out a new broadband infrastructure is the Australian suburbs and major regional centres. The city centres are already well served with fibre to the building, while it would be difficult to justify a rollout to sparse rural populations. For the purpose of this study, the target was taken to be ULL Band 2, which covers the suburbs and a wide selection of regional centres. This includes 585 Exchange Serving Areas (ESAs) covering 7.5M households, according to ACCC-supplied data. This is almost all the estimated households in the country. The model assumes a rollout to about 60% of Band 2 households – 4.5 million. The FTTN rollout is assumed to take place over 4 years starting in 2008, while the FTTH rollout takes 5 years. The rollout assumes complete cutover of each area to the new network architecture: that is, total homes passed is equal to total homes served.

Within an ESA, feeder cables radiate from the exchange to connect to geographic areas called Distribution Areas (DAs). At the boundary of each DA, there is a flexibility point (usually a pillar) at which feeder cable pairs are terminated and from which distribution cables fan out to connect to all the premises in the DA. For either FTTN or FTTH, the feeder cables are replaced with optical fibre cables. The major differences between FTTN and FTTH are in the upgrades at the edge of and within the DAs.

For FTTN, the flexibility point between the feeder and distribution is enhanced with a “Node” containing active optics and electronics. The optical fibre feeder cables are terminated at the node and the copper distribution cables are used for Very high speed Digital Subscriber Line (VDSL) connections from the node to each premises. At each customer’s premises, the VDSL connection is terminated with a VDSL modem.

For FTTH, the distribution cables are replaced with new optical fibre running through the DA to each premises. At the boundary between the feeder and distribution, a new passive optical device, an optical splitter, replaces the flexibility point and provides for a single feeder fibre to connect to a number (32 or 64) of distribution fibres. A single fibre is required for each household served. The fibre is connected via a new fibre drop wire to the household and is terminated by an Optical Network Unit (ONU) on the premises.

[1] Sanford C. Bernstein and Telcordia Technologies, “Fiber: Revolutionizing the Bells’ Telecom Networks”, A Joint Sanford C. Bernstein and Telcordia Technologies Research Study, May 2004.

In this study, the aim is to cost the alternatives of FTTN and FTTH in a national rollout, where ESAs are completely cut over to the new technology. We have assumed throughout that the civil infrastructure is in place – except for the new street cabinets required by FTTN and the new splitter enclosures required for FTTH – so that the major costs of greenfields preparation have been avoided.

In most cases, we have used Ovum-RHK estimates of US prices (converted at $US0.75 to $A1) for optical components, as Australian landed prices are not available to us. Over the five years of the plan period, we have assumed aggressive reductions in component prices consistent with the Ovum-RHK price forecasts. For Australian labour, we have used a fully allocated cost of $A45 per hour, obtained from a previous study.

For the financing parameters, we have used values provided by the ACCC. In particular, we have used a pre-tax Weighted Average Cost of Capital (WACC) of 13.98% and a general price inflation of 3.11%.

With these assumptions, we estimate the Net Present Values (NPVs) of the two plans as:

- FTTN to 4.5M homes in 4 years: NPV = $1,416M;
- FTTH to 4.5M homes in 5 years: NPV = $4,013M.

These estimates do not include calculation of cost savings over present mode of operation (all copper) but do include annual operations costs and depreciation charges.

The significant difference in value is largely due to the cost of pulling fibre in the distribution network for FTTH. We have assumed an industry estimate of $1.50 per fibre-metre in 2007. If this cost is reduced to one-third, that is, $0.50 per fibre-metre, as may be accomplished by sufficiently optimised work practices, then the two plans come closer in NPV:

- FTTN to 4.5M homes in 4 years: NPV = $1,416M (unchanged);
- FTTH to 4.5M homes in 5 years: NPV = $2,215M
  (i.e. about 60% more than for FTTN).

The operations costs per premises served are significantly different between FTTN and FTTH. In 2008, our estimate is that the FTTH operations cost per premises served is about 60% of that for FTTN. The FTTH cost includes a significant charge (about 25% of the cost) for maintenance of the ONU, on the assumption that, as the ONU is a relatively new piece of customer premises equipment and it contains a battery for emergency power backup, it will generate a high number of trouble reports and subsequent maintenance activities. If this were not included at all, then the opex cost per household would fall to 44% of the FTTN opex cost.

The opex cost per household for FTTN has two significant components: the costs associated with the node, for which we have provided estimates; and a copper maintenance charge of approximately $A29 (in 2008). The latter is based on estimates gleaned from ACCC public documents and, because of its historical basis, could be expected to change little. The opex charges relating to maintenance of the active node are estimates, but active electronics in the outside plant environment has traditionally generated significant maintenance activity.

# 1. Introduction

## 1.1 Project Objectives

This project is aimed at providing comparative costs for a “national” rollout of Fibre to the Home (FTTH) or Premises, as against a rollout of Fibre to the Node (FTTN). The results can be used to expand the debate in Australia about options for creating a broadband infrastructure for the country.

Given that most households are in the suburbs of the capital cities and major regional centres, the study has focused on a rollout to these regions, defined as ULL Band 2. About 7.5 M households are contained in this band, according to figures supplied by the ACCC.

The project also assumes a “national” rollout, that is, each exchange area is entirely overbuilt with the new access network and all customers are cut over to the new services. (Provision of voice service is included in all cases.) There is no attempt to justify this rollout in terms of new revenues for a telecommunications provider.

## 1.2 Terms of Reference

The complete terms of reference for the study appear at Annex A of this report.

## 1.3 Basis of Cost Model Assumptions

Much of the cost modelling for this project is based on averages, due to the nature of the data readily available on the Australian network. This is particularly the case for the copper loop lengths. Here, we have data on the proportion of access loops in five distance bands but no specific data for each exchange area. This means that cost differences depending on geography or the state of current plant cannot be specifically costed.

The rollout timing is based on cutting over complete Exchange Serving Areas (ESAs) to the new access technology. Each ESA is assumed to have the standard loop make-up. The number of households in each ESA has been estimated from the 2001 Census data, matching suburb names to ESAs, and then scaling the numbers to give the totals in each State as provided by the ACCC. The rollout numbers for each year are then set by nominating the ESAs to be cut over in each year. For FTTN, the annual rollout is set near to 1.125M homes, giving 4.5M homes over 4 years; for FTTH, the annual rollout is set near to 0.900M homes, giving 4.5M homes over 5 years.

The timing of the rollouts is based on annual events, that is, the cut-overs are assumed to occur at a fixed time each year, nominally the start of the year. No attempt has been made to reflect the timing throughout a year. The effect of this calculation is to overestimate the Net Present Value (NPV) of each plan, because the capital costs occur on average earlier in the model than they would in reality.

# 2. FTTN versus FTTH – a snapshot

## 2.1 Introduction

### 2.1.1 Fibre-to-the-X (FTTx)

“Fibre to the X” refers to the whole collection of fibre deployment possibilities in the access network. There are two main variants:

- Fibre to the Home (FTTH), also known as Fibre to the Building (FTTB) or Fibre to the Premises (FTTP). FTTH can be specific to the domestic consumer market, while FTTP can include business premises as well as homes. In this report, we take FTTH to be the encompassing term, meaning fibre to all premises.) FTTH has fibre running from an exchange all the way to the customers’ premises. At the customer’s end, the fibre is terminated at an Optical Network Unit (ONU) that provides connections for telephony and home networking. There are variants in the make-up of the access network:
    - Dedicated fibre. In this case, one or more fibres are dedicated to each premises. No sharing of fibre between customers occurs in the access network. This variant has the easiest upgrade path for future bandwidth enhancements and is commonly used for city business premises. Telecommunications providers have been reluctant to use this architecture for suburban rollouts because it provides no flexibility points in the access network, may be operationally complex to install, and is generally the most costly alternative. There are significant dedicated fibre deployments in Japan.
    - Passive optical networks (PONs). In this case, fibres radiating from the exchange are split into multiple strands at a passive optical splitter (a device using optical techniques only, no electronics) and one or more strands are terminated at the customers’ premises. The splitter may be located at the boundary between the feeder and distribution in the access network and hence provide some flexibility in deployment: if feeder fibre is terminated at a splitter that is not fully used, new premises can be served by connecting new distribution fibre to an unused port on the splitter. Generally PONs provide a cheaper deployment than dedicated fibre.
- Fibre to the Node (FTTN), also known as Fibre to the Neighbourhood or Fibre to the Cabinet (FTTCab), depending on how deep into the access network the fibre runs. In all cases, the feeder cables are fibre terminated at an active terminal – variously a node or cabinet – from which copper pairs are used to provide connection to customers’ premises. The copper carries Digital Subscriber Line (DSL) to provide high bandwidths to the customer. At the customer’s premises, there is an ADSL or VDSL modem to provide connection to a home network.
    - The cabinet terminating the fibres and providing the electronics for the DSL can be installed at the traditional feeder/distribution interface.

This variant leaves the distribution copper in place. FTTN and FTTCab usually refer to this case.

- Fibre can be installed deeper into the access, replacing some of the distribution copper with fibre. In this variant, a smaller street cabinet is installed near to customers' premises and permits higher bandwidths on the remaining copper. FTTC/FTTK usually refers to this case, where a curb-side cabinet may serve 8-24 premises.

