The National Broadband Network Brownfields Debate

Valuing FTTN and FTTP

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Abstract: This paper analyses the value of FTTN and FTTP along financial and non-financial dimensions. It reports on an open, public, dynamic 'value model' of FTTN and FTTP, and showcases two visual tools to enable assessment of their multiple, competing, emerging and slippery 'value dimensions'. The paper reports and compares empirically-derived FTTN and FTTP value dimensions from recent Ministerial Speeches at CommsDay Summit 2016 and Government expert reports with the value model.

Introduction

This paper examines, analyses and values Fibre to the Node (FTTN) and Fibre to the Premises (FTTP) in the context of the Australian National Broadband Network (NBN). A comparison of the two needs to take into account multiple 'dimensions of value'. For instance, while FTTN is cheaper to install, offers 'good enough' speed in the short term, and is faster to roll out, FTTP is seen, by some, to be better value, due to its length of useful life, lower maintenance costs, and faster maximum speeds.

This analysis of FTTN and FTTP uses value theory (see Appendix 2), which sees innovations, like the NBN, as complex, dynamic systems. That is, the value of the NBN is multi-dimensional, shifting with new information that appears often, and in quantity. Value theory suggests that analysis needs to use dynamic and flexible approaches, rather than the static and partitioned (public/private) approaches, for instance, of Vertigan (2014), the Liberal's NBN cost-benefit analysis, or the ALP's McKinsey NBN Implementation Study (2010).

This paper reports the results of the public dynamic model of the value of FTTN and FTTP (Ferrers 2016a, 2016b) and encourages the reader to play with the model's assumptions and come to their own conclusions. This model is a dynamic approach to understanding value, but it has some weaknesses. Two alternative models are presented which address some of these weaknesses. The first model allows multiple FTTN and FTTP value dimensions to be visualised. The second model takes into account the relative importance of multiple value

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dimensions, for example: time, price, need for speed, reliability, equity (see Appendix 3). All of these models are available for public use.

Through examining these models, this paper seeks to:

(1) add information to potentially shift the NBN value assessment for two key audiences,

(2) add to the long list of FTTN and FTTP pros and cons (see Appendix 4), and

(3) add the cost to replace FTTN with FTTP into the debate (Appendix 7).

The first audience that this analysis is aimed at is the NBN politicians. These include the Prime Minister, the Leader of the Opposition, the Communications Minister, the Shadow Communications Minister and relevant Innovation Ministers. The second audience is voters, who may have the NBN on their minds when they go to vote. So, the analysis attempts to be reasonably comprehensive for the first group but simple enough for the second group.

The Problem of valuing FTTN and FTTP

Two views have developed about which is the best way to roll out the Australian NBN. The current plan is to roll out FTTN to 3.7M (million) homes over the next two years (by 30.06.2018) at an installation cost of $6.3B (billion) (Table 1, Appendix 6). However the alternative view is that this $6.3B is a waste of money, since FTTN is a "technically inferior" (LeMay 2015a) system to the preferred FTTP system. In this view, FTTN will have to be upgraded soon to FTTP, since FTTN is close to the end of its useful life, and very little of the $6.3B will be of use in an upgraded FTTP system. By the government's own analysis, only 20% of the $6.3B would be re-useable in an upgrade to FTTP (Vertigan 2014), and some analysts believe, far less. So, this is close to a $6.3B problem for FTTP proponents. For FTTN supporters, if the 3.7B homes were rolled out with FTTP at a cost of $16B, this is a waste of $10B, when FTTN installation costs are substantially less (Table 1).

But, different types of analysis can give different results (Table 1, 2). A more comprehensive analysis of the best approach to implementing the NBN would include consideration of Hybrid Fibre/Coaxial (HFC) and Fibre To The Curb (FTTC), (which is briefly analysed in Appendix 1), but these are excluded from the main analysis for simplicity. Similarly FTTP, in this analysis, means brownfield existing homes, rather than greenfield new estates, which are for the first time installing phone and internet.

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Table 1 – FTTN vs FTTP: The Cost Perspective

	FTTN	FTTP
Install Cost $ per household	$2,100	$4,400
Install Cost for 3.7M households	$6.3B	$16.3B
Install Cost per household in other countries; Government Investment (see Appendix 8)	UK: <£100 Germany: €138 NZ: $1,062	NZ: $1,700 SG: $438
Operating Costs (350,000 premises) (LeMay 2015a)	$150M pa	$125M pa
Revenue (350,000 premises) (LeMay 2015a)	$175M pa	$275M pa
Total Revenue – Operating costs (roughly 10 times 350,000 premises) = NBN Co. Cash Profit	$250M pa	$1,500M pa
Time to payback installation costs	Approx. 27 years	Approx. 11 years
Useful life	5-20 years	20-40 years

What Table 1 shows, is that while FTTN is significantly cheaper to install, it generates far less profit for NBN Co., and takes a lot longer to pay back the initial investment. FTTP pays back the extra installation cost investment ($10B) in around 6.5 years, with NBN Co profits projected to be $1,500M per annum. But, for every year that FTTN remains in operation, over $1B is sacrificed through foregone revenue and lower operating costs. These figures suggest, even if FTTN is installed, that a quick upgrade to FTTP is financially attractive. The operating costs and revenue numbers come from leaked NBN Co. documents (LeMay 2015a). NBN Co. were asked to comment on these figures and they said: "the figures used as the basis for this analysis are from draft documents in early 2015 – not endorsed by our executive" (Johnston 2016).

While these figures are unconfirmed, they do add an interesting alternative slant to the focus only on installation costs. To the extent the operating costs and revenue numbers are correct, they shift the value of FTTP and FTTN, towards favouring FTTP.

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Table 2 – FTTN vs FTTP: The Return on Investment (ROI) Perspective

Return on Investment	FTTN	FTTN	FTTN	FTTP	FTTP	FTTP
	Investment	Return pa	ROI	Investment	Return pa	ROI
NBN Co.	$6.3B	$250M	4% pa	$16B	$1,500M	9% pa
GDP Revenue Operating$ NBN Profit	$6.3B	$1,750M $1,500M $250M	56% pa	$16B	$2,750M $1,250M $1,500M	34% pa

What Table 2 shows is that taking installation costs, operating costs and revenue into account, the GDP return for FTTN (56% pa) is significantly greater than for FTTP (34% pa). Both returns are extraordinarily high, and generated every year during the life of the asset, assuming revenue levels are maintained over time. The FTTN asset life is however much shorter than the FTTP life. The GDP benefit per year is the sum of NBN revenue, operating costs and NBN Co profit. While the profits for NBN Co. are greater for FTTP, the return on investment for FTTN is much greater, given its lower installation costs. Indeed, each year FTTN (once completed) generates close to 30% of its installation costs as revenue, whereas FTTP only generates a little under 20% given its substantially larger installation costs, though FTTP generates 50% more revenue per year.

