Final Report for the ACCC

Comparative Costing of NGN Fibre Access Networks in Australia

5 May 2006

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0 Executive summary

This report presents the findings from Phase 2 of a two-phase project conducted by Analysys on behalf of the ACCC to assess the cost of using alternative technologies for local access networks in Australia.

In Phase 2 we conducted an assessment of the costs of deploying next-generation fibre access networks in the five major cities of Australia, focusing mainly on ULLS Bands 1 and 2. We have also provided a high-level estimate of the cost of similar investment throughout other areas of Australia.

It should be noted that the calculations have been carried out to provide indicative costs, averaged across different categories of exchange service area (ESA). The results are sensitive to key assumptions concerning technical parameters, unit costs and customer demand.

We draw a number of conclusions:

- On the basis of our cost modeling it is clear that the deployment of fibre to the node (FTTN) is a substantially lower cost solution than fibre to the premises (FTTP); we note that an investment in FTTN could offer a 'stepping-stone' to later deployment of a FTTP solution should there be sufficient end user demand for this.

- Considering Telstra's cost estimate of AUD3.2 billion to deploy FTTN in the five major cities, it is not clear that our analysis offers an exactly comparable costing. However, it seems likely that Telstra's estimate is at the upper end of a plausible range for the cost of such an investment.

- Considering the cost of extending FTTN deployment beyond the five major cities, we do not expect the cost per premises served to be substantially higher than in the five cities. However, even with a FTTN deployment to existing intermediate nodes, few end users will be close enough to the node to benefit from substantially higher broadband services in Band 3and Band 4 areas.

- Whilst the cost of deploying FTTP is high, it is of a similar scale to the cost deploying new copper to Greenfield sites since the majority of the cost is related to civil works. We would therefore expect to see some deployment of FTTP in Greenfield situations.

- The initial cost of FTTP in other areas could be reduced by using a delayed roll-out in terms of homes actually served rather than homes passed. In particular, the fibre lead-in wire and CPE would only be required when a customer requested high-speed broadband services that could not be delivered over the existing copper network.

- Should the ACCC wish to derive a more accurate costing for FTTN or FTTP it would be necessary to obtain more detailed geographical and technical information regarding Telstra’s existing copper access network.

1 Introduction

Analysys has conducted an assessment of the costs of alternative next-generation access networks, to supply voice and data services, in support of the ACCC's current investigation. This report summarises the findings from our work on Phase 2 of the project, which assesses the costs of next-generation fibre access deployment (FTTN and FTTP). We have focused principally on an assessment of the cost of deployment in the five main cities in Australia but have also undertaken a high-level assessment of the cost of deployment in other areas.

We have assessed the initial and ongoing costs associated with fibre access deployment and have also estimated the potential savings for Telstra of such a deployment.

The results generated by our modelling are based on parameters for the architecture of Telstra's existing network, and unit costs and assumptions concerning how each technology is likely to be deployed. It should be noted that we have had access only to very limited information concerning Telstra's network and it has therefore been necessary to make assumptions that could have a significant impact on the overall cost. We therefore recommend that the results be treated only as an indicative guide. The ACCC should seek to validate some of these assumptions with Telstra if it requires a more accurate costing.

The outputs include an assessment of the total initial cost of deployment in the main five cities, and an average initial cost per premise for each of the ULLS Bands in Australia.

The remainder of this document is structured as follows:

- Chapter 2 provides an overview of wireline technologies
- Chapter 3 describes the modelling work undertaken and highlights key assumptions
- Chapter 4 discusses areas of potential cost savings
- Chapter 5 summarises our results and presents conclusions.

2 Overview of wireline technologies

2.1 Introduction

There are a variety of wireline options that can be used to provide voice and broadband services. We review here three specific alternatives:

- copper loops
- FTTN (and copper loops from these to the end users)
- FTTP.

Unlike FTTP, the first two solutions require the use (to varying degrees) of DSL technology provided over copper loops in order to deliver broadband services. The speed of service that can be delivered varies according to the length of these copper loops as illustrated in Exhibit 2.1 below. The shorter the copper loop, the higher the data rates that can be delivered.

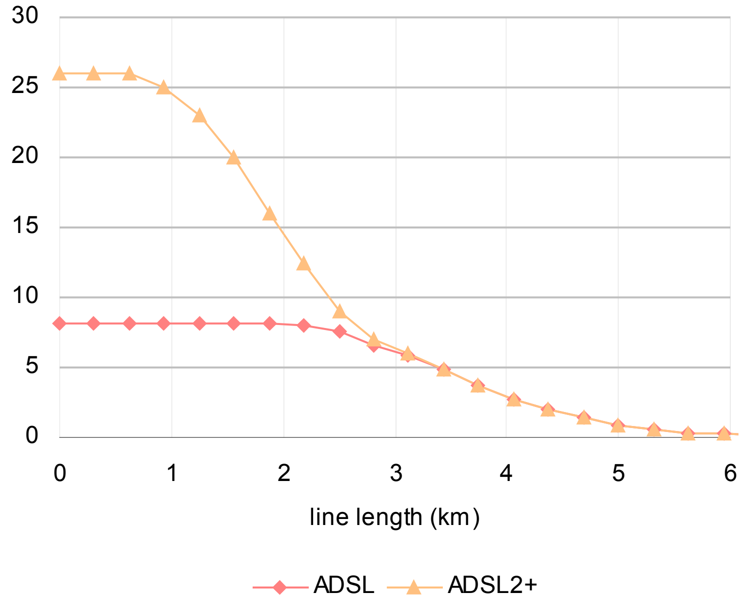

Exhibit 2.1: *Variations in xDSL access speed in Mbit/s versus line length [Source: Analysys, 2005]*

Using ADSL2+ technology we estimate that it is possible to deliver around 12Mbit/s (or slightly more) over loops of up to just over 2km in length. Since the copper loops do not run in direct straight lines to end users this typically equates to a radial distance of around 1.5km. This is consistent with Telstra's stated plans for the roll out of FTTN. For copper loops much longer than 2km in length (or 1.5km radial distance), ADSL2+ offers little advantage over standard ADSL in terms of the achievable data rate.

2.2 Copper loops

Telstra currently uses copper loops to deliver voice and broadband services to end users. The architecture varies depending on whether or not there is an intermediate node and if so, on whether pair gain equipment is used at this node. The three possible cases are:

- copper loop directly to the end user
- copper loop via an intermediate node
- copper loop via an intermediate node with large pair gain equipment.

2.2.1 Copper loop directly to the end user

In this case the end user is connected via a lead-in wire to a pit in the adjacent street, and on to the exchange or RSS / RSU, usually via a junction point with other copper wires. We expect that the cables from the exchange to the junction points would usually be ducted although a reasonable proportion would also be buried. The lead-in wire itself would normally be buried.