This report uses Fibre-to-the-Home (FTTH) for the all-fibre architecture and Fibre-to-the-Node (FTTN) for the fiber/copper pair architecture. It is assumed in FTTN that the cabinet is installed at the feeder/distribution interface.

## 2.2 Basic cost considerations for FTTx deployment

The total costs of FTTx deployments are highly influenced by local conditions, overall strategy, choice of vendors, legacy architectures, and local geography and therefore are rarely the same from country to country.

There are several key components to the costs of building an FTTx network although the actual proportions of each will vary from country to country and from network to network. The typical main costs, listed in descending order, are:

- civil works (aerial construction is cheaper than underground construction);
- active equipment (ONUs, OLTs, aggregation switches, and so on);
- passive cable plant (cables, cabinets, closures, and so on);
- planning and project management.

Ovum's experience indicates that civil works can account for as much as 70% to 80% of total capex for an FTTH project. This is usually substantially less for FTTN projects as legacy copper is used to carry the connection from the node to the premises, therefore requiring significantly less trenching and other civil works. Understanding this, vendors have been focussing efforts on innovating cable laying and using blown-fibre technologies for aerial as well as underground deployments in an attempt to reduce civil works costs for FTTx rollouts.

If properly planned and designed, the service life of a modern fibre-optic cable plant should exceed 20 years.

Access network costs can be grouped into two categories: the costs of building the network before services can be offered (homes passed), and the costs of building connections to new subscribers (homes connected).

More specifically, the homes passed portion of costs consists of:

- local exchange fit-out;
- feeder;
- cables and civil works;
- cabinet and splitters; and
- distribution cables and civil works.

The homes connected portion of costs relates to:

- drop cable and civil works;

- the modem or ONU; and
- the line-card of the OLT.

The take-up rate is the ratio of homes connected to homes passed and is a measure of how attractive subscribers find the network and the services offered. Triple-play packages in brownfield areas commonly have 30% to 40% take-up rates after a few years. In greenfield areas, one can often reach 90% to 100% take-up rates in the first year of operation.

Commercial success is dependent on the mixture of user services (for instance, fast internet, VoIP, TV and video) and the go-to-market strategy. Some incumbents have also argued that the regulatory environment could be an important factor in determining the short- to medium-term viability of an FTTx project, especially where the business case is relatively weak. This has led to discussion of "regulatory holidays" (giving relief from competition) and funding or other devices to improve the business case for a FTTx rollout.

Capital expenditures (capex) are extremely important but they are often not more important than operating expenses (opex). In some cases, opportunities to reduce opex (and other revenue considerations – please see Section 2.3) might justify the transition from older access technologies to FTTx. Other Ovum studies have suggested that FTTH can provide opex savings as significant as 40-60% compared to the operations cost of running legacy access networks.

## 2.3 FTTH versus FTTN – other considerations

The decision to deploy FTTH versus FTTN versus an upgrade to advanced DSL is rarely based on costs alone. Even though FTTx could potentially bring in potential opex savings, particularly in the longer term, these are unlikely to be sufficient to justify the huge up-front expenditures required. Alcatel estimates that the cost for FTTN deployment comes in at five times the capital cost of upgrading exchange-based DSLAM and customer-premises equipment to advanced ADSL2+/VDSL. For FTTH, this figure doubles again.[2] However, a significant portion of the FTTH capex is related to primary/civil infrastructure (mainly excavated ducts). In cases where such infrastructure is already in place and can be used, FTTH deployment costs are much closer to those of FTTN.

Potential revenues and competitive pressures are usually equally as important, if not more important, than expenditures when putting together the FTTx business case.

**Potential revenues**

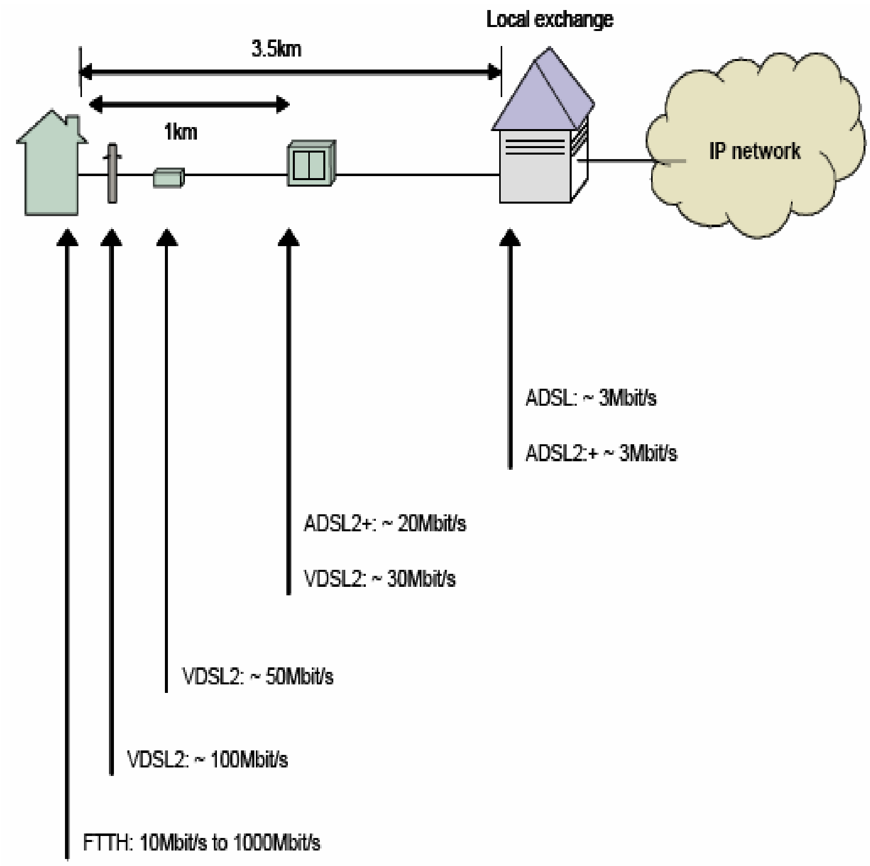
Moving from copper to fibre opens up new service opportunities for operators. There are endless possibilities of how to utilise the added bandwidth that fibre access networks provide. A key and perhaps most obvious benefit is very high speed Internet access, where theoretical download speeds for FTTH are up to 1Gbps. Another benefit is the additional VoIP (Voice over IP) features that are possible with the greater bandwidth. Business data services will also reap the benefits of the bandwidth, especially in the areas of improved storage solutions and disaster recovery

[2] "Fibre to...wherever makes best economic sense", Jean-Pierre Lartigue, Alcatel

assistance. Fibre will also better enable consumer services such as traffic control, home security monitoring, online gaming, telemedicine, distance learning, consumer home energy management, and online government practices.

Figure 2.1 illustrates the varying bandwidths available with fibre and xDSL.

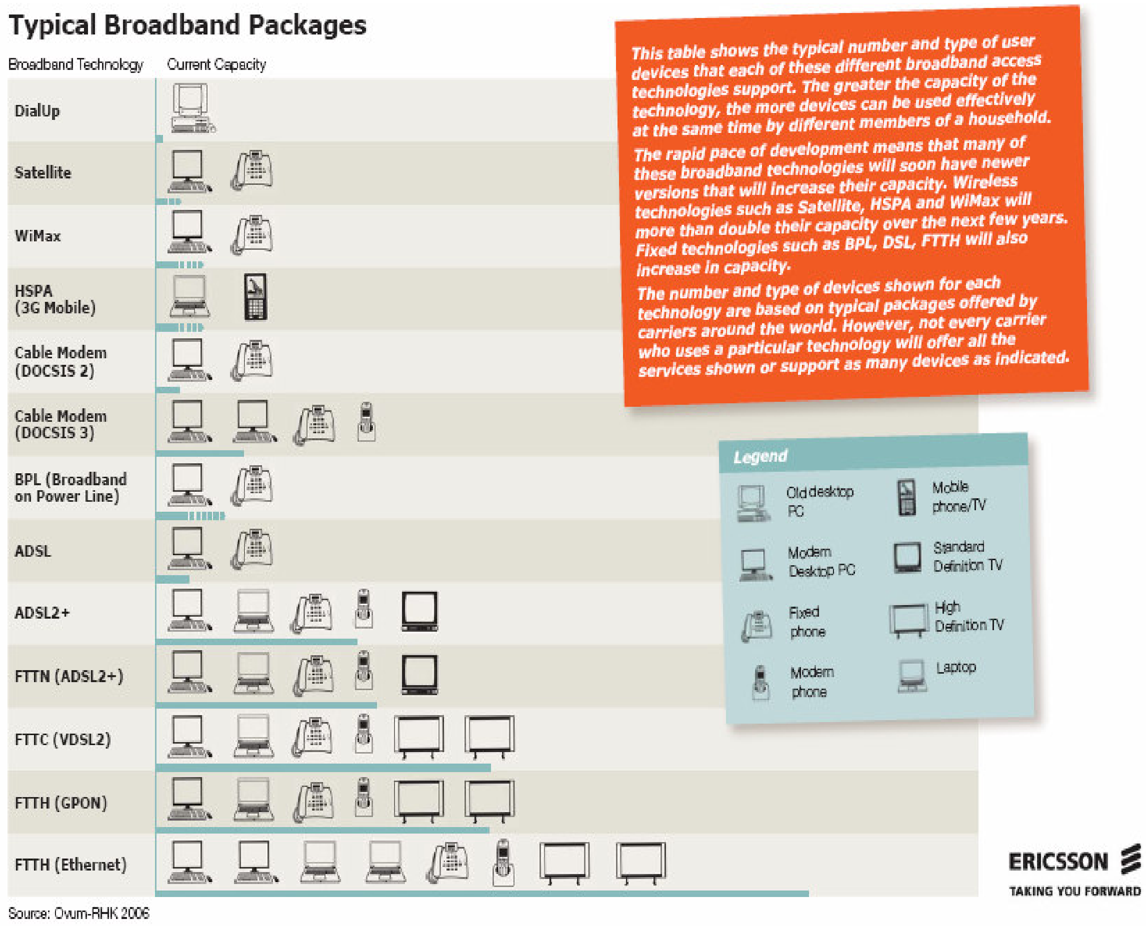
Figure 2.1: Bandwidths available with ADSL and VDSL




Source: Ovum

Figure 2.2, put together by Ovum-RHK for Ericsson, depicts the additional services available with FTTH and FTTN. FTTH clearly opens a wider range of service opportunities to service providers.