These returns on investment again shift the value of FTTP and FTTN more towards favouring FTTN, at least in the short term. Thus either FTTP (using gross return or time to pay back investment) or FTTN (using return on investment) can be preferred depending on the type of analysis. The Ferrers (2016a) model uses this GDP calculation to analyse and value FTTN and FTTP (plus depreciation).

In the next section, I will discuss the background to the NBN, including the magic of optic fibre. Then, I will analyse the value dimensions of the NBN by looking at two speeches from the CommsDay Summit 2016 by Minister Fifield and Shadow Minister Clare, and contrast the value dimensions mentioned there with external reports from Vertigan (2014) and McKinsey (2010), supporting the alternative positions.

Then, I will introduce my proposed solution to the value problem, a dynamic value model of FTTN and FTTP, and compare its value dimensions against those discovered in the speeches and reports. Lastly, two data visualisations will show the multi-dimensional and changing nature of the value of FTTN and FTTP.

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The Background

Optic fibre is the magical technology which combines lasers and glass fibre tubes to transmit digital data over long distances. Optic fibre is special because not only can the signal reach for many kilometres without power, and with amplifiers cross the oceans, bringing data around the world at the speed of light, but also by changing the laser boxes at each end, data capacity can be doubled for around 5% of the cost of installing the cable. Over the last forty years, this change in laser boxes has brought a million-fold increase in bandwidth that has enabled the bandwidth explosion and the falling price of data globally.

The NBN in Australia seeks to bring the fibre optic cable closer to homes, and thus improve data speeds which are currently limited by bringing fibre only to the telephone exchange, and using copper phone lines for the connection into homes. See further NBN history at Whirlpool (2016).

Fibre To The Node

FTTN uses optic fibre from the telephone exchange to a distribution box called a node, up to a few hundred metres from homes and then uses copper phone lines to reach into houses. This approach allows for download speeds approaching 100Mbps, but the speeds vary with the distance from the distribution box. Some benefits of this approach are: less construction on the last few hundred metres for millions of households, so the rollout proceeds more quickly (less digging up gardens), and at considerably less cost – in the order of $2,000 per household (Table 1).

A more exhaustive list of pros (10) and cons (8) of FTTN is provided in Appendix 4.

Fibre To The Premises

FTTP runs fibre all the way from the telephone exchange to the side of each house, but the fibre cable must be hauled down every street, either on power poles or through ducts, and across or under lawns to reach homes. Some benefits of this approach are that download speeds of 1,000 Mbps are available immediately (if rarely in practice), with virtually unlimited bandwidth in the future, as the laser boxes are switched inside the exchanges. (In the lab, tests have shown fibre optic cables are capable of moving over 10,000 times more data than current available products, but laser boxes capable of these speeds are many years away from being affordable.) However, the cable has a long lifetime, and low maintenance, so is likely to remain useable for decades, with future upgrades to laser boxes providing

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significant regular improvements to fibre capacity. As capacity improves, it is likely to result in significant drops in price per unit of data transported.

A more exhaustive list of FTTP pros (11) and cons (7) is provided in Appendix 4.

There is no comparison in an FTTN FTTP speed test. Since 1975, FTTP has had a million-fold improvement in speed on a single fibre, from 45 Mbps in 1975 to 100,000,000 Mbps or 100 Terabits per second in 2016 (Wikipedia 2016a). For more speed, a bundle of up to 12 fibres adds 12 times the data capacity (Wikipedia 2016a). In contrast, FTTN has seen a thousand-fold improvement in FTTN, from 6Mbps in 1993 (Gilder 1993) to 8,000Mbps (Palmer 2016) in the lab in 2016.

Table 3 – FTTN vs FTTP: The Time Test

	FTTN	FTTP
Time to install	3.7M households in 2 years	10M households in 8-10 years, (per NBN 2016, p.18, 39)
Life of Asset	5-20 years	20-40 years

Table 4 – FTTN vs FTTP: The Goal and Opponent comments

	FTTN	FTTP
ALP Goal		"Do it once, Do it right, Do it with fibre." Tony Windsor in 2010 (Taylor 2014) NBN Co Statement of Expectations (Wong & Conroy 2010) "provide access to high-speed broadband to all Australian premises… connect 93% of Australian homes, businesses and schools to FTTP… up to 100Mbps"
ALP supporter comment	"Technically inferior" (LeMay 2015a)	
Coalition Goal	"Deliver fast, affordable and reliable broadband years sooner" (Liberal Party 2012: 6) "…ensuring all Australians have access to very fast broadband as soon as possible, at affordable prices, and at least cost to taxpayers… at least 50Mbps to 90% of fixed line premises… upgrade paths are available as required" NBN Co Government expectations (Turnbull & Cormann 2014, 1-2)	

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Coalition comment	"we will get the network completed six to eight years sooner [FTTN] than it would be under [FTTP]… and $30 billion cheaper or at less expense to the Government, which makes broadband more affordable" (ABC 2015; NBN 2016, 18, 39)	"…wasting money on the greatest white elephant this country has ever seen, the National Broadband Network" Prime Minister Abbott (Abbott 2012). "…no evidence consumers are willing to pay higher charges for 100 megabits per second" (Liberal Party 2012, 5).

In Tables 3 and 4, the battle lines are drawn between two versions of the NBN. On the one hand, FTTN is rolled out years faster, giving "all Australians … access to very fast broadband as soon as possible, at affordable prices… at least cost to taxpayers… at least 50Mbps…[with an] upgrade path" (Turnbull and Cormann 2014, Table 4). On the other hand, the all-fibre FTTP has long-term cost advantages, from the rapid improvement in data carrying capacity, as shown by the million-fold improvement in the last forty years, though it is slower to install at a national level. The decision is between cheaper/affordable now (FTTN Table 1), cheaper later (FTTP Table 1), fast enough now, or very fast later. But, there are more value dimensions to FTTN and FTTP than just price, speed and timing.

A value analysis of FTTN and FTTP – a multi-dimensional dynamic comparison

This section makes a value analysis of FTTN and FTTP. Firstly, I report on value dimensions of FTTP and FTTN discovered through examining two documentary sources:

> (1) recent speeches of Minister Fifield and Shadow Minister Clare, at the recent CommsDay Summit (Fifield 2016; Clare 2016, Appendix 9), and
>
> (2) expert reports to support the alternative FTTN FTTP positions; Vertigan (2014) and McKinsey (2010) (Appendix 10).

I summarise below the value dimensions found, and compare them to a dynamic financial value model to assess the value of FTTN and FTTP. Then, I compare the dynamic model to the empirically derived value dimensions, to test its adequacy, and then make some suggestions to improve the model for unaccounted value dimensions.