Power is provided via the copper loop itself and batteries located at the exchange ensure lifeline access.

We understand that this architecture is sometimes used in urban areas to serve end users close to an exchange building, and in rural areas it may also be used to serve more isolated end users at some distance from the exchange building. This is illustrated in Exhibit 2.2 below.

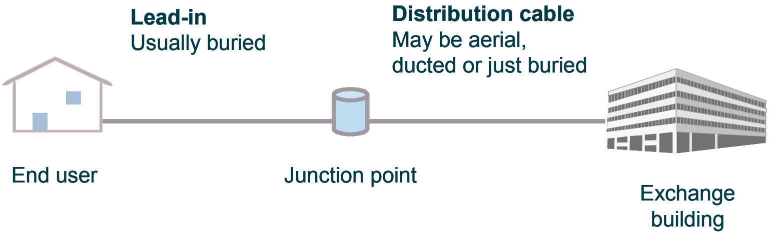

Exhibit 2.2:

Copper loop directly to end user [Source: Analysys, 2006]

2.2.2 Copper loop via an intermediate node

In this case the end user is connected via a lead-in wire to a pit in the adjacent street and via a junction point as before, and then via an intermediate node serving a ‘distribution area’ to the exchange. In Australia these distribution areas serve an average of 140 lines. We expect that the cables from the intermediate node to the junction points would usually be ducted although a large proportion may also be buried in some more rural areas. Again, the lead-in wires themselves would be buried. The large cables from the exchange to the intermediate node would also largely be ducted and in many countries pressurised air or gel filling is used as a means of keeping the cables dry.

Again, power is provided via the copper loop itself and batteries are located at the exchange building to ensure lifeline access.

We understand that this is the most common form of architecture used and that around 92% of premises are connected to exchanges via intermediate nodes. This is illustrated in Exhibit 2.3 below.

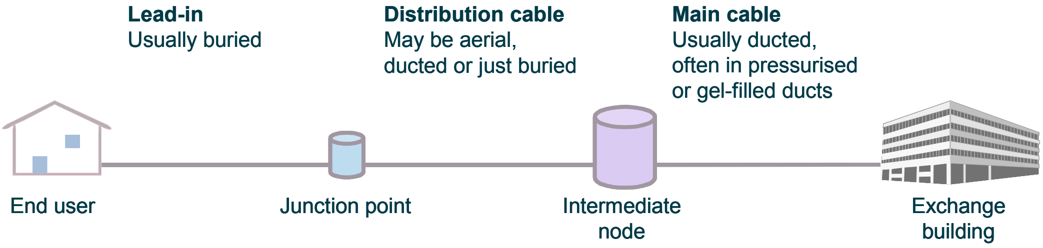

Exhibit 2.3: *Copper loop via an intermediate node [Source: Analysys, 2006]*

The majority of intermediate nodes are fed by copper from the exchange building with one copper pair for each end user. Lifeline power is available from batteries at the exchange building and DSLAMs for broadband services are also located at the exchange. However, approximately x%[1] of intermediate nodes rely on large pair gain equipment to share loops between multiple users. This sort of architecture is typically used in urban areas when housing growth exceeds the initial capacity of the network; it can also be used in rural areas where it is more cost effective to use pair gain at an intermediate node than to build a new exchange in order to serve small population centres. We understand that Telstra has used four different systems:

- C-MUX: This is the current choice for new deployment and incorporates DSLAM capability at the intermediate node. We understand that the node is served by fibre from the exchange and that it uses batteries at the node to provide lifeline power. C-MUX nodes are therefore equivalent to an FTTN deployment. The data from Telstra indicates that x% of nodes with large pair gain equipment use a C-MUX. This figure rises to around x% when considering only those nodes at a radial distance greater than 1.5km from the exchange building.

- RIM: This is the precursor to the C-MUX and is used at about x% of nodes (x% for nodes further than a radial distance of 1.5km from the exchange) with large pair gain equipment. We understand that the node is again served by fibre from the exchange and that it uses batteries at the node to provide lifeline power. However, RIMs do no incorporate DSLAM capacity and it is therefore not possible to provide DSL over lines connected to an unmodified RIM. At some RIMs Telstra has installed a miniature C-MUX (a ‘mini-MUX’) to provide DSL services but we understand that the capacity of this system is limited.

- RCM and DCS-20: These systems are precursors to the RIM, and are today used at around x% of nodes with large pair gain equipment. This remains roughly the same when considering only nodes greater than a radial distance of 1.5km from the exchange building. It is not clear whether these nodes are served by fibre from the exchange and for the purposes of our costing work we assume that they are not.

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[1] This figure drops to around x% when considering only intermediate nodes at a distance greater than 1.5km from the central exchange

Some nodes have more than 1 large pair gain system installed.

For users connected to the exchange building via an intermediate node with large pair gain equipment, it is only possible to deliver DSL services if a DSLAM is installed at the node. We believe that DSL services are therefore only available at nodes with a C-MUX or (in a limited capacity) at nodes with an RIM and at which an additional mini-MUX has been installed. In these cases the relevant length of copper is from the node to the end user.

The use of different types of large pair gain equipment installed at intermediate nodes is summarised below:

	Deployment	*Proportion of all nodes affected*	*Served with fibre*	*Lifeline power at the node*	*DSL availability*
C- MUX	Current solution for new build	X%	Yes	Yes	Yes
RIM	Precursor to C-MUX	X%	Yes	Yes	Limited availability if an additional mini-MUX has been deployed
RCM / DCS-20	Precursor to RIM	X%	Unlikely	We assume this is provided at the exchange	We assume not

Exhibit 2.4: *Summary of different types of nodes [Source: Analysys, 2006 (based on analysis of information from Telstra)]*

2.3 Fibre to the node

FTTN is the solution proposed by Telstra and involves reducing the length of copper loop by placing the DSLAM in a street cabinet at an intermediate node. The lead-in wires, junction points, and distribution cables remain unaltered in this solution.

The requirements for newly built infrastructure and equipment consists of:

- fibre connection from the exchange to the intermediate node
- active electronics at the intermediate node consisting of some form of multi-service access node

- battery back-up at the node for lifeline access
- a new street cabinet to house the additional equipment at the node.

All cases in which new equipment is installed will require an appropriate process for testing and configuring of the new equipment.

We understand that Telstra’s proposal is to upgrade the existing intermediate nodes rather than install new nodes. However, we note that in some cases (mainly in rural areas) there will remain copper loops of more than 2km in length (or 1.5km radial distance from the node). In Band 1 all distribution areas are entirely within 1.5km of their centres. In Band 2, which includes the majority of distribution areas, around 1.7% of distribution areas are not entirely within 1.5km of their centres. This figure rises to 18% in Band 3 and 29% in Band 4.