Figure 2.2: Typical Broadband Packages




***Source: Ericsson, Ovum-RHK***

### Other considerations

Competitive pressures are also a key consideration for FTTx deployment. In the USA, for example, where cable competition is strong, Verizon and SBC have found it imperative to roll out FTTx to enable them to match the offerings of the cable operators that include broadband internet and voice over IP with their analogue and digital TV.

Time-to-market considerations are also important. Deciding between FTTH and FTTN will be driven by understanding which markets will benefit from faster, full-coverage FTTH that will take a longer period to deploy and which markets require faster data rates urgently, but may require further upgrading to the ultimate broadband technology – FTTH – at some point in the future.

An upgrade from FTTN to FTTH is not entirely straightforward. The fibre feeder may be reused but the active node and the distribution copper must be replaced with passive fibre components. That is, the major costs of an FTTH rollout are still eventually incurred, while the costs of the active nodes were incurred in the earlier FTTN rollout. It is likely, therefore, that any upgrade from FTTN to FTTH would not be contemplated until the original FTTN equipment had been fully depreciated, unless competitive pressure for greater bandwidth were to drive an earlier change.

Another consideration in choosing FTTN versus FTTH is how much of the network is rural and how much is urban or suburban. An operating company can leverage FTTN in areas with limited customers and lower entry costs in rural areas, making broadband services available to customers more quickly.

Every operating company must consider its own business case in relation to the capabilities of the existing network. Since an FTTN strategy seeks to leverage existing facilities as much as possible, it will ultimately come down to what each individual carrier sees as the real demand for customer bandwidth – and where that demand will be five to ten years from now.

Clearly, operators and service providers need a flexible approach, as well as a flexible technology platform. New network architectures and topologies will need to seamlessly evolve over time across the various operator localities, while maintaining consistent subscriber management and service delivery.

## 2.4 Passive Optical Networks (PONs) and GPON

There are basically two fibre architectures being deployed today for providing high-bandwidth services to the end user: point-to-point and passive optical networking (PON). Point-to-point connects a single OLT port to a single ONU with no sharing of fibre or electronics. While point-to-point is the simplest architecture, it is also the most expensive on a per-connection basis. It can transport very high data rates to the building it connects. PON, on the other hand, supports multiple ONUs (usually 16, 32, or 64) from a single OLT port and is more cost-effective for fibre-to-the-home applications.

### 2.4.1 PON and its role in the network

PON is based on the premise of a point-to-multipoint architecture. Passive splitters are located downstream from the exchange and typically can split the fibre signal up to 64 times over a maximum distance of 10-20 km. This means that the downstream bandwidth is split, or shared, between users as well. The splitters are considered passive because they require no external power and have no operational electronic components. The four primary ways to implement a Passive Optical Network are as ATM Passive Optical Network (APON), Broadband PON (BPON), Ethernet PON (EPON), and Gigabit PON (GPON).

In the mid-1990s, North American and European operators joined together to form the Full Services Access Network (FSAN) committee to develop standards for passive optical networks (PONs). Currently there are three standardised versions of PON: Ethernet PON (EPON), whose standards were written by IEEE, Broadband PON (BPON) and Gigabit PON (GPON), both of whose standards were written by the ITU. All three of these PON architectures have seen deployment around the world.

Figure 2.3 compares these three standardised PON networks, as well as two other types of PON — Wavelength Division Multiplexing PON (WDM-PON) and Optical Code Division Multiple Access PON (OCDMA-PON) — being developed for next-generation deployments.

Figure 2.3: Comparison of various PON architectures

| | BPON | GPON | EPON | WDM-PON | OCDM-PON |
|---|---|---|---|---|---|
| Users/PON | 32 | 64 | 16 | 100s | 16 |
| Downstream data rate | 622 Mbps | 1.244 Gbps - 2.488 Gbps | 100 Mbps - 10 Gbps | 1-10 Gbps | 1 Gbps |
| Upstream data rate | 155 Mbps | 100 Mbps - 2.488 Gbps | 100 Mbps - 10 Gbps | 1-10 Gbps | 1 Gbps |
| Distance | 20 km | 20 km | 20 km | 20 km | >30 km |
| Standard | ITU-T G.983 | ITU-T G.984 | IEEE 802.3ah | none | none |
| Cost | Low | Medium | Low | High | High |

***Source: Ovum-RHK***

### 2.4.2 BPON, GPON, and EPON

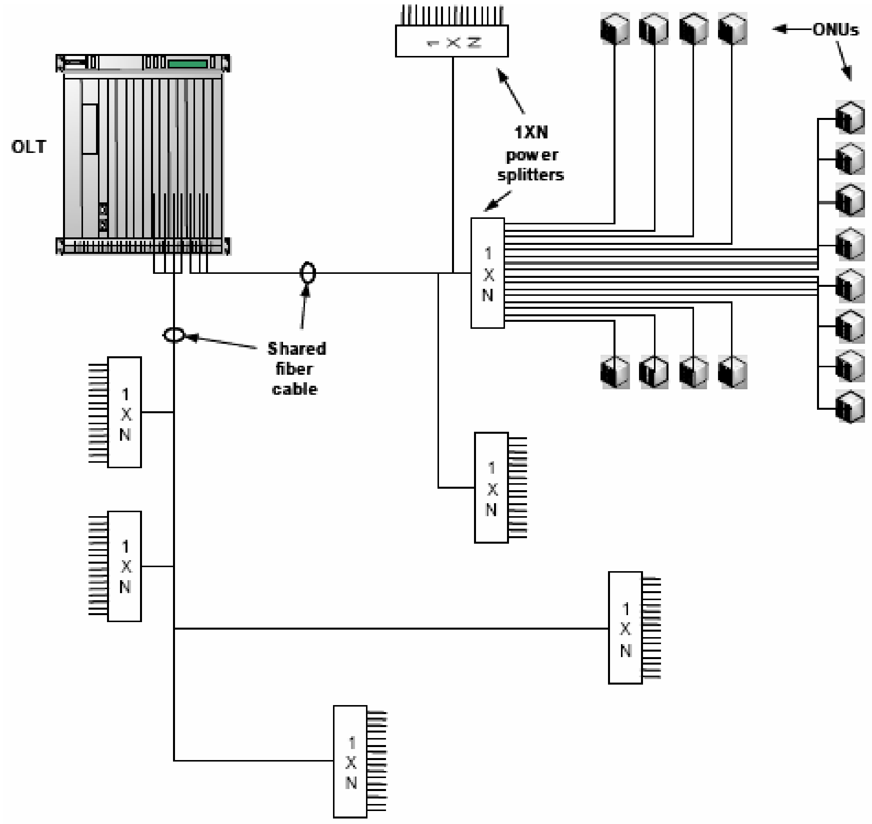
The three passive optical networks in use today are the BPON, GPON, and EPON. At the physical layer all three PONs look the same. Figure 2.4 shows a generic architecture.

The 1xN splitter can be any split ratio that supports the carrier's requirements for PON type, loss, distance, data rate, etc. Each OLT port is shared by N ONUs. Typical split ratios are 1:32 and 1:64 but higher splitting ratios, such as 1:128, are possible where there is sufficient optical budget and appropriate functionality in the OLT line-cards.

Optical splitters can be cascaded to provide feeder fibre appearances at several distribution areas. This mimicks the standard design of a copper feeder network. However, this has not been a popular deployment strategy because it opens up issues of fibre administration: a particular operational advantage of fibre plant is that it is left in place and not rearranged to meet new demand.

Provided that the splitting ratio does not limit the optical budget too severely, the upgrade of a PON to higher bandwidths generally requires upgrades only to the end equipment – that is, to the OLT line cards in the exchange and the ONU at the customers' premises. It is likely that lower splitting ratios will therefore be favoured in large-scale rollouts in order to provide the widest options for upgrades in the future.