Summary of Value Dimensions – Empirically derived

The analysis of Ministers' speeches (Appendix 9) shows a strong divergence in what Ministers Fifield and Clare value from FTTN and FTTP. Minister Fifield pushes the FTTN

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agenda of a faster, lower-cost rollout with good enough speeds, and the flexibility of the multi-technology approach. Clare prefers to mainly criticise the FTTN approach (rising costs, delays, congestion), but suggests FTTC is an improvement without committing to this approach. Both Ministers argue their approaches are in line with international comparisons, FTTN to improve international rankings and FTTP to follow the AT&T's lead. Many other FTTN and FTTP value dimensions are not mentioned by either Minister (see Appendix 9).

The analysis of expert reports (Appendix 10) shows a divergence in value dimensions between FTTN and FTTP. McKinsey emphasises affordability and maximising usage, including social benefits, whereas Vertigan emphasises willingness to pay, and places far less emphasis on business or public benefits. Table 5 below combines the results of the analysis of Ministers' Speeches (Appendix 9) and expert reports (Appendix 10).

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Table 5 – FTTN vs FTTP: Summary of Value Dimensions found in Minister Speeches and Expert Reports

	FTTN	FTTP
Value dimensions found	• Flexible on which tech (MTM) • Fast enough services to meet current needs, but congestion • Fastest rollout to reach users quickly • Lower cost rollout • No new (future) needs/apps • No WTP for highest speeds • Rising costs, delay FTTN • New tech increasing speed for users (FTTC)	• Equity of access • Social/national benefits • High use of data • Fastest services / use • Reliability of FTTP to deliver advertised speeds • More services competition

In the next section, I present a financial dynamic value model which captures some of the value dimensions derived above. In the following section, I consider improvement to the value model to account for further value dimensions, including non-financial ones, such as equity or reliability of service.

A Dynamic Value model of FTTN and FTTP

To create a dynamic model to include all the value dimensions found in the previous section is challenging. A dynamic value model was constructed (Ferrers 2016b, Appendix 5), which takes account of:

- time to market / cost of delay (based on GDP impact of delay), and so captures benefits of early installation (cost, time)
- revenue, build and running costs of FTTN and FTTP (Table 1; NBN 2016; LeMay 2015a), and so captures current (but not future) benefits of higher speeds on FTTP, benefits of lower expected maintenance costs in the longer term on FTTP, current expected cost of FTTN maintenance
- cost of capital (cost of spending/revenue at different times)
- GDP impact on households of early install of FTTN (at lower and upper bounds of potential impact)
- replacement of FTTN with FTTP at year 20.

However, the dynamic model is not capable of accounting for all the value dimensions noted in Table 5 above. For instance, delays in rolling out FTTN, congestion on FTTN, flexibility of technology and new technology in the form of FTTC could not be captured.

This model uses a net present value (NPV) calculation (Appendix 5). NPV uses interest rates (the discount rate) to convert future cash flows to a present day equivalent. If the result of the calculation is a positive number, this indicates that a profit will be made, taking into account

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the revenue and expenses that are incurred at a future time. The GDP calculation simulates the NBN impact on a single household, compressing 20 years of installation costs, revenue, and operating costs to a single profit-like figure. You can see the derivation and development of the model at Ferrers (2015). The analysis assumes FTTN remains in place over the coming 20 years.

The model calculates NPV under a number of different scenarios. Under each of these scenarios, sometimes FTTN has a higher result and sometimes FTTP has a higher result. The model tests three variables:

1. delays in FTTP rollout from zero to eight years, shown in two year increments
2. discount rates, ranging from 0% to 10%
3. impact on $70,000 household income of early use of FTTN, ranging from 0% to 2%.

So, there are sixty different combinations of assumptions modelled in Tables 6a to 6c below. What the analysis shows is that under certain assumptions, FTTN is preferred (Table 6 in white), while under others, FTTP is preferred (Table 6 in grey). Replacement of FTTN cost (but not rollout time) is also modelled (Appendix 7) and where this extra expense changes the result from a pro-FTTN to a pro-FTTP result, the cells are highlighted (Table 6 in pink).

Table 6a – Comparing FTTN and FTTP impact on a household over 20 years; where early FTTN gives 0% boost to household GDP.

Years delay FTTP	0 yr	2 yr	4 yr	6 yr	8 yr
	$'000	$'000	$'000	$'000	$'000
10% discount rate	7	3.5	1	1.5	3
5% discount rate	9	6	3	0	2
3% discount rate	10	7	4	1	2
0% discount rate	12	9	6	3	0

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Table 6b – Comparing FTTN and FTTP impact on a household over 20 years; where early FTTN gives 1% p.a. boost to household GDP.

Years delay FTTP	0 yr	2 yr	4 yr	6 yr	8 yr
	$'000	$'000	$'000	$'000	$'000
10% discount rate	7	1	4	7.5	11
5% discount rate	9	3	2	7	11
3% discount rate	10	4	1	6	11.5
0% discount rate	12	6.5	1	5	11

Table 6c – Comparing FTTN and FTTP impact on a household over 20 years; where early FTTN gives 2% p.a. boost to household GDP.

Years delay FTTP	0 yr	2 yr	4 yr	6 yr	8 yr
	$'000	$'000	$'000	$'000	$'000
10% discount rate	7	1	8	14	18
5% discount rate	9	0	7	14	20.5
3% discount rate	10	1.5	6.5	14	21
0% discount rate	12	4	5	14	22.5

What is apparent from Tables 6a to 6c and Figure 1 is that:

- at 2% p.a. impact on household GDP, FTTN is preferred (shown in white), even with short delays, except at low discount rates.
- at 1% p.a. impact on household GDP, FTTN is preferred (shown in white), , so long as delay to install FTTP is four years or more.
- at 0% impact on household GDP, FTTP is preferred (shown in grey), at up to six years delay at low discount rates, and at four years delay at any discount rate.
- the boundary is only slightly changed when you take into account replacement of FTTN with FTTP (shown in pink).

In Appendix 5, the NPV for FTTP and FTTN, individually, are both shown. Since these figures in Appendix 5 are all positive, it shows that FTTP and FTTN projects are worth pursuing in their own right, regardless of comparison.

The reliability of these assessments is based on the validity of the financial costs, operating costs and revenue still making sense over the next 20 years. There is large

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uncertainty over whether FTTN revenue could be sustained over 20 years without significant loss of customer satisfaction, as FTTP speeds would likely have increased significantly beyond what FTTN is capable of.

Visualising FTTN and FTTP impact on a household over 20 years

Figure 1 below shows a data visualisation of the sixty combinations modelled in Tables 6a to 6c, some which show a higher result for FTTN (in blue) and others which show a higher result for FTTP (in orange).