Additional nodes could be installed, but this may be substantially more costly if there is not a convenient place in the network, or if (as is likely) the new nodes serve a small number of customers. For example, even in Band 4 for the 29% of distribution areas that aren’t entirely within 1.5km of the node the majority of the area and therefore the majority of the premises within these areas do fall within a 1.5km radial distance.

2.4 Fibre to the premises

FTTP involves removing the entire copper loop (the drop wire and cable to the intermediate node and to the exchange) and laying fibre in its place. It would also be necessary to provide new network termination equipment in each of the premises.

It is not clear whether or how lifeline access would be provided under this scenario. One option might be to lay copper alongside the fibre to provide back-up power from the exchange.

3 Fibre access cost model

3.1 Introduction

We have assessed the cost of delivering local access using two different technologies:

- **FTTN**: This is similar to Telstra’s stated proposal and involves rolling out fibre to the intermediate nodes serving distribution areas which cover areas at least 5% of which lie outside a 1.5km radius around each exchange.
- **FTTP**: This involves rolling out fibre to replace copper lines all the way from the exchange building to the customer premises. We have modelled a GPON solution and have included the costs of optical network termination equipment at the customer premises.

In both cases we have focused on the five major cities but have also included a costing for the other parts of Australia that are served via intermediate nodes.

The cost model is structured as illustrated in Exhibit 3.1, below:

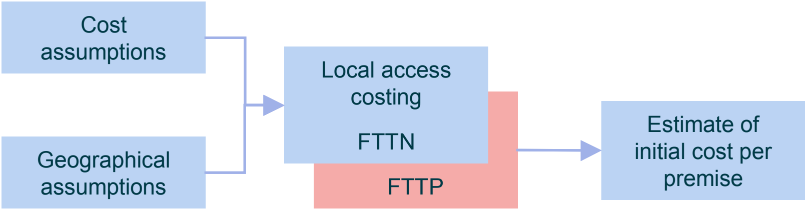

***Exhibit 3.1:** Overview of cost model [Source: Analysys]*

We take geographical data and make assumptions to calculate the amount of fibre, ducting, node equipment and customer premises equipment (CPE) required for each solution. This is combined with cost data to calculate an estimate of the initial cost per premises by geotype and within any of the five major cities or across all distribution areas in Australia for either FTTN or FTTP.

The model consists of a base case and several scenarios in which any of the values of input parameters can be modified. The model has been designed in such a way as to allow further scenarios to be added relatively easily. In the rest of this section we describe the modelling assumptions and key parameters relied on in the model.

We have sought to benchmark the technology parameters used in the model against data from a range of sources, including:

- vendor specifications and price lists
- field experience of operators
- day rates of engineers suitable for different installation work
- Analysys's internal data sources.

3.2 Geotype definitions

Telstra has assigned a band number (1-4) and a zone description (depending on population of the area served) to each exchange in Australia. The ESA is the area of land within which any buildings will be served by an exchange building located (usually centrally) within that ESA. The ESA is the surrounding area served by a (usually centrally) based exchange building.

The four bands are used by Telstra to differentiate the prices of ULLS, with Band 1 representing the cheapest areas and Band 4 the most expensive, usually more rural, ESAs.

The four zone classifications are:

- urban (greater than 10 000 people)
- major rural (between 2501 and 9999 people)
- minor rural (between 201 and 2500 people)
- remote (200 people or less).

The band and zone classifications are independent of each other. We have combined the four bands with the four zones to create 16 distinct geographical types (geotypes) as we did in Phase 1.

The majority of ESAs can be broken down further into the distribution areas served by an intermediate node. We have considered the cost of providing FTTN and FTTP in all distribution areas with each inheriting the geotype classification of its parent exchange. Three of the zones in Band 1 have no ESAs. We therefore consider a total of 13 relevant geotypes in this study (one in Band 1 and four in each of Bands 2-4).

- Band 1 – urban
- Band 2 – urban
- Band 2 – major rural
- Band 2 – minor rural
- Band 2 – remote
- Band 3 – urban
- Band 3 – major rural
- Band 3 – minor rural
- Band 3 – remote
- Band 4 – urban
- Band 4 – major rural
- Band 4 – minor rural
- Band 4 – remote.

The distribution of exchange areas by band and zone is discussed in more detail in our Phase 1 report. Although the majority of exchange areas are in Band 4, the majority of distribution areas, premises and locations are in 'Band 2 – urban' geotype as shown in Exhibit 3.2 below.

Geotype	*Number of distribution areas*	*Number of premises*	*Number of locations*
Band 1 – urban			
Band 2 – urban			
Band 2 – major rural			
Band 2 – minor rural			
Band 2 – remote			
Band 3 – urban			
Band 3 – major rural			
Band 3 – minor rural			
Band 3 – remote			
Band 4 – urban			
Band 4 – major rural			
Band 4 – minor rural			
Band 4 – remote			

***Exhibit 3.2:** Number of distribution areas, premises and locations in each geotype [Source: Analysys, DCITA, MapInfo ExchangeInfo Plus]*

In addition we have defined the set of ESAs which make up each of the five major cities and can therefore calculate the costs for each of the geotypes in any of the five cities, the aggregate of all five cities, or in all distribution areas across the country.

The definition of city boundaries has been set by taking the continuous blocks of Band 1 and Band 2 exchanges in the area of each of the major cities. No Band 4 ESAs are included in any of the city definitions but there are a few Band 3 ESAs included in the Sydney and Brisbane definitions so as to have continuous areas without gaps. These gaps typically relate to areas within a city such as airports or parks. A map of the ESAs making up the definition of the city of Brisbane is shown in Exhibit 3.3 below.

[redacted]

Exhibit 3.3: *Definition of the ESAs bounding Brisbane [Source: Analysys, MapInfo]*

The ESAs in the five major cities serve around 5.6 million premises in total. Based on the assumption that the ratio of businesses to residential premises is consistent across Australia we estimate that this equates to 1.5 million business and 4.1 million residential premises.

Not all of the Australian ESAs are split into distribution areas. In our scenario covering all distribution areas we reach almost 10 million out of a total of around 10.9 million Australian premises. This equates to around 91% of premises. However the area covered by the distribution areas is only around x square kilometres out of a total area of just under 8 million square kilometres. This equates to only around x% of the total area of Australia.

For the avoidance of doubt, we note that we have not included in any scenario the cost of providing fibre access to premises not currently located within a distribution area.

3.3 FTTN costing

The FTTN scenario involves laying fibre to the intermediate node and installing electronics at this node. FTTN is the solution proposed by Telstra and involves reducing the length of copper loop by placing the DSLAM in a street cabinet at an intermediate node. The lead-in wires, junction points and distribution cables remain unaltered in this solution.

The requirements for newly built infrastructure and equipment consists of:

- fibre connection from the exchange to the intermediate node
- active electronics at the intermediate node consisting of some form of multi-service access node
- a new street cabinet to house the additional equipment at the node
- battery back-up at the node for lifeline access.