Figure 2.4: Generic PON architecture for BPON, GPON, and EPON




***Source: Ovum-RHK***

### 2.4.3 PON deployment trends

Leading the way with PON deployment is Asia-Pacific, with EPON as the primary architecture of choice. Next in line for PON deployment is North America. Although BPON has been the predominant architecture there, we expect it to give way to GPON with its higher payload in late 2007.

Figure 2.5 below provides the regional outlook for BPON, EPON and GPON. It is noteworthy that Ovum-RHK foresees that GPON looks to be the dominant standard after 2008 across North America and China-India; and after 2009 in Asia-Pacific.

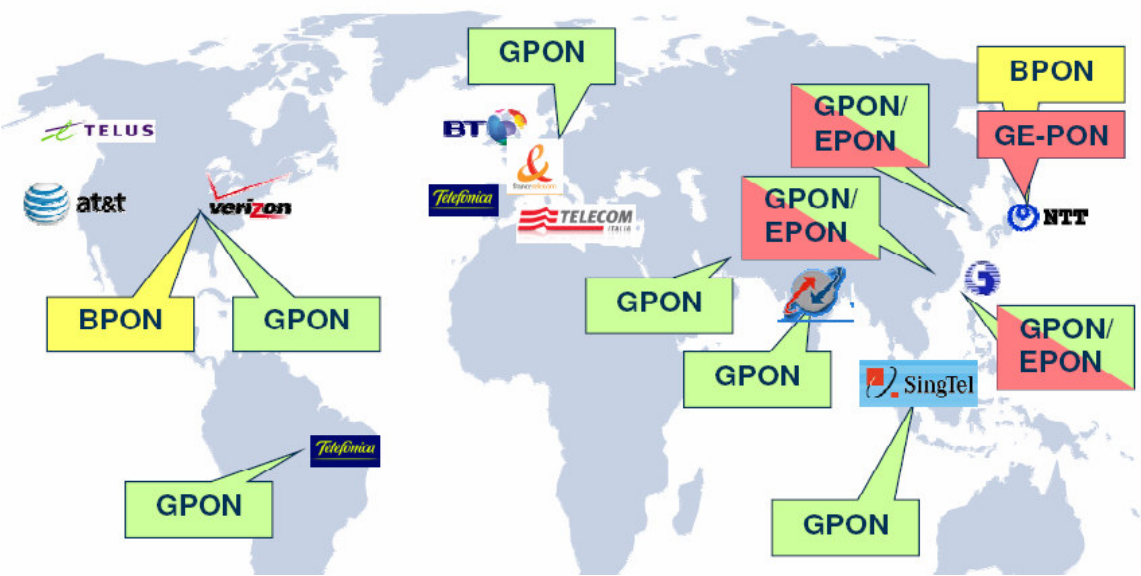
Figure 2.5: Global outlook by region for BPON, EPON and GPON

| | North America | W. Europe | China-India | Asia-Pacific |
|---|---|---|---|---|
| BPON outlook | Transition to GPON starting 2007, crossover in 2008 | Unchanged from BNS: none | Legacy, still used by smaller players until 2009 | Legacy, transition rapidly to EPON, crossover in 2007 |
| EPON outlook | Unchanged from BNS: peaks in 2007 | Unchanged from BNS: none | Passed over in favor of GPON | Dominant through forecast period |
| GPON outlook | Dominant after 2008 | Increases 1.25x in 2006 to 3x in 2010-11 from BNS | Dominant PON technology for China Telecom, BNS BPON units migrated +50 – 100K ONT for trials peaking in 2009 | Unchanged from BNS: small quantites in out years; optimistic technology scenario has AP converting to GPON with midpoint in 2009 |

***Source: Ovum-RHK***

Figure 2.6 provide examples of operators that have deployed PON. Ericsson has stated that GPON has the potential to be the dominant PON standard.

Figure 2.6: Examples of global GPON deployment




***Source: Ericsson***

# 3. FTTN and FTTH model assumptions

## 3.1 General assumptions

### 3.1.1 Scope and timing of rollout

The model assumes a rollout to 4.5 million Band 2 consumers (about 60% of the total). The FTTN rollout is assumed to take place over 4 years, starting in 2008, while the FTTH rollout takes 5 years. The rollout assumes complete cutover of each area to the new network architecture: that is, total homes passed is equal to total homes served.

### 3.1.2 Technology assumptions

We assume FTTN/VDSL2 and FTTH (GPON) are the standards and technologies of choice for the FTTN and FTTH deployments, respectively. For the FTTN/VDSL2 rollout, we have included a VDSL modem for each household. It is possible, however, for a household to retain its traditional, copper-based POTS service, in which case the VDSL modem is not necessary and would not be installed. For the FTTH rollout, an ONU is installed in each household. The ONU provides a standard RJ11 telephone jack for POTS service and, while it is locally powered, it includes a battery to provide power for a few hours after a power failure.

### 3.1.3 Financial assumptions

**WACC**

We have used a pre-tax WACC (Weighted Average Cost of Capital) of 13.98%, as provided by the ACCC.

**Inflation**

We have used an inflation rate for prices of 3.11% based on the Fischer formulation. Inputs have been provided by the ACCC and obtained from publicly available data from the Reserve Bank of Australia.

**Depreciation**

We have applied straight-line depreciation for the assets throughout the model. Economic lifetimes for the fibre components have been set to 20 years, with other components having 10, 15 and 20 year lives.

### 3.1.4 Exchange Serving Areas

**Population Density**

The model assumes that Band 2 household density, spread and distribution of premises from the local exchange broadly fall within the category of “Urban”. As such, we assume that the general rollout design is similar across Band 2 and the same equipment specification has been used for all Exchange Serving Areas (ESAs).

**Exchange Serving Areas and spread of premises**

The rollout is assumed to occur ESA by ESA. ESAs are cut over to the new technology one at a time.

The list of 585 ESAs in Band 2 was obtained from the ACCC. Each ESA had a location name and a State, as well as other data that was not used. In addition the ACCC provided the number of households in Band 2 by State. Ovum spread the households by State to the ESAs in the following manner:

1. The ESA name was matched to a Census locality name and the number of households in the Census locality was obtained from the 2001 Census data. The matching of ESAs to localities was possible in all but one case.

2. The numbers of households in each State were then allocated to the ESAs in that State in proportion to the Census data obtained in step 1. (In the one case not matched to a locality, the ESA was assigned the number of households in the State divided by the number of ESAs in the State.)

The approximate distribution of households per ESA is used for timing the rollout of technology but the specific distribution of households is not important in the current model because the loop make-up is the same for each ESA. If more specific data on the telecommunications plant in each ESA were obtained, it would be important to provide a better estimate of the number of households by ESA as well.

**Loop make-up**

The loop make-up for an ESA is the length of feeder and distribution cables and the distribution of households in the Distribution Areas (DAs). The ACCC provided data on the average total cable (loop) lengths for Band 2 premises, as shown in Figure 3.1.

Figure 3.1: Average loop make-up distribution from the local exchange for Band 2

| 0 < Distance <= 500 | 500 < Distance <= 1500 | 1500 < Distance <= 3000 | 3000 < Distance <= 4000 | Distance > 4000 | Total Premises in ESA |
|---|---|---|---|---|---|
| 2.10% | 24.50% | 42.50% | 15.70% | 15.20% | 100.00% |

***Source: ACCC estimates***

This loop make-up, which is typical for Australian suburban environments, was used for all ESAs. This gives an average loop length of about 2.5 km.

The proportion of the total length that is feeder and the proportion that is distribution are also important. Using a general rule of thumb, Ovum has used 70% of the length for the feeder component and 30% for the distribution. This gives average lengths of about 1.8 km for the feeder and 755 m for the distribution. In addition, we have assumed a drop wire length (from the street to the premises) of 6 m.

**Timing of rollout**

The model timing is driven by specifying for each year which ESAs are to be cut over to the new technology. The timing differs for FTTN and FTTH: the maximum number of households to be cut over to FTTN each year is set to 1,125,000 households; and for FTTH 900,000. These limits are set as guidelines only in the model.

### 3.1.5 Leveraging the existing ducts

A key assumption in the model is that in deploying fibre from the local exchange to the node and then onwards to the homes (in the case for FTTH), fibre will follow the existing tree-and-branch copper routes. We assume that existing ducts or poles will be reused for fibre. This excludes alternative loop architectures such as fibre rings.

As such, the model will not include costs associated with trenching and other civil works (other than installation and associated testing costs). Please note that this assumption could significantly reduce the resulting capex in the model, particularly for the FTTH rollout. Ovum's experience indicates that the costs associated with civil works can account for 70% to 80% of the total capital expenditures for an FTTH rollout. These costs reduce significantly when existing ducts and poles are used or when overhead wiring is utilised.

In the FTTN model, it is assumed that the distribution copper plant is unchanged. The wholesale cost estimate for opex charges in this case is based on publicly available calculations and includes a component of civil works cost. We assume this is necessary as part of the maintenance of the distribution copper.

The model also assumes all exchanges remain and are available. No exchanges are sold or relocated and new capital costs in exchanges associated with setup and power are not required.