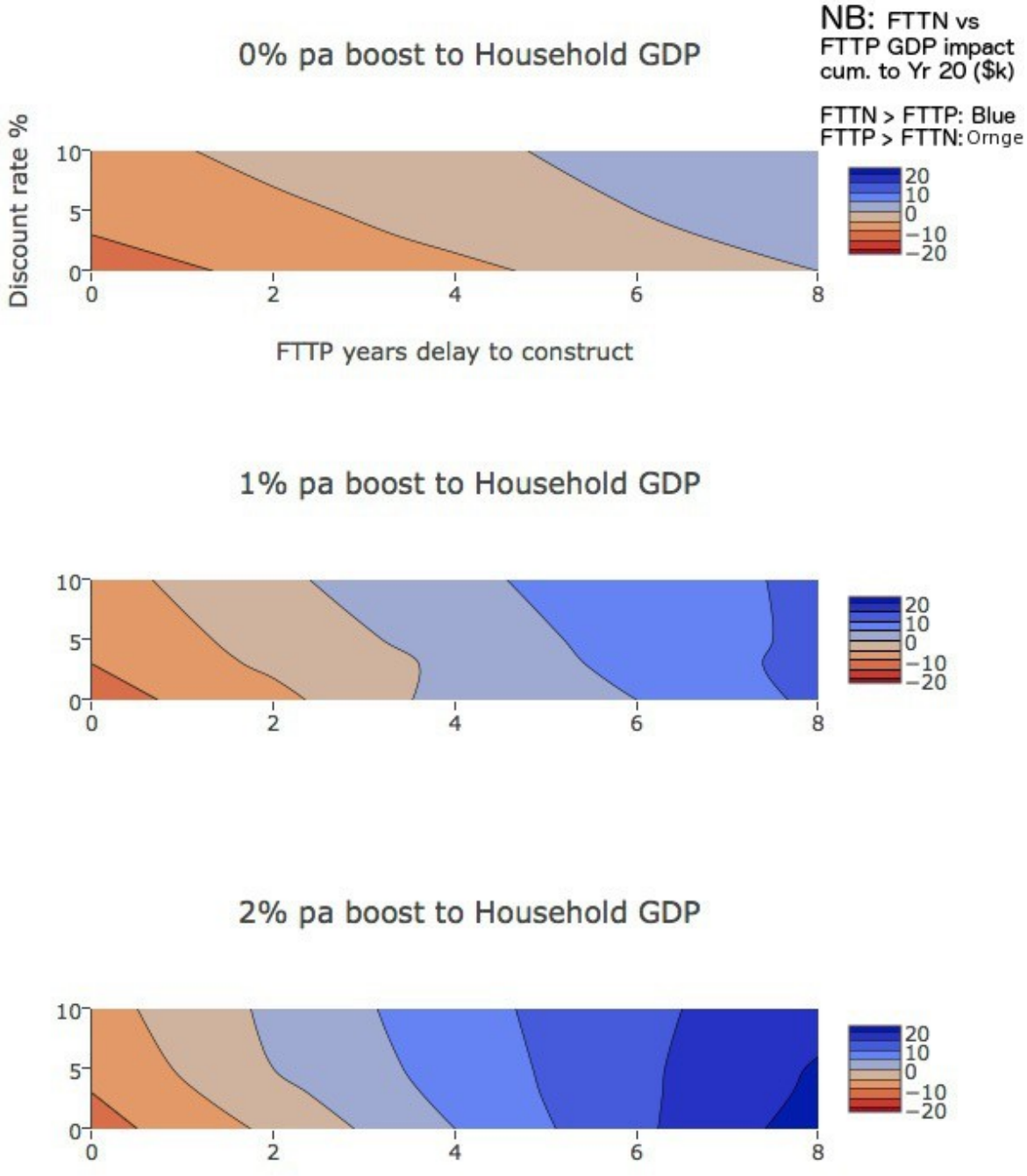

Figure 1 – Heatmap showing assumptions preferring FTTN (blue) and FTTP (orange) – Ferrers (2016a)

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An updated heatmap diagram including cost of FTTN replacement with FTTP (per Appendix 7) is available at Ferrers (2016c).

Figure 1 above shows that assumptions can justify either FTTN (including replacement cost) or FTTP. This result seems to fly in the face of much analyst commentary, which focuses only on the technical advantages of FTTP.

The value model, as demonstrated, is openly available (Ferrers 2016b) for improvement or enhancement. One improvement might account for new applications possible on FTTP, and potential declining user satisfaction on slower FTTN services. In the next section, I seek to extend the value model with a tool that allows adding value dimensions, and to include different weights to the importance of those dimensions.

Extending a value model of FTTN and FTTP

This section proposes an enhancement to the above value model, taking into account a number of non-financial dimensions. Weightings are also given to dimensions to suggest their relative importance. Readers are invited to submit their further dimensions and weighting through an online survey. Such a survey could show how value dimensions for the FTTN and FTTP vary over time, and around Australia. I also provide a couple of visualisations that express the multi-dimensional models: through

(1) a radar chart which shows many dimensions; and
(2) an Aster chart, which also allows the weighting of dimensions.

Table 7 below indicates the author's assessment of several FTTN and FTTP value dimensions, and their relative importance. I also make an overall value assessment which seeks to state my overall value position towards FTTN and FTTP.

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Table 7 – Comparing value of FTTN and FTTP on multiple value dimensions.

Note: Author's assessment and weighting of FTTN and FTTP value dimensions, and ratings noted as stars (* low to *** high value). More detail of dimensions – Appendix 3.

Value dimensions	Weight	FTTN	FTTP
Installation cost per household	25	$2,100	$4,400
Future capital expenditure (CAPEX) improvements	10	80% of $4,400 sometime (Vertigan 2014)	5% of $4, 400 for significant speed improvements (Senate Committee 2015)
Time to rollout	25	Quick (0-3 yrs)	Slow (+6-8 yrs)
Life of asset	25	Shortish	Long
Operating Costs (OPEX) (for 350,000 premises)	10	$150M pa	$125M pa
Revenue (for 350,000 premises)	10	$175M pa	$275M pa
Current Need	10	***	***+
Future Need	25	*	***
Reliability	25	**	***
Equity	10	**	***
Simplicity (new admin systems)	0	*	**
Beauty (digging up lawns)	5	**	*
Unknown Unknowns	25	**	*
Author's value assessment	Overall, even though FTTP has higher benefits logically to me, I value the quicker FTTN rollout to avoid the unknown unknowns, over the FTTP benefit of lower longer term costs. However, I am concerned that if the FTTN is left in place for a long time, its value will quickly diminish. So, I prefer FTTN, but subject to a commitment to switch to FTTP in a timely manner. However, my value assessment is subject to change with new information. Ideally, I prefer the disagreeing parties to agree on a joint plan to reduce risk, for instance implementing FTTC, or a commitment to retire FTTN progressively after 10 years.		

As can be seen from Table 7, FTTN and FTTP can be compared along multiple value dimensions. Many FTTN and FTTP value dimensions are non-financial dimensions. I use the example above of the author's value assessment, not to provide a correct answer, but to showcase two helpful tools to visualise the multiple dimensions of FTTN and FTTP. My value assessment is visually displayed in Figure 2 and Figure 3 below, where the differences between FTTN and FTTP become visible.