It is also necessary to conduct testing and configuration of the new equipment.

We assume that fibre links are required only to those intermediate nodes serving premises greater than 1.5km from the exchange building. In practice we have excluded all nodes in distribution areas that are 95% within a 1.5km radial distance buffer around the exchange. This is shown using an illustrative diagram Exhibit 3.4 below.

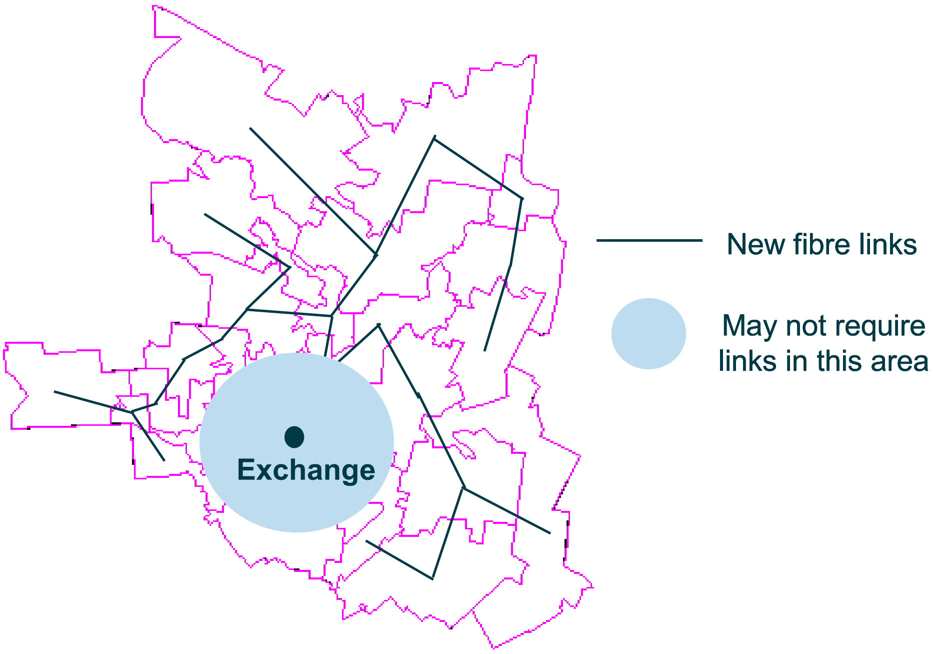

Exhibit 3.4: *Illustrative fibre links to individual distribution areas in an ESA [Source: Analysys, MapInfo]*

The ESAs in the five major cities include x distribution areas out of a total of around x. Only x intermediate nodes serve distribution areas which are less than 95% contained within a 1.5km buffer around each exchange and of these, x are C-MUX nodes and therefore already have FTTN. This leaves x nodes to be upgraded by a FTTN deployment, a number close to the 20 000 nodes quoted by Telstra. Of these, x nodes have RIM equipment and therefore we assume already have fibre connecting the exchange to the node but do require further investment at the node itself. The remaining x nodes require a full FTTN build.

3.3.1 Assets required

Fibre

We estimate the length of fibre required based on radial distance from the exchange to the centre of each distribution area (calculated using GIS data), multiplied by a 'non-straight-line factor' to account for the need to route around buildings. In the central business district we assume this factor is 1.4 (i.e. the distance along two sides of a square rather than across the diagonal) but in less dense areas we use a lower factor (1.3 in Band 2, 1.2 in Band 3 and 1.1 in Band 4).

For FTTN it is only necessary to run fibre to the intermediate nodes in distribution areas that are less than 95% covered by a 1.5km radial distance buffer around the exchange building and which do not have C-MUX or RIM equipment installed at the node (implying they are already connected to the exchange by fibre). We therefore include only these nodes when calculating the radial distances as described above.

Civil works

To calculate the distance over which civil works are required (a distance that is less than the length of fibre because multiple fibres can share the same duct or cable) we have calculated the average number of distribution areas requiring new fibre per ESA and the average area of each. We then assume a simplified network architecture based on roughly hexagonal shapes for each distribution area. Exhibit 3.5 below shows the structure of the civil works required to link the intermediate nodes in an exchange area assuming such hexagonal shapes.

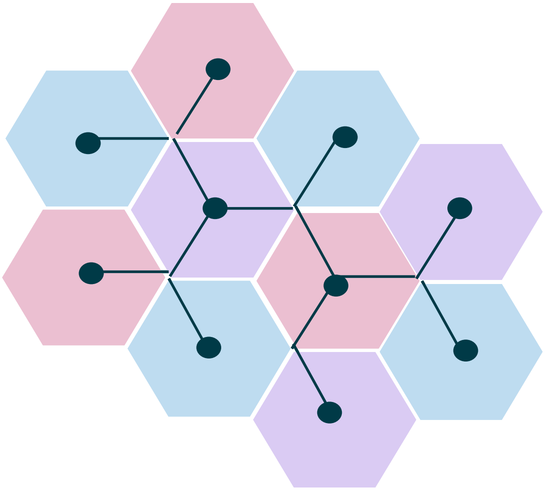

Exhibit 3.5:
Structure of civil works for connecting intermediate nodes [Source: Analysys]

After calculating the length of civil works required on average in each ESA this is multiplied by the number of ESAs in the geotype to arrive at a total length of civil works required in each geotype. This is then split between ducting, burying of fibre and aerial infrastructure according to the proportions of each assumed for main cable. These proportions vary by geotype but in the base case, no aerial infrastructure is used for main cable. The proportion that is buried rather than ducted is also zero in Band 1 but rises to 55% in Band 4.

For the fibre that is ducted we assume the re-use of existing duct rather than laying new duct where possible. In the base case of the model we assume that there is space available for new fibre in 50% of existing duct. This means that fibre can be blown down the duct without the need to dig up the ground. We consider this to be a plausible assumption because fibre cables are typically much narrower than copper cables so that there may be space to lay fibre alongside the copper even if there is not space for additional copper cable. In 25% of duct we assume that it is possible to withdraw copper to make additional space to blow fibre, again without digging up the ground; this may be possible without network disruption if obsolete copper is the reason that the duct is currently full. Finally, for the remaining 25% of duct we assume that it is not possible to create space for fibre and that new duct must be laid.

Node equipment

At all the node sites to which we have run new fibre, new equipment also needs to be installed at the node. For each node therefore a cost is incurred for a new cabinet, planning and creation of fallback solutions for these cabinets, ports for backhaul to the exchange, battery back-up and new DSL and voice combination line cards.

Whilst we assume that it is not necessary to lay fibre to nodes with RIM equipment at them, these node costs, with the exception of the battery back-up, are also incurred at the RIM nodes. There are no node costs incurred at the C-MUX nodes since these are already capable of providing DSL services to the end customer.