### 3.1.6 Spare capacity and redundancy

The model assumes 20% extra capacity built into the fibre feeder for future capacity expansion. We assume 1x32 splitters are used for the FTTH GPON. Hence, for every 32-way split in the FTTH distribution network, only 26 "slots" are utilised. This allows the spare capacity in the splitter and OLT to be utilised quickly and cost effectively to service new houses in the ESA when the need arises.

For the FTTN, the equivalent assumption is that only 80% of the VDSL ports in a cabinet are filled.

These assumptions overstate the feeder and OLT costs somewhat but represent a more realistic scenario than assuming full fill of all components. Capacity expansion of these architectures, for which there is still little experience, may prove to be operationally complex. Building in spare capacity at the installation stage can reduce future reconfiguration costs.

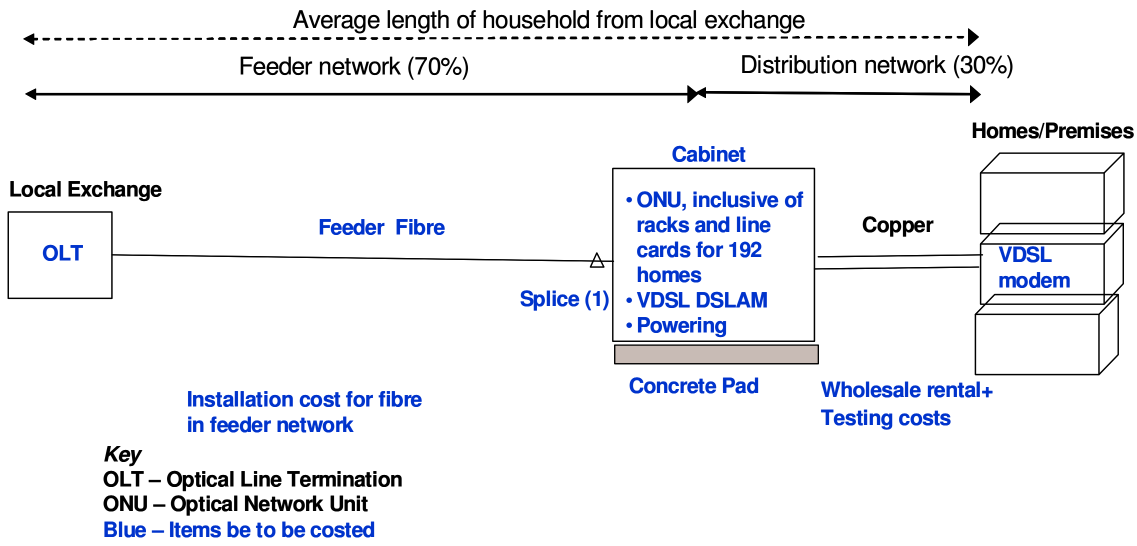
## 3.2 FTTN – Capex and opex components

Figure 3.2 below presents the capital cost components of the FTTN model. The items in blue have been costed in the model and are described in detail below. In line with typical network planning practices and our cost model design, we work through the network diagram from right to left: that is, from the customer premises, to the cabinet and then to the local exchange.

The operations and maintenance expenditures, where related to the capex components, are also described and costed in this section.

Please note that the costs in this section are the current 2007 costs. In the model, we have applied a year-on-year percentage price decrease from the first year for capex to reflect the global trend of FTTx equipment prices as volume and deployments pick up. On the other hand, the operations costs have been inflated year-on-year at an annual inflation rate of 3.11%.

Figure 3.2: Fibre-to-the-Node: Network components




*Source: Ovum*

## 3.2.1 In the customer premises: VDSL Modem

### Capex

Each household connected will be supplied with a VDSL modem/router. This VDSL modem is self-installed and, as such, no installation costs are incurred.

We assume that the cost of a VDSL modem is $80 in 2007 and decreases at 5% per annum.

### Opex

We have assumed an annual operations cost of 5% of the modem cost. This is likely to be part of an equipment supply arrangement. We have assumed no further operator costs. That is, it is assumed that VDSL modems can be replaced by the customer and we ignore any trouble reporting or inventory carrying costs. VDSL modems are likely to be reliable.

### Depreciation

The VDSL modem is assumed to have a 10-year lifetime. We consider the effect of a shorter lifetime in the model sensitivity analysis.

### 3.2.2 The distribution network: Copper

**Opex**

Legacy copper connects the node/cabinet to the homes – one copper pair for each VDSL modem (and hence each household connected). We assume that the required copper is in place and is available at either an internal charge (to the incumbent) or external wholesale rental charge. This wholesale charge is an operational cost.

In order to assess the operations cost of the copper, we referred to previous ACCC calculations. In December 2005, an ACCC Final Decision[3] gave an upper bound for "network cost per month" in 2005-2006 of $11.89 for Band 2 lines. We have not tried to analyse this number in detail but we note that the calculation of this upper bound includes a charge for civil works as well as maintenance and replacement of the copper loop.

As an approximation to the charge for the distribution network, we have taken 20% of the $11.89 per line per month as the 2007 charge. This approximation is designed to take account of the distribution copper only, an allowance for civil works and cost changes to 2007. While there are many effects here, we expect that this is an underestimate of the operational costs associated with the distribution network, as we note that most of the trouble reports and other activities in the loop are associated with the distribution portion. We test the sensitivity of the model results to this value.

The charge noted above equates to a per annum charge of $28.54 per line in 2007. We assume it increases in line with inflation year-on-year. This is the total operational cost pertaining to the copper distribution included in the model.

There are likely to be up-front costs incurred for the manual connection between the port and copper loop and for the testing and preparation of the copper to cope with the higher bandwidth requirements. In the model, we have assumed no operations costs associated with line testing or preparation. In so far as these costs are included, they are factored into the installation costs of the cabinet line cards.

### 3.2.3 The remote node/cabinet

**Capex**

The remote node, in the form of a cabinet in our model, houses active equipment including the optical termination line cards and VDSL MSAN (Multi-service Access Node). The model assumes that legacy cabinets or pillars are unsuitable for the purpose of the FTTN and, as such, have to be replaced or new cabinets installed alongside existing cabinets/pillars. We have not costed in the expenses associated with decommissioning existing cabinets/pillars.

The model factors in the following set up costs for the cabinets:

[3] ACCC, *Assessment of Telstra's ULLS and LSS monthly charge undertakings,* Final Report (Public version), December 2005. The relevant number is found in Table 6.4.1, page 35. The ACCC report is available at: http://www.accc.gov.au/content/index.phtml/itemId/660425/fromItemId/269280 .

- The cabinet itself;
- Capital cost of powering and temperature control;
- Concrete pad;
- Optical network termination line cards;
- VDSL MSAN.

All these capital items have been given 10-year asset lives.

Figure 3.3 details these costs. Please note that the figures are inclusive of the relevant installation costs and splicing.

The VDSL ports (line cards) are costed to include voice as well as data, a so-called “combination” card. While a cheaper, POTS-only card could be used for POTS-only lines, the installation of a combination card provides the operator with greater flexibility.

A key assumption is that a standard sized and fully-equipped cabinet is used across the exchange service areas and these cabinets have the capacity to serve a maximum of 240 households. However, as we are assuming 20% spare capacity, only 192 ports are installed. This leaves the network operator with the option of putting in more line cards to cater for future expansion.

**Opex**

Ovum estimates that the operations and maintenance costs of the cabinet and its contents are about 10% of the installed first cost plus 5% of the equipment cost. Again, we test other levels of opex in the sensitivity analysis.

Figure 3.3: Remote node (cabinet) costs

| Equipment | Specifications | Cost per unit 2007 ($A) | Price Trend (Annual) |
|---|---|---|---|
| **Capex** | | | |
| VDSL Port | 1 per VDSL line. We equip each cabinet with 192 ports. | 47 | -10% |
| VDSL MSAN | 1 per cabinet | 16,000 | -10% |
| Cabinet | Cabinet (standard cabinet size to cater for 240 VDSL lines) | 26,667 | -5% |
| Capital costs for powering | Including relevant installation costs | 2,000 | -5% |
| Concrete pad | Including relevant installation costs | 933 | -5% |
| **Opex** | | | |
| Operations costs of cabinet | | 10% of installed first cost plus 5% of equipment cost | |
| Operations cost of VDSL equipment | | 10% of installed first cost plus 5% of equipment cost | |

***Source: Ovum***

### 3.2.4 Feeder network: Fibre

**Capex**

A feeder fibre pair connects the cabinet to the Optical Line Termination (OLT) at the exchange. The capital costs of fibre include the cost per metre of fibre itself and the installation or fibre pull costs per metre.

As discussed, the model assumes that the required ducts are in place and available at no cost and, as such, excludes trenching and other civil works costs. This is a significant simplification but is based on the assumption that the feeder plant is generally well maintained.

The model also assumes that the cost of fibre and related capital costs are trending downwards at approximately 1% per annum and that fibre has an asset life of 20 years.

**Opex**

Ovum estimates an annual operations and maintenance charge of 2% of the installed first cost for the feeder fibre plus an annual charge of 5% of the equipment cost.