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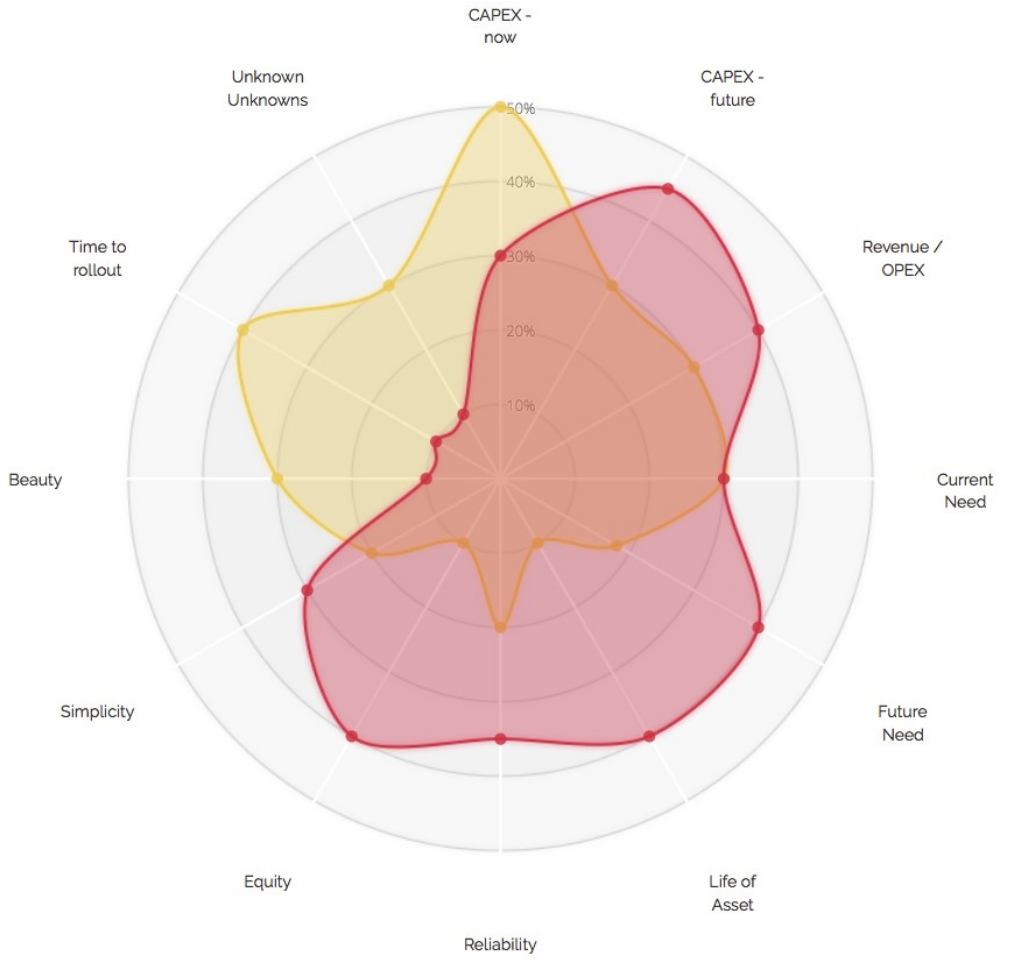

Figure 2 – Comparing FTTN and FTTP on multiple value dimensions (Radar Chart)

Note: Closer to edge indicates increased value. FTTN shown as Yellow, FTTP as Red.

Table 7 can be conveniently displayed as a Radar Plot (Ferrers 2016d). The plot shows on some dimensions FTTN is preferred (closer to edge) and on other dimensions FTTP is preferred. Assuming dimensions are weighted evenly, if FTTN or FTTP has a greater area on the chart, this means that it has a higher value. According to value theory, dimensions can be traded off, one against the other, but there is no rational basis for this, so it is done on an intuitive or emotional basis.

This is an 'apples and oranges' problem. Apples and oranges are measured on different scales, as are nearly all the dimensions on the radar plot (excepting revenue and CAPEX). Overall, you can see the pattern of contrasting value dimensions of FTTN and FTTP. A weakness of the Radar plot is that each dimension is given the same weighting. This, we fix in the second tool, shown in Figure 3.

An alternative to the Radar plot is the Aster plot (Ferrers et al. 2016), which enables a weighting for the value dimensions. In Figure 3, I use the weightings of Table 7, to display and contrast the value of FTTN (left side) and FTTP (right side). In the Aster chart, closer to

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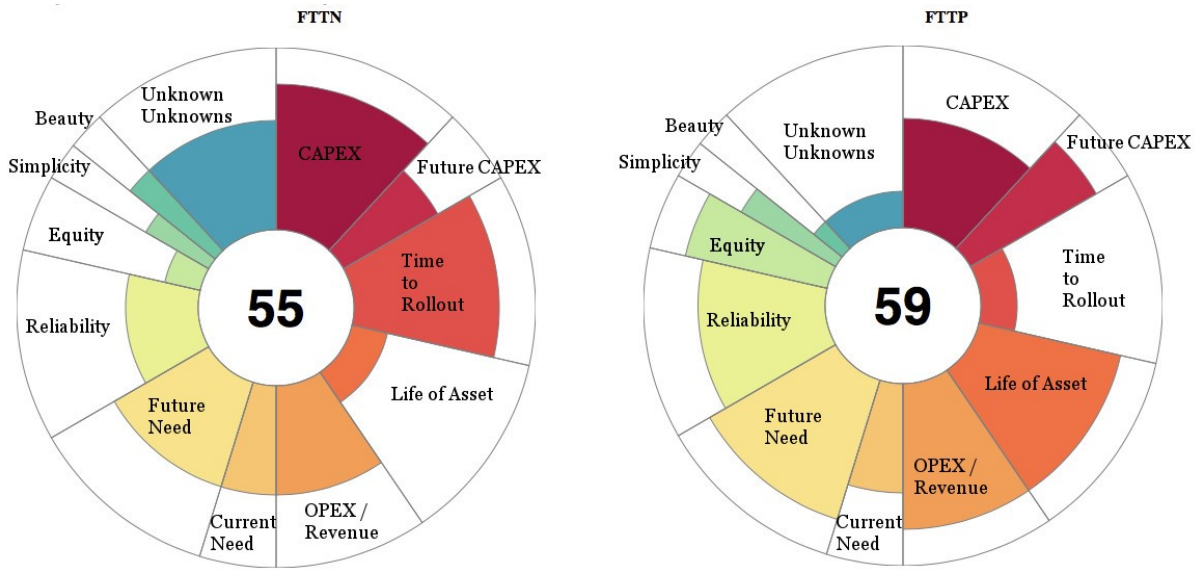
the edge and a larger slice of pie, indicates higher value. The range of 12 value dimensions is indicated with different colours. Extra dimensions can easily be added, as well as weightings adjusted. It is easy to see how FTTN wins (larger piece of pie) on some dimensions, such as capital expenditure and time to rollout, while FTTP wins on other dimensions, such as life of asset and reliability. An overall value rating, shown in the centre of the Aster plot indicating overall value favours FTTP, but not by much.