For end users within a 1.5km radial distance of the exchange building we assume that similar equipment is located at the exchange building. In particular we include the cost of a multi-service access node and new DSL and voice combination line cards. However, no new cabinets are required.

3.3.2 Costs

The technology-dependent costs can be divided between capital and operating costs. The capex cost is simply the unit cost for each asset multiplied by the number deployed in that year.

The opex cost is split into two distinct sub-categories. The first of these is the ongoing opex costs, which are calculated as a proportion of capex (typically 15% in the base case of the model) paid each year for operating and maintaining the equipment. The second is the one-off opex costs, which are the installation costs of the equipment, and correspond to the amount of an engineer's time required to install the equipment and carry out certain tests on equipment at the node. For any equipment housed in the street cabinet the installation cost is included in the installation cost of the cabinet itself. The installation costs for civil works and fibre is included in the capital cost.

The values of each cost item used in the model for a FTTN deployment are shown in Exhibit 3.6 below. There is often a range of costs due to variations by geotype

Cost item	*Combined unit cost for capex and installation (AUD)*
Laying duct (per m) – highest cost in Band 1 urban	30-120
Burying cable (per m) – highest cost in Band 1 urban	10-100
Aerial infrastructure (per m)	20
Withdrawing copper (per m)	12
Blowing fibre (per m)	12
Fibre including splicing (per m)	0.20
Active electronics, new cabinet and sundries (per node)	68 450
Battery back-up (per node)	3000
MSAN at exchange building	8000
Voice and DSL combination line card (per customer)	120

Exhibit 3.6: *Capex and installation costs used for FTTN in the base case of the model [Source: Analysys]*

3.4 FTTP costing

The FTTP scenario involves replacing the entire copper loop with fibre and we consider a GPON solution. The lead-in wires, junction points and distribution cables are all replaced by fibre. This is not a solution that has been proposed by Telstra.

The requirements for newly built infrastructure and equipment consists of:

- fibre connection from the exchange to all intermediate nodes (including those serving premises within 1.5km radial distance of the exchange building)
- optical equipment at each exchange building
- splitters each serving 16 users
- fibre connections from the intermediate nodes to the splitters
- replacement of the drop wires with fibre CPE.

We do not include the cost of providing lifeline power since it is probably impractical to install a battery at each customer premises.

For FTTP we assume that fibre is required to all intermediate nodes including those serving premises less than 1.5km radial distance from the exchange building. The only nodes to which we do not need to provide new fibre are those with C-MUX or RIM equipment, which are already connected to the exchange by fibre. However, it is still necessary to add new fibre on the customer facing side of these nodes.

3.4.1 Assets required

CPE

We have assumed that the number of CPEs required is based only on the number of premises in the genotype, and that a CPE is provided to all premises. We assume that a splitter with ONU equipment is required for every 16 customers in the base case, although we note that operators are now beginning to deploy 32-way splitters and have tested the impact of this possibility. 32-way splitters are capable of providing end users with downstream data rates of up to 20Mbit/s, and higher data rates could be achieved using 16-way splitters.

Node and exchange equipment

It is assumed that a new cabinet is installed at every intermediate node and a GPON optical line termination device (OLT) is required at every exchange building within the geotype. We note that a greenfield deployment might rely on OLTs at a smaller number of sites but consider that a 'scorched-node' approach is likely to be the most efficient for Telstra to employ, making use of existing duct and other infrastructure.

Main cable

To estimate the length of main cable fibre and civil works required in each genotype under the FTTP model, we have used the same approach as for FTTN except that in the FTTP case it is necessary to provide fibre to all nodes, even those close to the exchange.

Distribution cable

To estimate the required length of distribution cable a similar approach is used. We base the distance estimates for the fibre and duct to reach the splitters from each node on an assumption that splitters are uniformly distributed across each distribution area, and serve roughly hexagonal areas. Fibre length is calculated on the basis of the average distance of each splitter to the centre of the distribution area and as before we multiply these lengths by the appropriate routeing factor for the geotype in question.

The estimate for civil works length is based on a simple spanning tree between splitters covering hexagonal areas. This total length of civil works is then split between ducting, burying and aerial infrastructure according to parameters dictating the percentage of cabling transported using each method in each geotype. In the base case it is assumed that between 5% and 20% of this cable is aerial depending on the geotype and that between 0% and 55% is buried. The remainder of the cable is ducted and again we assume that existing duct is used, with copper withdrawn first in cases where the duct is already full.

Drop wire

For the drop wire (from the splitter to the customer premises) a different approach has been taken. To estimate the length of fibre and duct needed here we consider the average building plot. The area of this has been obtained by dividing the portion of each distribution area used for premises (assumed to be 75% of the total area in the base case) as opposed to roads, parks, train stations etc. by the number of locations in the area. We have initially assumed that each building occupies a street plot 3 or 4 times as long as it is wide depending on the geotype.

On the basis of these parameters we derive an average building frontage length for each geotype. In the base case this is on average 18.5m in the five major cities, which is consistent with other data that we have obtained, including a detailed report on housing in New South Wales.

We assume a simple configuration of fibre from each splitter to the premises as shown in Exhibit 3.7, below.

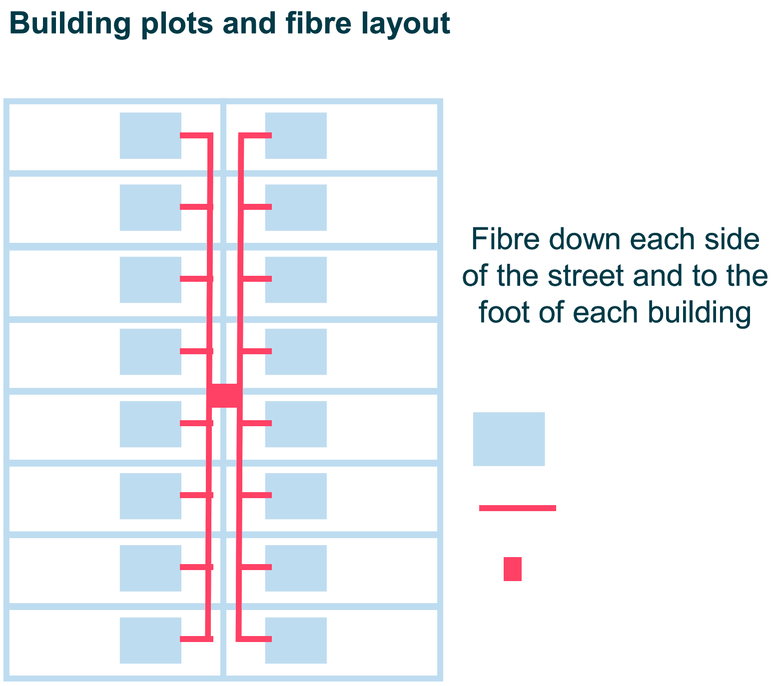

Exhibit 3.7:*Configuration of fibre from the splitter to the premises [Source: Analysys]*

This configuration allows the calculation of an average drop wire length as a function of building frontage. We are therefore able to estimate the total length of fibre and civil works required for the drop wire from a splitter in each geotype and this is then scaled by the number of splitters used in the geotype.