Figure 3.4: Feeder network: Fibre and associated costs

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| Fibre pair per metre | Single mode fibre (including the cost of sheath). Fibre pairs in feeder. | 0.11 |
| Installation cost per metre | Including fibre pull and other relevant costs | 1.50 |
| Fixed installation cost | Including cost of terminating the fibre pair | 82.67 |
| **Opex** | | |
| Operations costs of feeder fibre | | 2% of installed first cost plus 5% of equipment cost |

***Source: Ovum***

### 3.2.5 At the local exchange: Optical Line Termination (OLT)

**Capex**

The model assumes that the local exchanges are in place and are available for use at no cost. As such, we have not costed the capex related to setting up or preparing exchanges for FTTN equipment including capital costs of powering or additional inter-office transmission equipment.

In our model, the local exchange is used to house the Optical Distribution Frame (ODF) and Optical Line Termination (OLT), that terminates the fibre pair from the feeder network.

Please note that we have not costed the ODF in the model as no costs are available. In some cases, the ODF function may be built into the OLT.

Each OLT consists of the following components:

- 1 Rack;
- 5 shelves;
- 5 control cards (1 per shelf);
- Point-to-point Ethernet Line card (20 cards per shelf, 24 ports per card, 1 feeder fibre pair per card).

A ten-year life has been assumed for each item and the relevant costs detailed in Figure 3.5 are assumed to trend down at 5% per annum. Please note that these costs are inclusive of installation costs.

**Opex**

Ovum estimates an annual operations and maintenance charge of 7% of the installed first cost of the OLT and its components.

Figure 3.5: Optical Line Termination

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| Rack | 1 rack per OLT | 2,667 |
| Shelf | 5 shelves per rack | 1,333 |
| Control card | 1 control card per shelf | 4,667 |
| Line card | Point-to-point Ethernet line card. 20 line cards per shelf; 24 ports per line card; 1 fibre per port. | 8,667 |
| **Opex** | | |
| Operations costs of OLT and its components | | 7% of installed first cost |

***Source: Ovum***

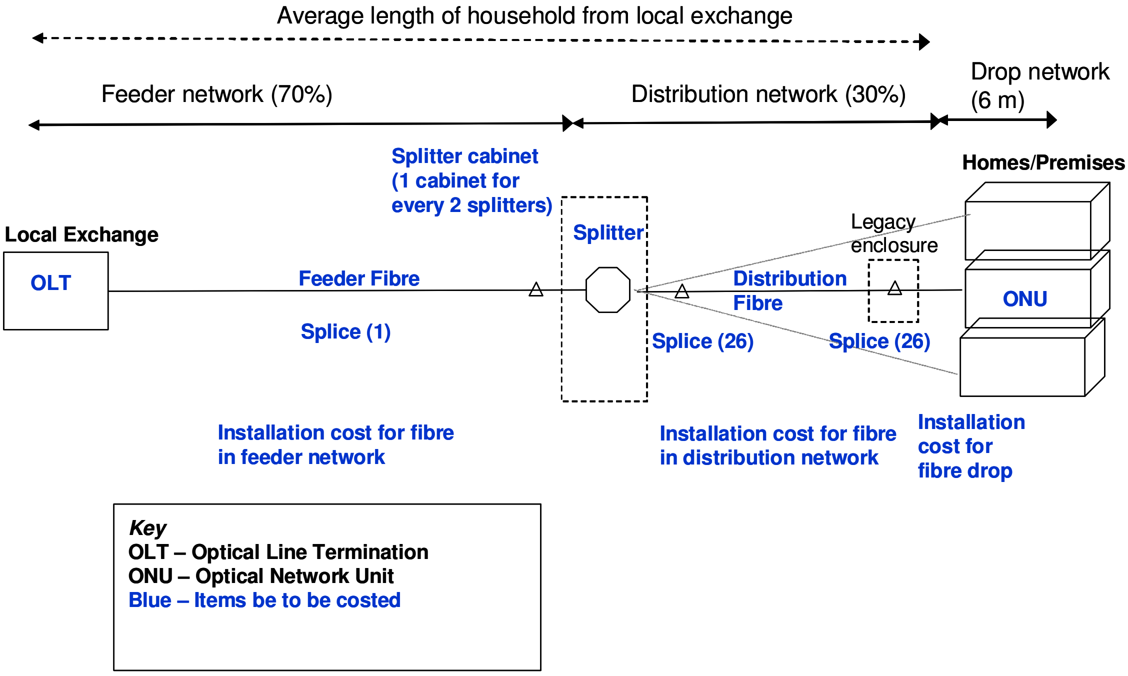
## 3.3 FTTH – Capex and opex components

Figure 3.6 presents the capital cost components of the FTTH model. The items in blue have been costed in the model and are described in detail below. As with the FTTN model and in line with conventional network planning practices, we work through the network diagram for FTTH from right to left, that is, from the customer premises, to the splitter and then to the OLT in the local exchange.

The operations and maintenance expenditures, where related to the capex components, are also described and costed in this section.

As before, the costs in this section are the current costs (2007). In the model, we have applied a year-on-year percentage price decrease for capex to reflect the global trend of FTTx equipment prices as demand and deployment pick up. On the other hand, the operations costs have been inflated year-on-year at an annual inflation rate of 3.11%.

Figure 3.6: Fibre-to-the-Home: Network components




*Source: Ovum*

### 3.3.1 In the customer premises: Optical Network Unit

**Capex**

Each household connected will be supplied with an Optical Network Unit (ONU). The ONU will need to be installed in the premises by skilled technicians and, based on Ovum experience, this would take typically 4 work hours per household. As such, the capex associated with the ONU will include the ONU itself and a separate charge for installation cost.

Ovum research indicates that the cost of the type of ONU used in the model is decreasing at a CAGR of -23% and we have applied this to the model. The asset life is 20 years.

The installation costs will increase at the standard inflation rate.

**Opex**

Ovum estimates an annual operations and maintenance charge of 10% of the installed first cost of the ONU plus 5% of the equipment cost. This assumes that the ONU will generate trouble reports and will require regular change-out of the battery. We consider the effect of this in the model results.

Figure: 3.7: In the customer premises: Optical Network Unit

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| ONU | GPON 1 Gbps ONU | 83 |

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| Installation cost | 4 work hours per ONU. We have assumed fully-loaded labour cost of $45 per work hour. | 180 |
| **Opex** | | |
| Operations costs of ONU | | 10% of installed first cost plus 5% of equipment cost |

***Source: Ovum***

### 3.3.2 The drop cable: Fibre and splices

**Capex**

Single fibre strands in the drop cable connect the ONU in the customer premises to the distribution fibre. We have estimated the average length of the drop fibre to be 6 metres. The capital costs of fibre include the cost per metre of fibre itself and the cost per metre of pulling fibre on poles.

The fibre strands in the drop cable have to be spliced at the point they meet the distribution network. We have selected fusion splices for the FTTH model. We assume that existing enclosures are available to protect the spliced fibres.

As discussed, the model assumes that the required ducts/poles are in place and available at no cost and, as such, excludes trenching and other civil works costs. This is a significant simplification and, in reality, such expenditures arising from civil works are likely to make up a significant proportion of overall capex.

The model also assumes that the fibre costs are trending at a -1% CAGR, whilst splice costs have a CAGR of -5%. All assets in this section have a life of 20 years.

**Opex**

The opex for all components of the drop has been set at 2% of the installed first cost plus 5% of the equipment cost.

Figure: 3.8: The drop: Fibre and splice costs

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| Fibre strand per metre | Single mode fibre (including the cost of the sheath). Length: 6 m. | 0.05 |
| Installation cost per metre | Including cost of pulling fibre on poles | 6.72 |
| Splice | Fusion splice. 1 splice for every strand of drop fibre | 6.67 |
| **Opex** | | |
| Operations cost of drop fibre | | 2% of installed first cost plus 5% of equipment cost |
| Operations cost of splice | | 2% of installed first cost plus 5% of equipment cost |

***Source: Ovum***

### 3.3.3 The distribution network: Fibre

**Capex**

The capex in the distribution network comprises the cost of the fibre (driven by the fibre length) and related installation costs (also driven by fibre length). The costs for distribution fibre are the same as those for feeder fibre given in Figure 3.10.

The model also assumes that fibre costs are trending at -1% CAGR.

All assets in this section have a life of 20 years.

**Opex**

The opex for all components of the distribution network has been set at 2% of the installed first cost plus 5% of the equipment costs.

### 3.3.4 Splitter

**Capex**

A 1:32 splitter splits the feeder fibre into 32 strands of distribution fibre. The splitters are housed in splitter cabinets and we have selected a standard cabinet size that can house up to 2 splitters per cabinet.

Building in the 20% spare capacity assumption, the model assumes that on average only 26 of the 32 fibre splits are used.

The splitter and splitter cabinets have asset lives of 20 years. The cost of the splitter has a CAGR of -14%; for the splitter cabinet cost, the CAGR is only -5%.

**Opex**

The opex for the splitter-related components has been set at 2% of the installed first cost plus 5% of the equipment cost.

Figure 3.9: Splitter-related costs

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| Splitter | 1:32 splitter | 14 |
| Splitter cabinet | 2 splitters per cabinet | 533 |
| **Opex** | | |
| Operations cost for splitter and splitter cabinet | | 2% of installed first cost plus 5% of equipment cost |

***Source: Ovum***

### 3.3.5 The feeder network: Fibre and splices

**Capex**

A feeder fibre connects the splitter to the Optical Line Termination (OLT) at the exchange. The capital costs of fibre include the cost per metre of fibre itself and the installation or fibre pull cost per metre.