A reader can download this chart from Ferrers (2016e) and add their own dimensions and weightings, to come to their own FTTN and FTTP value assessment. You can share your FTTN and FTTP value dimensions, and your weightings (including postcode) at Ferrers (2016f).



Key: Weight	Value Dimension
25	CAPEX: Installation costs
10	Future CAPEX: Improvements
25	Time to rollout
25	Life of Asset
20	Operating Costs / Revenue
10	Current need
25	Future need
25	Reliability
10	Equity
5	Simplicity
5	Beauty
25	Unknown Unknowns

Figure 3 – Aster plot of multi-dimensional weighted value dimensions of FTTN (left) and FTTP (right)

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Conclusion

In this paper, I have analysed FTTN and FTTP using a value approach. A value approach assumes value shifts with new information, where many dimensions compete for importance, new dimensions may arise and weightings shift, giving rise to new attitudes. For instance, new techniques, such as NG-PON2 may massively increase FTTP data throughput and hence reduce cost per unit of data. This paper seeks to add a new value perspective to potentially shift the FTTN and FTTP value assessment for Ministers and voters. While Coalition Ministers prefer short term benefit and hence FTTN, ALP Ministers prefer long term benefit, and hence FTTP. Which is better, now or the future is a value question so the two views are 'incommensurable'. Figure 1 shows both FTTN and FTTP are financially justifiable at up to 20 years from now, though FTTN is much more limited in its technical capacity.

I have provided above two alternative dynamic approaches to valuing FTTN and FTTP. The first is a financial value model, open and public, where a user can amend the assumptions and explore or add to the financial dimensions. A second approach adds non-financial dimensions to the analysis, such as future needs, reliability, equity and unknown unknowns. The two data visualisations of the second approach allow a complex view of FTTN and FTTP to be visually presented and compared.

Ultimately the choice between FTTN and FTTP becomes a choice between which analysis variables that you, the reader, are prepared to commit to, set as a priority, and what weight you will give to each of these variables. You can share your weightings in an online survey at Ferrers (2016f). I urge you to use these tools to discover what you prefer, what you value more, and what value dimensions are of importance to you in regards to FTTN or FTTP.

Table 8 – Summary of significant FTTN FTTP value dimensions (more in Appendix 3)

Type of Value	FTTN	FTTP
Benefits	Cheaper in the short term Quicker to rollout Fast enough in short term	Faster by far Cheaper in the longer term Long lived asset
Problems / Risks	Needs to be replaced soon Higher maintenance and replacement costs	Not sure what to use speed for Slower to rollout
Overall value:	Quick wins Fast enough, cheaper now, sooner in use.	Build for the future Do it once, Do it right.

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Appendix 1: FTTN vs FTTP vs Skinny Fibre FTTC

Table A1 – Fibre to the Curb compared to FTTN FTTP

	FTTN	FTTC	FTTP
Fibre reaches to	Node	Curb	The home
Speed	Up to 100Mbps	Up to 1000Mbps	Up up up
Install cost	$2,100 per household	Unknown	$4,400 per household
Maintenance	Medium/uncertain	Low	Low
Revenue potential	Medium/Low	Medium/High	Medium/High
Reliability	Medium	High	High
Useful Life	Short/Medium	Medium / Long	Long
Ease to upgrade	Low	Medium	High
Cheap to upgrade	No	Middle	Yes

Note: According to the NBN Co CEO at Senate Enquiry in May 2016, while NBN Co has been trialling Fibre to the Curb for some twelve months, to date, there is only one working installation of the technology. This suggests Fibre to the Curb is quite some way from working at scale.

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Appendix 2: What is a value theory of innovation?

A value theory of innovation was developed looking at consumers buying smartphones. Consumers expressed value in 80 different ways about their smartphones, and these value elements were expressed as 12 value dimensions. This analysis of the FTTN and FTTP tests these same 12 value dimensions in a new technology domain to provide confidence in the validity of these value dimensions. Other value dimensions may appear in different technologies.

Value in theory

- Value is subjective (though in other theories objective); personal, so depends on perspective. See an examination of the consumer value literature in Ferrers (2013) Section 7.6 and innovation value literature in Section 7.1.
- Value is dynamic; moves with new information.
- Value is complex; multi-dimensional (see Table 7).
- Value is financial, social, emotional, personal.
- Value is a trade-off between competing dimensions: time, cost, quality, future-proofing, function (speed), reliability. See Ferrers (2013), Appendix 5.
- Value is measurable, though it is unclear what units can compare competing dimensions. Emotion as a possible common currency of value.
- Value is simple. Regardless of underlying complexity, value is compressed into a vector showing strength and direction: strongly/weakly, negative/positive, and expressed as an attitude.
- Value is not comparable rationally across value dimensions, but can be compared and summarised emotionally as an overall attitude. See an example in Table 7. One cannot rationally compare beauty and power, time and cost, simplicity and emotion, novelty and community, or any of the other 60 combinations across 12 value dimensions.

Source: Ferrers (2013).

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Appendix 3: FTTN and FTTP value dimensions – non-financial

Table A3 – FTTN and FTTP value dimensions – non financial

	FTTN	FTTP
Current / Future needs	Serve current needs well	Suitable for future applications
Time	The short term	The long term
Community	Liberal Coalition, Telcos	ALP, Academics, Technical Enthusiasts
Equity	Service depends on distance from exchange. Can be congested since shared medium.	Congestion only due to CVC provisioning. Distance does not impact service quality.
Reliability, Service	Moderate reliability Very easy to install. Potential for unreliability through water damage or age.	High reliability But challenges during installation, such as damaging cabling.
Novelty, Power	Faster	Fastest
Simplicity, Emotion	Simplicity: complex system for NBN to manage multi-network types, i.e. HFC, FTTN, FTTP	Simplicity: single system Emotion: petition 275,000 to Parliament to keep FTTP
Beauty	Invisible (using phone lines)	Underground (trenching), impact on gardens
Duty	At least 50Mbps to 90% of households with fixed lines as soon as possible	93% of households with fixed lines to get FTTP

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Appendix 4: A more exhaustive list of Pros and Cons