Once again the total length of civil works is split between duct, buried cable and aerial cable. For the drop wire we assume in the base case that this is always buried.

3.4.2 Costs

As in the case of FTTN, the technology-dependent costs can be divided between capital and operating costs. These are dealt with in the same way as in the case of FTTN.

For the costs which are common to both FTTN and FTTP the same cost parameters are used in both cases except for the cabinets which in the FTTP case are much simpler since it is not necessary to include active electronics at the node. The costs of civil works (laying duct, burying cable and aerial infrastructure) can however vary between main cable, distribution cable and drop wire segments. The costs are initially the same in all segments in the base case of the model (although they do vary by geotype).

The costs of each cost item used in the model for a FTTP deployment separate to those already described for FTTN are shown in Exhibit 3.8 below.

Cost item	*Capex and installation cost (AUD)*
GPON OLT (per exchange)	1600
Splitter and ONU (per 16 users)	5000
CPE (per user)	600
Street cabinet for use in FTTP	8000

Exhibit 3.8: *Capex and installation costs used for FTTP in the base case of the model*

[Source: Analysys]

3.5 Output

For both FTTN and FTTP we assess the initial cost per premises and the total initial cost across all ESAs. These results are available for each geotype in each city and in weighted average form for the four geotypes in each band. In addition, results are available for the aggregate of the five major cities and for all distribution areas in Australia.

For FTTP, we also calculate the lengths of cable required in each segment (main, distribution and drop wire) for each node, splitter and premises in each geotype and in each city. Should the ACCC wish to calibrate the model against Telstra's existing copper network, these would be important outputs to consider.

4 Areas of potential cost saving

4.1 Introduction

In this section we explore briefly the areas in which Telstra may be able to achieve cost saving by deploying a next-generation access network.

4.2 Core network

Most of the savings associated with next-generation networks relate to upgrades to the core rather than the access network. Significant economies of scope are possible because of the ability to convert voice traffic to IP and to share assets with the data network. Reductions in service provisioning costs may also be significant. For example, if multi-service access nodes are installed in exchanges it is possible to upgrade users from a voice-only connection to a combined voice and broadband connection remotely, without requiring an engineer to visit the exchange and physically re-route the tie cables.

These core network savings are outside the scope of our study.

4.3 Access network

The network savings associated with next-generation access networks are limited. The main benefits are the improved service offerings. These benefits are not modelled explicitly.

FTTN and especially FTTP solutions require much less equipment to be deployed at the exchange, and so require less space. Therefore, deployment of these solutions could enable Telstra to sell off land. However, in order to estimate the potential cost savings it would be necessary to have access to detailed information concerning the size of existing exchange buildings, the land-value in these areas and any relevant planning restrictions.

As noted earlier, copper cable between the exchange and an intermediate node are often installed in pressurised or gel-filled ducts to ensure that they are kept dry. This may not be as important with fibre cables and there is therefore a limited opportunity to save costs over the lifetime of a cable. We also expect fibre to have a lower maintenance cost per metre that the equivalent copper cable. The possible savings in this area are likely to be some reasonable proportion of the current depreciation and maintenance costs associated with the copper cabling.

The existence of FTTN may also reduce the additional cost of deployment for services such as high-bandwidth leased lines, since fibre will already exist deeper in the network. A deployment of FTTP will significantly further reduce the additional cost of such services. To estimate these benefits would require detailed information concerning the current demand and cost of supply for such services.

5 Results and conclusions

It should be noted that the cost estimates have been carried out at a high level in order to provide indicative costs that represent an average for the different categories of ESA. In particular, the limited geographical data that has been available to us allows only very approximate estimates for the estimated required lengths for fibre and ducting etc. Our results therefore show potential error factors to reflect the level of certainty in the different assumptions that were necessary to reach our conclusions.

In addition to the error margins we note that the results are also sensitive to key assumptions concerning technical parameters and unit costs, and may be subject to a further possible error margin of around +/-10%.

5.1 FTTN results

5.1.1 Initial cost per premises

Exhibit 5.1 below shows the initial cost per premises, which is a combination of capital costs and installation costs, for each of the five major cities and for all distribution areas in Australia. The average cost per premises presented includes a weighting for the zero cost associated with serving premises within a radial distance of 1.5km from the exchange building.

The values shown are the weighted average cost per premises in each of the areas. The results are shown for the base case with the error bars representing the potential error based on different assumptions about fibre and civil works lengths. The results may be subject to a further possible error margin of around +/-20% due to variations in unit cost parameters.

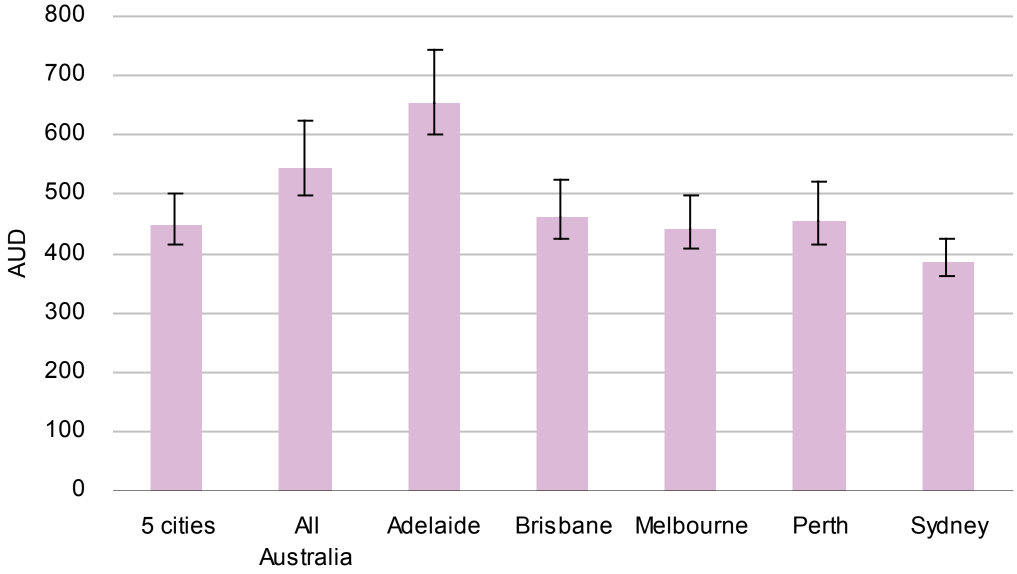

Exhibit 5.1: *Initial cost per premises for FTTN in each of the major cities [Source: Analysys]*

The initial cost per premises is higher in Adelaide than in any of the other major cities. This is due to a slightly different network topology in Adelaide compared to the other cities. Across all distribution areas there is an average of 150 premises per distribution area and this is consistent across the five major cities as a whole with 149 premises per distribution area. However in Adelaide, there is an average of only 112 premises per distribution area. Also in Australia as a whole and in the five major cities only 48% of distribution areas require new fibre to be built to the node due to their proximity to the exchange or the existence of fibre links. However, in Adelaide this figure rises to 62%. Therefore the amount of new fibre required per premises is higher in Adelaide than in the other cities.