As discussed, the model assumes that the required ducts are in place and available at no cost and, as such, excludes trenching and other civil works costs. This assumes that the feeder network is relatively well maintained.

The model assumes that the cost of fibre and related capital costs are trending downwards at approximately 1% per annum and that fibre has an asset life of 20 years.

**Opex**

Ovum estimates an annual operations and maintenance charge of 2% of the installed first cost for the feeder fibre plus 5% of the equipment cost.

Figure 3.10: Feeder network: Fibre and associated costs

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| Fibre strand per metre | Single mode fibre (including cost of sheath). | 0.05 |
| Installation cost per metre | Including fibre pull and other relevant costs | 1.50 |
| Splice | Fusion splice. 1 splice for each strand | 6.67 |
| **Opex** | | |
| Operations cost of feeder fibre | | 2% of installed first cost plus 5% of equipment cost |

***Source: Ovum***

### 3.3.6 At the local exchange: Optical Line Termination (OLT)

**Capex**

The model assumes that the local exchanges are in place and are available for use at no cost. As such, we have not costed the capex related to setting up or preparing exchanges for FTTH equipment including capital costs of powering or additional inter-office transmission equipment.

In our model, the local exchange is used to house the Optical Distribution Frame (ODF) and Optical Line Termination (OLT), that terminates the fibre pair from the feeder network.

As with the FTTN model, we have not costed an ODF.

Each OLT consists of the following components:

- 1 Rack;
- 5 shelves;
- 5 control cards (1 per shelf);
- GPON line card (20 cards per shelf; 4 ports per card; up to 32 homes per port).

A ten-year life has been assumed for each item and the relevant costs detailed in Figure 3.11. Please note that these costs are inclusive of installation costs.

**Opex**

Ovum estimates an annual operations and maintenance charge of 2% of the installed first cost of the OLT and its components plus 5% of the equipment cost.

Figure 3.11: Optical Line Termination

| Equipment | Specifications | Cost per unit ($A) |
|---|---|---|
| **Capex** | | |
| Rack | 1 rack per OLT | 2,667 |
| Shelf | 5 shelves per rack | 1,333 |
| Control card | 1 control card per shelf | 4,667 |
| Line card | GPON line card. 20 line cards per shelf; 4 ports per line card; up to 32 homes per port. | 21,333 |
| **Opex** | | |
| Operations costs of OLT and its components | | 2% of installed first cost plus 5% of equipment cost |

***Source: Ovum***

# 4. Model results

## 4.1 The base case

Using the data described in Section 3, the overall Net Present Value (NPV) of each rollout is as follows:

- FTTN to 4.5M homes in 4 years: NPV = $1,416M; NPV/home = $315;
- FTTH to 4.5M homes in 5 years: NPV = $4,013M; NPV/home = $892.

That is, in NPV terms, it costs approximately 2.8 times the cost per home of FTTN to provide FTTH.

A detailed breakdown of the costs shows that the capital costs for FTTH are dominated by the cost of installing fibre in the distribution network. The cost make-up for 2008 is shown in Figure 4.1 below.

Please note that the capex items in Figure 4.1 are derived from taking the relevant 2007 prices and applying an appropriate discount for price declines (for equipment) or inflation (for installation costs). The specific figures used for discounting or inflating the capex items are provided in the assumptions in Section 3.

Figure 4.1: FTTH cost make-up per home served – 2008 costs

| Equipment | Capex | Opex |
|---|---|---|
| Optical Network Unit | $249.24 | $11.80 |
| Drop | $41.89 | $0.85 |
| Splicing | $6.33 | $0.46 |
| Distribution | $1,207.21 | $26.23 |
| Splicing | $6.33 | $0.46 |
| Splitter | $0.45 | $0.03 |
| Splitter cabinet | $9.74 | $0.71 |
| Splicing | $0.24 | $0.02 |
| Feeder | $108.34 | $2.35 |
| Rack | $0.24 | $0.00 |
| Shelf | $0.61 | $0.01 |
| Line cards | $97.44 | $1.95 |
| Control cards | $0.43 | $0.01 |
| | **$1,728.50** | **$42.94** |

***Source: Ovum***

The distribution fibre and its installation make up about 70% of the capital cost per home served.

The equivalent cost make-up for FTTN is shown in the following figure.

Figure 4.2: FTTN cost make-up per home served – 2008 costs

| Equipment | Capex | Opex |
|---|---|---|
| VDSL modem | $76.00 | $3.92 |
| Copper rental | | $29.42 |
| Cabinet | $132.39 | $36.20 |
| Power | $9.90 | |
| MSAN | $75.00 | |
| Combo Card | $43.55 | |
| Concrete pad | $4.62 | |
| Feeder | $29.34 | $0.64 |
| Splicing | $0.03 | $0.00 |
| Rack | $0.01 | $0.00 |
| Shelf | $0.01 | $0.00 |
| Line cards | $1.79 | $0.04 |
| Control cards | $0.01 | $0.00 |
| | **$372.64** | **$70.22** |

***Source: Ovum***

In this figure, the total operations cost for the node is shown in the “Cabinet” row.

Here the capital costs are mainly associated with the cabinet and the VDSL lines.

In terms of opex, FTTH per home served is about 60% that of FTTN. For FTTH, the opex cost includes a substantial charge for the ONU. If this cost can be reduced or avoided, for example by encouraging customer maintenance of the battery, then the FTTH operations costs fall dramatically, as the proponents of FTTH claim.

The FTTN opex is dominated by the costs induced by the remaining copper and the cabinet. The opex for the copper is based on estimates from publicly available ACCC calculations and, because of its historical cost basis, could be expected to be reasonable and unchanging. The opex cost induced by the cabinet is less certain, given that there is little operating experience to date.

## 4.2 Sensitivity analysis

In this section, we examine some possible changes to the data. These variations have been suggested either during the data collection phase or in discussions with Ovum analysts.

### 4.2.1 FTTH Installation of distribution fibre

The cost of FTTH is dominated by the cost of installing the distribution fibre. Although our estimates are consistent with other data we have seen (particularly Ovum-RHK data from the US), it may be possible to gain greater efficiencies in installation in a national rollout, as the work crews become more experienced.

If, for example, the fibre installation cost in the distribution were to fall to one-third of the currently assumed cost of $1.50 per metre, then the NPVs of the two plans become closer:

- FTTN to 4.5M homes in 4 years: NPV = $ 1,416M; NPV/home = $315 (unchanged);

- FTTH to 4.5M homes in 5 years: NPV = $2,215M; NPV/home = $492.

For FTTH, the capex cost per home in 2008 drops to $950.

If in addition the FTTH opex could be reduced through a more reliable ONU, it may be possible to justify an FTTH rollout on cost alone.

### 4.2.2 FTTH Optical Network Unit operations cost

If the ONU were assumed to be as reliable as other network equipment, so that its induced operations cost for the operator was only 2% of the installed first cost, then the opex per home for FTTH would fall to $36.12 (2008 costs). That is, there would be a 50% savings in opex per line over FTTN. It is reported that Verizon is predicting opex savings of this order.

### 4.2.3 FTTN Node operations costs

We have assumed that the FTTN cabinet induces an annual operations cost for the operator of 10% of the installed first cost (plus 5% of the equipment cost as an operations charge). Some telecommunications providers, notable France Telecom, have suggested that the opex associated with active electronics in the loop is very significant.

If the FTTN cabinet opex for the operator is raised to 20% of the installed first cost, then the NPV for FTTN rises to $1,684M and the opex cost (2008 value) per home rises to $95. While this is substantially more than the value for FTTH, this difference alone would not justify an FTTH business case.

### 4.2.4 FTTN Distribution copper costs

We have assumed a charge of $28.54 per line per year (2007 cost) for the operations cost for the distribution copper. This estimate, as explained in section 3.2.2, is derived from a publicly available ACCC calculation. From the same source, the Telstra claimed total network cost per access line in 2005/2006 is $15 per month.

In the extreme case, we could assume that the full $15 charge is levied per access line. That is, the operations cost (2007 value) for the distribution copper is $180 per line per annum. If this is included, the NPV for the FTTN rises to $3,119M (while the FTTH NPV remains unchanged at $4,013M). The FTTH value is then only 30% more than the FTTN NPV. The opex cost per line for FTTN in 2008 rises to $226.

### 4.2.5 FTTN VDSL modem

We have assumed that the FTTN VDSL modem has an economic life of 10 years. It has been suggested, however, that modems are in fact costed for much shorter lives and are changed out regularly.

If we assume a lifetime of only 5 years, the FTTN NPV rises modestly to $1,450M, a rise of less than 3% over the base case.

# 5. Other points for consideration

## 5.1 Discontinuing local exchanges

**The Dutch case**

KPN has attracted global interest by announcing a radical transformation - that it is ripping out its legacy networks, including telephone exchanges and copper wires, and replacing the whole system with a nationwide fibre-to-the-kerb system that will deliver broadband services at 30-50 Mb/s[4]. According to the CEO of KPN's fixed network, Eelco Blok, alternative operators will be welcomed onto the network with a street-cabinet version of local loop unbundling.