Table A4 – A more exhaustive list of FTTN FTTP Pros and Cons

Type of Value	FTTN	FTTP
Benefits	• CAPEX less (NBN) "lowest cost" -> more affordable ($6.3B for 3.7M hh) $2100/hh. Net benefit $18B vs FTTP (Vertigan 2014). • Quicker to rollout (ABC 2015); "as soon as possible" (Turnbull & Cormann 2014); (6-8 yrs: NBN 2016, 18) • Provides option for upgrades (option value) • Sufficient for median demand at 2023; 15mbps. (Vertigan 2014) • Capable of 50-100mbps (20-50 mbps down), for 80% of premises. Good enough speed (Vertigan 2014) • FTTN should support 100mbps over short copper within a few years (Liberal Party 2012). • No need to dig across lawns. • Early GDP impact makes worthwhile at 0,1,2%/hh/yr • Good for Telstra to extend life of copper. • Users (> 50%) buying NBN at FTTN capable speeds currently (Vertigan 2014)	• Faster; more than 10x (or more) than FTTN eg NG-PON2 (Gregory 2015) • Future proof; longer lifetime use (N=30 yrs) • Cheap to upgrade speed (5% CAPEX) (Senate Committee 2015) • Cheaper OPEX (NBN) (LeMay 2015a) • More revenue (NBN) (LeMay 2015a) • Fairer, no slower speed on distance from exchange, all get same service • Countries aspire to FTTP speeds in plans. (OECD 2015a, 21-23) • Some countries fast rollout FTTP (NZ) • Carriers rolling out more FTTP (AT&T, Verizon, Google) • Petition; 270k supporters of FTTP to Parliament (LeMay 2014) • No power required between exchange and home (passive)

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Type of Value	FTTN	FTTP
Problems	• Shorter life (perhaps less than 10yrs) - already obsolete • When/if replace with FTTP then only 20% of FTTN CAPEX reuseable on FTTP (Vertigan 2014) • Maintenance /remediation costs; higher/unknown • Contention, congestion at peak time • Power required at nodes, so slower to install and more expensive to run, more to maintain • Slower the further from exchange; 50% at 500m, 75% slower at 1000m. Impact on 20% of households. (Vertigan 2014, 46). • Slower upload speeds. • Countries replacing FTTN with FTTP eg NZ.	• Install costs more $4400/hh; (NBN 2016) • 6-8 years longer to rollout (NBN 2016) • No demonstrated apps for fastest speeds. (Liberal Party 2012) • No willingness to pay more for fastest speeds (>100Mbps) (Vertigan 2014) • Only 14 countries have more than 10% FTTP (OECD 2015b) • Need to dig up gardens to install. • Something better might come along - Telstra 4G at 1Gbps
Slogan	"deliver fast, affordable and reliable broadband years sooner" (Liberal Party 2012, 6) "ensuring all Australians have access to very fast broadband as soon as possible, at affordable prices, and at least cost to taxpayers… at least 50mbps to 90% of fixed line premises… upgrade paths as required" NBN Co Government expectations (Turnbull & Cormann 2014, 1-2)	"Do it once, do it right, do it with fibre" Tony Windsor 2010 (Taylor 2014)
International comparison (see Appendix 8)	NZ rolled out FTTN, switched to FTTP. Only two countries spending more (in total) than AU; US $45B over 10 yrs, Sth Korea $25B. But US has 321M population, Sth Korea has 49M population. No-one is spending more per household than Australia. Many countries (at 2014) rolling out FTTN; including Sth Korea, US, Germany, UK, Sweden. All countries except AU (FTTP) and Singapore allow infrastructure competition.	NZ rolled out FTTN, switched to FTTP.

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Appendix 5: GDP NPV totals, shown net in Table 6a, b, c.

Table A5.1 – Comparing FTTN and FTTP impact on a household over 20 years; where early FTTN gives 0%, 1% or 2% boost. Discounted Interest at 0%.

Note: Shaded column indicates better outcome.

GDP	Delay = 0 yrs		2 yrs		4 yrs		6 yrs		8 yrs	
Yr20	FTTN	FTTP	FTTN	FTTP	FTTN	FTTP	FTTN	FTTP	FTTN	FTTP
	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000
0%	20	32	20	29	20	26	20	23	20	20
1%	20	32	23	29	25	26	28	23	31	20
2%	20	32	25	29	31	26	37	23	42	20

Table A5.1 – Comparing FTTN and FTTP impact on a household over 20 years; where early FTTN gives 0%, 1% or 2% boost. Discounted Interest at 10%.

Note: Shaded column indicates better outcome.

GDP	Delay = 0yrs		2		4		6		8	
Yr 20	FTTN	FTTP	FTTN	FTTP	FTTN	FTTP	FTTN	FTTP	FTTN	FTTP
	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000
0%	9	16	9	13	9	10	9	8	9	6
1%	9	16	12	13	14	10	15	8	17	6
2%	9	16	14	13	18	10	21	8	24	6

Source: Ferrers, R. (2016g).

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Appendix 6: NBN by the figures

Table A6 – NBN Corporate Plan (NBN 2016) Summary, p.60, p.67.

Year	'15	'16	'17	'18	CAPEX '16-18	$CAPEX/hh** '16-18	$/hh p.67
Premises Passed	'000	'000	'000	'000	$B	$	$
FTTN	-	500	2,035	3,745	6.3	$1,682	$2,300
FTTP - brown	708	1,080	1,270	1,515	2.5	$3,097	$4,400
FTTP - green	189	260	370	505			
HFC	-	10	875	2,350	2.6	$1,106	
Other (eg Satellite/wireless)	316	782	892	947			
Total	1.2M	2.6M	5.4M	9M			

NB: CAPEX = installation cost; hh = households/premises; Passed = infrastructure in place, but not necessarily connected.

Note: ** Does not include Infrastructure lease costs, ie pits and pipes.

See Table 8 (p.67) in NBN Corporate Plan (NBN 2016), which shows FTTP at $3,700 per household, which suggests $0.5B spent in 2015 relates to 2016-18 connections, plus infrastructure lease ($700 per household); Total $4,400 per household.

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Appendix 7: Cost of Replacing FTTN with FTTP (Yr 10, Yr 20)

The original analysis (Ferrers 2015) uses $4,400 as CAPEX for FTTP (and NBN 2016, p.67). Vertigan (2014) suggests 20% of FTTN investment could be reused for FTTP. A substantial portion (say 60%) of FTTP is a labour cost which could rise with inflation at 2, 3, or 5% pa. What would $4,400 spent in 10 or 20 years, adding in labour inflation, discounted (Wikipedia 2016b) to today's dollars at interest rates used in the above analysis, be worth now? Model at: https://dx.doi.org/10.6084/m9.figshare.2008689.v9

Table A7.1 – Cost to replace FTTN with FTTP at Yr 20, given Labour Inflation and Discount Rate

Note: A 20% saving on FTTP from FTTN reuse, per Vertigan (2014); $3500 CAPEX.

Labour Inflation	0%	2%	3%	5%	Median
Installation Cost	$'000	$'000	$'000	$'000	$'000
Discount Rate 10%	0.5	0.7	0.8	1.0	Say 1.0
5%	1.3	1.7	2.0	2.6	2.0
3%	1.9	2.5	2.9	3.9	3.0
0%	3.5	4.5	5.2	7.0	5.0

Table A7.2 not analysed in text, so is provided for information only.