The lowest costs are found in the two largest cities, Melbourne and Sydney, where there is also a higher density of premises than in the other cities. As expected, the average cost per premises for all of the Australian distribution areas is higher than the combined figure for the five major cities. This is due to the higher cost of Band 3 and Band 4 ESAs in more rural areas of Australia, bringing the average cost up.

Exhibit 5.2 shows the results for initial cost per premise excluding the cost of line cards for all end customers and the cost of MSAN equipment at the exchange building.

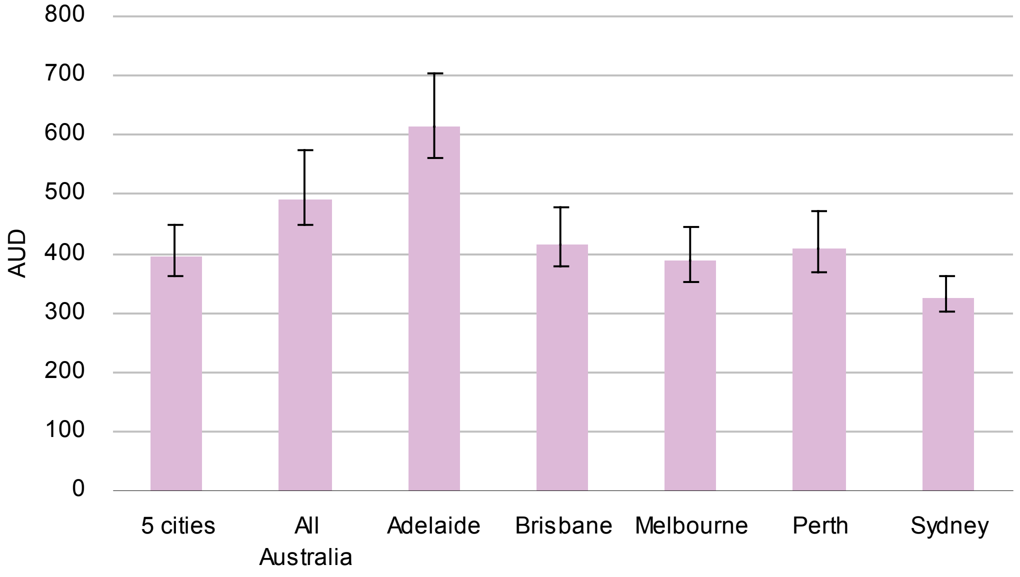

Exhibit 5.2: *Initial cost per premises for FTTN in each of the major cities excluding line cards and MSANs at the exchange building [Source: Analysys]*

The relative costs in each city are similar to those shown in Exhibit 5.2 but with a slightly lower cost per premise in all cases.

5.1.2 Total initial cost

Exhibit 5.3 below shows the total initial costs for FTTN in the five major cities broken down into civil works, electronics and line card costs for each of the two cases with and without the costs at the exchange included.

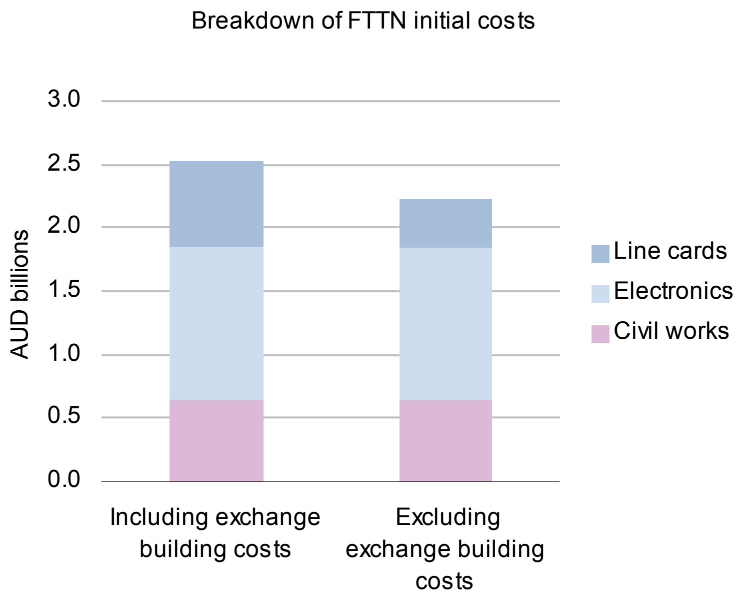

Exhibit 5.3:

Breakdown of total initial costs for FTTN for the five major cities, base case scenario

[Source: Analysys]

In the base case, the total figure estimated for the initial capital and installation costs across all geotypes in the five major cities is just over AUD2.5 billion. This is lower than the figure of AUD3.1 billion quoted by Telstra, although the lack of detail provided in Telstra's costing means that it is not possible to be sure whether the two figures are directly comparable. The majority of the cost is made up of electronics costs at the intermediate nodes, although the cost of civil works and line cards are also both significant. Excluding the cost of additional line cards and MSANs at the exchange buildings reduces the cost estimate to AUD2.2 billion.

Considering all distribution areas in Australia the total cost rises to AUD5.1 billion (AUD4.6 billion excluding costs at the exchange buildings) with a similar breakdown of costs to those shown in Exhibit 5.3.

Area	*Total cost (million AUD)*	*Total cost excluding costs at the exchange (million AUD)*
Adelaide	362	340
Brisbane	348	313
Melbourne	768	672
Perth	289	258
Sydney	757	637
All cities	**2526**	**2225**
Other distribution areas	2601	2414
All Australian distribution areas	**5127**	**4639**

Exhibit 5.4: *Summary results for each area [Source: Analysys]*

5.2 FTTP results

5.2.1 Initial cost per premises

Exhibit 5.5 below shows the initial cost per premises, which is a combination of capital costs and installation costs, for each of the five major cities and for all distribution areas in Australia. Again, the results are shown for the base case with the error bars representing the potential error based on making different assumptions about fibre and civil works lengths. The results may be subject to a further possible error margin of around +/-10% due to variations in unit cost parameters.