KPN's transformation will replace its core network, telephone exchanges and local loops and will take until 2010. The project will cost up to an estimated €1.5 billion. Instead of a conventional presence at the centre of each community, the incumbent is building a nationwide infrastructure of kerbside boxes. Some of the project's investment will be funded from the sale of the real estate currently used for its legacy telephone exchanges. According to Blok: "The cost is between €1 billion and €1.5 billion, and we will spend that in the period from 2006 to 2010. We will fund that out of the sale of our real estate that will become available for sale because we are moving all our active equipment from the local exchanges to the street cabinets."

With its all-IP migration, KPN hopes to sell almost 80% of the technical real estate on its balance sheet and will raise approximately €1 billion. Whilst the sale of the real estate will probably not fund 100% of the investment in the all-IP network, it could raise between 75% and 100% of the monies required.

Incumbents and regulators worldwide are following the KPN project with interest. If proven successful, we could soon be seeing more operators emulating its approach to recouping the huge investment required for an all-IP migration or FTTx rollout.

## 5.2 PON splitting ratio: 32 versus 64 split for FTTH

In keeping with the Full Services Access Network (FSAN) standard 2, the FTTH network has a maximum reach (distance between the local exchange and the subscriber) of 20 km and can accommodate up to 32-way total splitting in the PON. The PON splitting may be achieved by a single split at the local convergence point (LCP) or a distributed split with lower port count splitters at the LCP and the network access point (NAP)[5].

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[4] "Dutch courage", Global Telecoms, November-December 2006.

[5] "Value of Reach-and-Split Ratio Increase in FTTH Access Networks", Mark D. Vaughn, David Kozischek, David Meis, Aleksandra Boskovic, and Richard E. Wagner, *Journal of Lightwave Technology*, Vol. 22, No. 11, November 2004.

The standard solution also features single-fibre transmission with a representative wavelength plan being 1490 nm and 1310 nm digital downstream and upstream transmission, respectively, and 1550 nm analog transmission downstream.

In practice today, the maximum reach of 20 km and a PON split of 1:32 cannot be achieved simultaneously.

Comprehensive cost modelling of fibre-to-the-home passive optical network solutions, which includes outside plant, head end, and premises equipment and labour, reveals the potential of 4%–5% savings per subscriber ($100–$140) for networks with enhanced reach-and-split ratio compared with equipment available today.[6]

## 5.3 Technological advances

Vendors are continuing efforts to streamline and improve FTTx equipment.

**OLT/ONT FTTH not requiring powering by the home electric circuit**

Zhone in mid-June 2007, announced what is thought to be the first Optical Line Terminal/Optical Network Terminal (OLT/ONT) Fibre-to-the-Home (FTTH) Gateway that does not need to be powered by the home electric circuit. Theoretically that eliminates the big power outage risks surrounding fibre – though the power will still have to come from somewhere.

Zhone's new offering, called the zNID, is claimed to be the only FTTH network gateway to provide advanced Layer 3 intelligence for remote monitoring and traffic prioritization of Quality of Service (QoS). It can also be managed remotely via a TR-069 automatic configuration server. TR-069 is the management standard currently used for millions of DSL installations worldwide. Inside the home it supports provisioning by using standard coax cable and ordinary twisted pair phone line for complete "HomePNA" (the technology advocated by the Home Phoneline Networking Alliance) coverage with no new wiring.

Perhaps more interesting is the ability to power the zNID using the copper that used to be used to deliver services such as POTS. According to Zhone: "zNID is ... the first gateway to derive its power from the existing phone lines in the home, further eliminating the risks and costs of hiring technicians to drill and run in-home cable".

The remote management functionality is also important. "By bringing Layer 3 processing to the subscriber site we save service providers in installation and management costs and just as importantly improve service for our customers and the end-consumer", said Eric Presworsky, Zhone's vice president of product management and advanced technology.

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[6] Richard E. Wagner, *Journal of Lightwave Technology*, Vol. 22, No. 11, November 2004.

# 6. Summary and conclusions

While Fibre to the Home (FTTH) may be seen as the ultimate access network, it is difficult to justify the additional cost over Fibre to the Node (FTTN) in a business case. The present study indicates that, for a comparable rollout to 4.5M homes, the Net Present Value of the FTTH plan is about three times the cost of the FTTN plan. This is not exactly a like-for-like comparison, as the FTTH architecture can deliver significantly higher bandwidths per household, but it is unlikely that new revenues would overcome the cost barrier.

Nor are the operations costs of the two architectures so substantially different that an FTTH rollout could be justified on operations cost savings alone. There is about a 60% reduction in operations costs for FTTH over FTTN. For the present study, we have assumed that the new Optical Network Unit (ONU) for FTTH at the customer's premises will generate significant operations costs from trouble reporting and maintenance activities. Even if this cost could be excluded or avoided, it would still be many years before the additional capital expenditure for FTTH could be paid back through operations cost savings.

The capital cost of the FTTH rollout is dominated by the cost of installing fibre in the distribution areas to the homes. This represents about 60% of the total capital cost. Much of this cost is driven by labour and is not declining at the rate of the costs for fibre-based components. Even if it could be reduced by optimised installation practices, the present study suggests that the FTTH plan would still incur one-and-a-half times the NPV of the FTTN plan. This comes closer to being justified by additional revenues and potential operations cost savings.

The operations costs for FTTN associated with the outside cabinet and the remaining copper pairs remain an area of uncertainty. However, even if pessimistic assumptions are made about high maintenance costs for the node, the FTTN NPV remains substantially lower than that for FTTH. Again, operations cost savings are not enough to justify FTTH; new revenues would be needed.

In all of this study, the major costs of new civil works have been avoided by assuming that the pit and pipe network for distribution is in reasonable shape and the cabinets for FTTN can be sited where needed. If substantial civil works were required in the distribution network, then the gap between FTTH and FTTN costs would only increase.

The use of fibre in the access network raises the possibility of radical changes to network architecture. The possibility of closing or bypassing exchanges has not been explored in the present project but would be worthy of further study.

# Annex A: Terms of Reference

The ACCC wishes to consider an FTTH alternative to the current FTTN proposals by undertaking a study of the capital and operational costs associated with each alternative.

The study will assume a rollout to 6 million Australian households and should provide similar characteristics in terms of peak bandwidths and quality of service. The ACCC wishes to receive a report on the costs of the alternative network upgrades in terms of capital costs and operational costs. The report will provide annualised capital and operational expenditures for each rollout and will specify the costs that are common to each plan. The report will also estimate, if it is possible to obtain reasonable figures, the operational cost savings to access providers from the current method of operation as the rollouts proceed.

The two alternative plans will be compared based on Net Present Value. The consultant will look to the ACCC to provide standardised parameters for converting cash flows to present values. Capital costs will be converted to annualised costs using a weighted average cost of capital (WACC) provided by the ACCC.

The ACCC proposes that the rollouts should be assumed to begin from 1 January 2008 and be completed over five years. The staging of the rollouts within this timeframe should be defined by the consultant based on international practice data but should be consistent with a national scheme for complete replacement of the current access network. That is, the rollouts would occur on a programmed basis, with whole distribution areas being cut over at one time.

The consultant should also consider if there are major cost differences between a Fibre/VDSL proposal and a Fibre/ADSL proposal and highlight any significant differences. However, the main emphasis of the report will be on a comparison of these hybrid fibre copper schemes with a full fibre (fibre to the home and to the premises) alternative.

The ACCC wishes to compare the total costs of FTTN and FTTH. For this reason, the ACCC wishes to have all costs estimated, including those that are common to FTTN and FTTH. For example, the cost of customer premises equipment (including battery power packs for lifeline telephony service, where it is provided by the telecommunications carrier) should be included in the costing.

For the FTTH alternative, the ACCC proposes that it should be based on the Gigabit capable Passive Optical Network (G-PON, ITU-T Recommendation G.984) standard. For the purposes of costing, the consultant should assume 32-way optical splitting in all environments (to give minimum fibre costs). Layer-2 deployment will use GPON Encapsulation Method (GEM), as a minimum-cost method for supplying voice and data services.

For the design of the FTTN costing model, the consultant should adopt the standards and specifications of the publicly available proposals, in so far as they are known. The consultant may seek the ACCC's guidance on this matter. The consultant should endeavour to base capital and operational costs on Australian practice and prices. However, where equipment has not been landed in Australia to date, European or USA costs, suitably adjusted, may be used. The ACCC will provide comments on adjustments of costs to Australian conditions, where relevant. The ACCC and the consultant will agree early in the project on the comparative capabilities of each alternative for the costing study. The capabilities of interest include the interfaces to be provided on network termination equipment and peak bit-rates for internet-access service. The study should preferably compare like with like, that is, each alternative should provide the same capabilities to all households passed at the end of the rollout period.

The study will not include costing of issues outside the five-year rollout period. Where possible, however, the consultant may comment on time-horizon effects such as the ongoing operational cost savings beyond five years. Further, the upgradeability of any alternative to ever increasing bandwidth demands will not be costed but the consultant may comment on upgrade issues. (Some versions of FTTN are not readily upgradeable to fibre to the home but, if they are significantly cheaper, they can be used in the costing study.)