Table A7.2 – Cost to replace FTTN with FTTP at Yr 10, given Labour Inflation and Discount Rate

Labour Inflation	0%	2%	3%	5%	Median
CAPEX	$'000	$'000	$'000	$'000	$'000
Discount Rate 10%	1.4	1.5	1.6	1.9	1.5
5%	2.2	2.4	2.6	3.0	2.5
3%	2.6	3.0	3.2	3.6	3.0
0%	3.5	4.0	4.2	4.8	4.0

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Appendix 8: International Broadband Strategies

Table A8 – Comparison of International Broadband strategies including FTTN and FTTP

Who?	$Govt investment	$/hh*	Infrastructure Competition	Services Competition	FTTN	FTTP
High $ per household						
Aust: Labor	$30B	$3,125	N	Y	nil	93%
Aust: Coalition	$29.5B	$3,072	Y	Y	mainly	15-25%
Sth Korea	US$25B	US1,275	Y	Y	60%	40%
NZ	NZ $1.7B	NZ1,062	Y	Y	some	75-80%**
Medium						
France	EU12B	EU451	Y	n/a	SOME	mainly
Singapore	S$1B	S$438	N	Y	nil	100%
US	$45B 10yrs	$350	Y	n/a	34%	66%
Low						
Germany	EU4.5B	EU138	mainly	Y	63%	37%
Sweden	SEK250M	SEK63	Y	Y	44% FTTx	44% FTTx
Finland	EU132M	EU60	Y	Y	n/a	mainly
UK	GBP1.1B	GBP42	Y	Y	75%	25%
Others to include?						Canada China Indonesia

Source: Table G.1,G.2,G.3,P.158-164, Vertigan Report 2014; ** Crown Fibre Holdings Limited (2016).

Source: Population (CIA 2016): est '15: Germay 81M, Sweden 10M, Sth Korea 49M, US 321M, UK 64M, New Zealand 4M, Australia 24M, France 66.5M, Singapore 5.7M, Finland 5.5M.

NB:* Assumes 2.5 persons per HH (household). $/HH - Author calculation.

Notes:

1. Infrastructure competition everywhere, except Singapore, Labor NBN. (Orange exceptions)

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2. High proportions of FTTN common.(indicated in Yellow)
3. Australia has highest per household government investment, by either party. (indicated in Blue)
4. Majority FTTP is approaching a majority eg Singapore, Finland, with much smaller investment, and recently New Zealand, US, France. (indicated in Purple)
5. Australian has highest government investment in world, except for US, South Korea, with in excess of 2-10 times Australia's population.

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Appendix 9: Value Dimensions from Ministers' Speeches – CommsDay Summit 2016

Table A9 – FTTN vs FTTP: Value dimensions of Fifield and Clare Speeches (CommsDay 2016)

	Minister Fifield (Coalition)	Shadow Minister Clare (ALP)
Positives of their policy approach	• Affordable ie less installation costs • Ubiquity (all in rollout) • Flexible - Technology agnostic, so could take advantage of skinny fibre • Meeting current mainstream needs ○ 30 to 50% takeup of VDSL indicates "exceed mainstream needs" in Belmont NSW • Faster time to rollout • Improve Aust. performance in international rankings	• FTTC 10x FTTN speeds (New speed)
Negatives of alternative approach	• Slow to deploy (FTTP) • Expensive (FTTP) • Consumers not willing to pay for fastest speeds (>100Mbps) (MTM) ○ Most consumers choose 25Mbps or less (MTM) ○ Very few consumers paying for 1000Mbps - implication CVC problem • Inflexible FTTP technology approach	• Rising cost of FTTN (from $600 to $1600 per household) • Delays rolling out FTTN (from completed in three years(2016), to 30k premises active in three years, now due for completion 2020), due to: ○ Negotiating with Telstra ○ Power connections • Congestion on FTTN at peak times eg 100Mbps connection getting <1Mbps (reliability) • New tech (FTTC) speeds 10x FTTN; skinny fibre • AT&T switching from FTTN to FTTP (community) • Not prioritising underserved areas (equity)
Value dimensions not mentioned	• Asset Life of FTTN (time) • Future needs • Best speeds on FTTP • Simplicity of single system FTTP • Equity of service on FTTP (no congestion)	• Willingness to pay for faster speeds (function / price) • Impact of CVC on high speed services (price) • Likely rollout delays in FTTP • Higher CAPEX Cost to rollout FTTP • Other high FTTN rollouts (Appendix 8)

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Value dimensions mentioned	• Flexible on which tech • Fast enough services to meet current needs • Fast rollout to reach users quickly • Lower cost rollout • Improve International Rankings	• Rising costs, delay • New tech increasing speed for users (FTTC) • Equity of access • Reliability of FTTP to deliver advertised speeds • International comparison (AT&T)

Source: Fifield (2016), Clare (2016).

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Appendix 10: Value dimensions from Expert Reports

Table A10 – FTTN vs FTTP: Value Dimensions from Expert Reports

	FTTN	FTTP
Expert Report	Vertigan (2014)	McKinsey & Co (2010)
Focus	Cost / Benefit	Affordability (more use, p.110) Entry level price same as for ADSL (price, p.110) Maximise take-up; same price for twice the speed ie 25Mbps vs 12Mbps (more speed, p.110) Remove data caps (more data, p.260) Competition at services layer (more services, p.260) Extend FTTP to 93%
Strengths	Reasoned economic argument Cost Benefit analysis	Focuses on value creation, including affordability, reliability rather than up-front cost (CAPEX).

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	FTTN	FTTP
Expert Report	Vertigan (2014)	McKinsey & Co (2010)
Weaknesses	Model calculations not provided, only totals. Some details removed because commercial in confidence. Business benefit estimate at 50% more than consumer benefit (p.78). (low benefit) Public benefit estimated at 5%, private benefit 95% ie willingness to pay (WTP, p.17) => Only upgrade to FTTP when private benefit (WTP) justifies replacement cost. Assumes compression improves at 9% pa, so more data without line speed increase (p.77) No benefits for 20% households without internet (p.69). (low benefit) 2% p.a. increase in demand for speed. (p.189) Panel estimates FTTP Operating cost 100% greater than NBN Co. (p.56-7), and removed $4B of NBN Co installation cost savings for FTTP (p.56-7). (high cost) Significant criticisms noted by Gregory (2014) and Senate Interim Report (Senate Committee 2015), Ch.4. Criticisms Include: the report is not fully independent, such as from the Productivity Commission, the panel includes strong NBN critic, such as Prof. Henry Ergas.	More on how than why Not a cost benefit analysis, so no financial forecasting, cashflows, or return on investment.
Key Uncertainty	Growth in demand for high speed broadband (p.13) Willingness to pay (WTP) for >50Mbps (p.17)	
Summary - value types	• Use years sooner • No new needs/apps • No WTP for highest speeds • Low business and public benefits	• Social/national benefits • High use of data • Faster use • More services (competition)

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