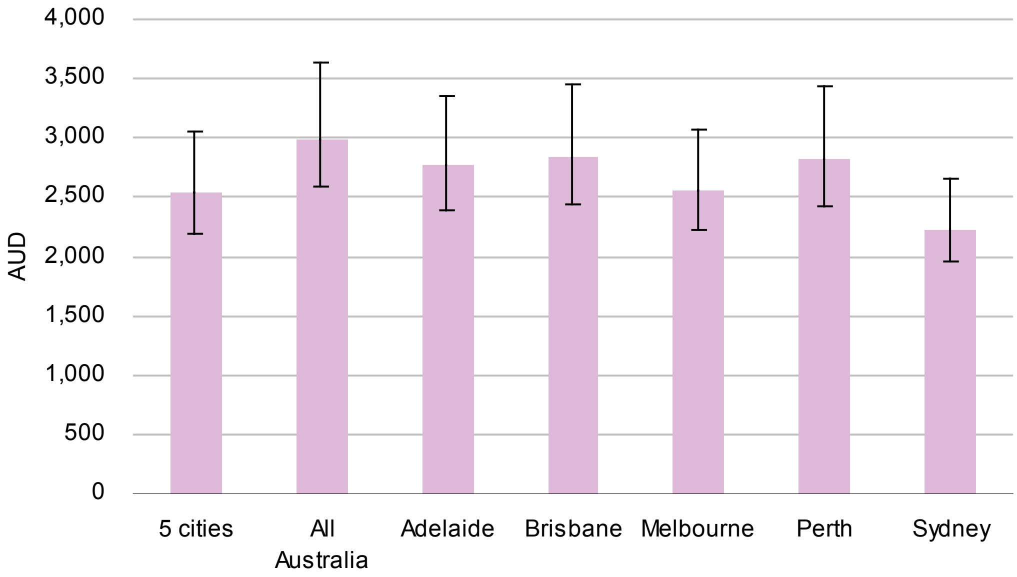

Exhibit 5.5: *Initial cost per premises for FTTP in each of the major cities [Source: Analysys]*

Unsurprisingly, given the extent of civil works required the costs are considerably higher than the cost per premises in the FTTN case. Once again, costs are lowest in Sydney and Melbourne, which have the highest density of premises. The cost per premises in the five major cities is lower than the cost averaged over all the distribution areas in the country. However, the difference is not as great as might be expected since we assume that civil works costs are lower in the less built-up Band 3 and Band 4 areas. It should also be noted that the costing across the whole country only includes the 9.4 million premises that lie within Telstra distribution areas.

The potential errors are larger than in the case of FTTN due to the greater costs associated with the civil works, which is the source of the majority of the uncertainty.

5.2.2 Total initial cost

Exhibit 5.6 below shows the total initial costs for FTTP in the five major cities broken down into civil works, electronics and CPE costs.

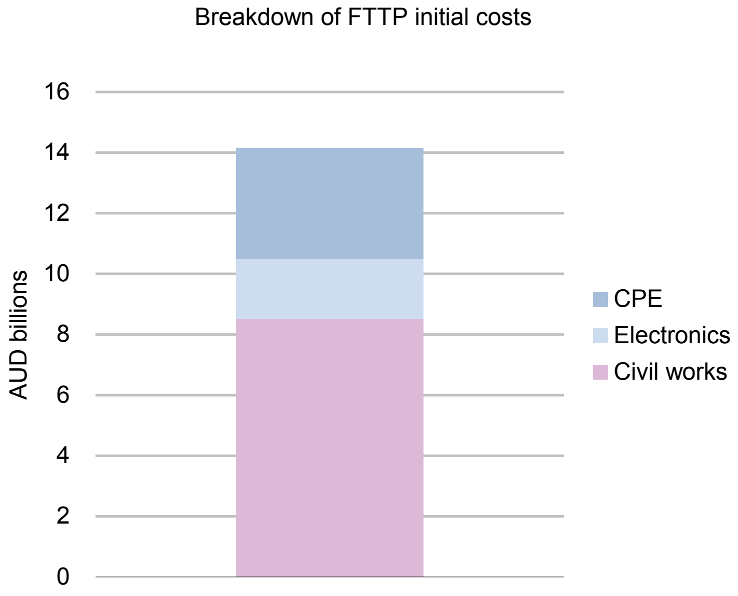

Exhibit 5.6:

Breakdown of total initial costs for FTTP for the five major cities [Source: Analysys]

The total figure for the initial capital and installation costs across all geotypes in the five major cities is just over AUD14 billion. This is substantially higher than the figure of AUD2.2 billion for FTTN. The majority of the cost is this time made up by civil works costs due to the much greater amount of fibre required to reach the customer premises. CPE is also a significant cost. Taking into account all distribution areas in Australia, the total cost rises to just under AUD28 billion with a similar breakdown of costs to that shown in Exhibit 5.6.

Area	*Total cost (million AUD)*
Adelaide	1531
Brisbane	2136
Melbourne	4434
Perth	1790
Sydney	4364
All cities	**14 291**
Other distribution areas	13 941
All Australian distribution areas	**28 232**

Exhibit 5.7:

Summary results for each area [Source: Analysys]

5.3 Conclusions

On the basis of our cost modeling it is clear that FTTN is a substantially lower-cost solution than FTTP. Whilst FTTP is able to provide downstream data rates of 20Mbit/s and above, FTTN would be capable of delivering 12Mbit/s to the majority of users, which is significantly greater than current capability. FTTN also offers the advantage of providing a 'stepping-stone' to the subsequent deployment of FTTP should this be justified by sufficient end-user demand. In particular, the fibre laid between exchanges and intermediate nodes is an essential part of a FTTP deployment.

With respect to Telstra's cost estimate of AUD3.2 billion to deploy FTTN in the five major cities, it is not clear that our analysis offers an exactly comparable costing. However, it seems likely that Telstra's estimate is at the upper end of a plausible range for the cost of such an investment.

Considering the cost of extending FTTN deployment to distribution areas beyond the five major cities, we do not expect the cost per premises served to be very substantially higher. However, we also note that even with a FTTN deployment to existing intermediate nodes, fewer end-users will be close enough to the node to benefit from substantially higher broadband services in Band 3 and Band 4 areas.

Whilst the cost of deploying FTTP is high, it is of a similar scale to the cost deploying new copper to Greenfield sites since the majority of the cost is related to civil works. We would therefore expect to see some deployment of FTTP in Greenfield situations.

The initial cost of FTTP in other areas could be reduced by using a delayed roll-out in terms of homes actually served rather than homes passed. In particular, the fibre lead-in wire and CPE would only be required when a customer requested high-speed broadband services that could not be delivered over the existing copper network.

Should the ACCC wish to obtain a more accurate costing for FTTN or FTTP it would be necessary to gain access to more detailed geographical and technical information regarding Telstra's existing copper access network.