Final report for InternetNZ

Broadband Strategy Options for New Zealand

Analysis of possible infrastructure models

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NETWORK STRATEGIES
• Telecommunications Strategy •

0 Executive summary

Achieving affordable very high-speed broadband connectivity (with an InternetNZ target of 100Mbit/s for domestic users and 1Gbit/s for commercial users) for 75% of New Zealand's population within ten years will require a substantial capital investment. This study uses techno-economic modelling to estimate the required investment under a number of different technology, business and market scenarios.

The following business models were examined:

- the lit-fibre (Layer 2) fibre to the premises (FTTP) operator that provides Ethernet services (using either GPON or active Ethernet technologies), and has to build its network from scratch
- the 'Layer 0' provider that provides an open access structure-only (duct) network
- a 'Layer 1' provider that provides unlit fibre in a GPON architecture (rather than a point-to-point topology)
- the utility expansion model where a utility uses existing ducts and poles to deploy fibre (and offers Layer 2 services).

Note that these FTTP models are not based on an extension of Telecom's ADSL2+ cabinetisation and do not rely on use of the Chorus network fibre and ducts.

The total investment requirements for the various business models (Exhibit 0.1) indicate the level of significance of the costs of trenching and installing ducts. Any network that can avoid these costs – such as in the utility expansion model – will realise significant cost savings. Note, that with respect to the utility expansion model it is assumed that existing ducts and poles are used to deploy fibre for 50% of the network.

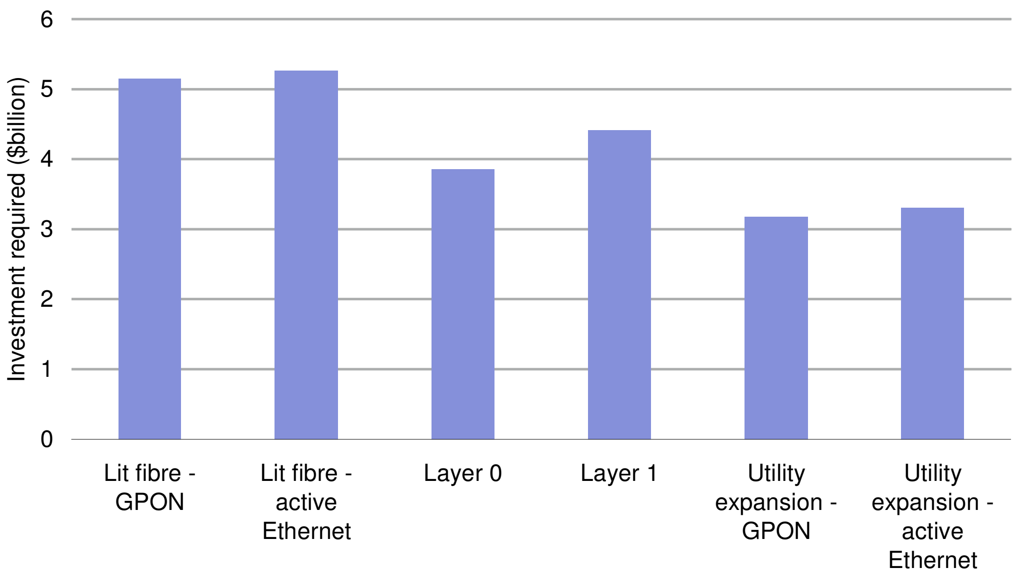

Exhibit 0.1: *Total investment required, by business model [Source: Network Strategies]*

In addition we modelled an extension to Telecom's current cabinetisation rollout based on a fibre to the node (FTTN) architecture. This scenario takes Telecom's plans one step further: rather than using ADSL2+ (with a theoretical maximum of 24Mbit/s), it uses VDSL2 which has a theoretical maximum data rate of 250Mbit/s. It is important to note that while significantly cheaper than FTTP, a FTTN/VDSL2 network is dependent on a legacy copper network that is likely to be unable to provide the required services to a large proportion of homes.

Exhibit 0.2 shows the investment required per premise passed[1] (excluding per-premise costs), and per customer connected[2] (including per-premise costs and assuming a 'premium' 30% take-up scenario), for each technology type. The investment per premise passed for FTTP is about $2000, while the cost of FTTN/VDSL2 is considerably lower, at approximately $500.

1 Network investment divided by the number of premises that are within network coverage

2 Network investment divided by the number of customers

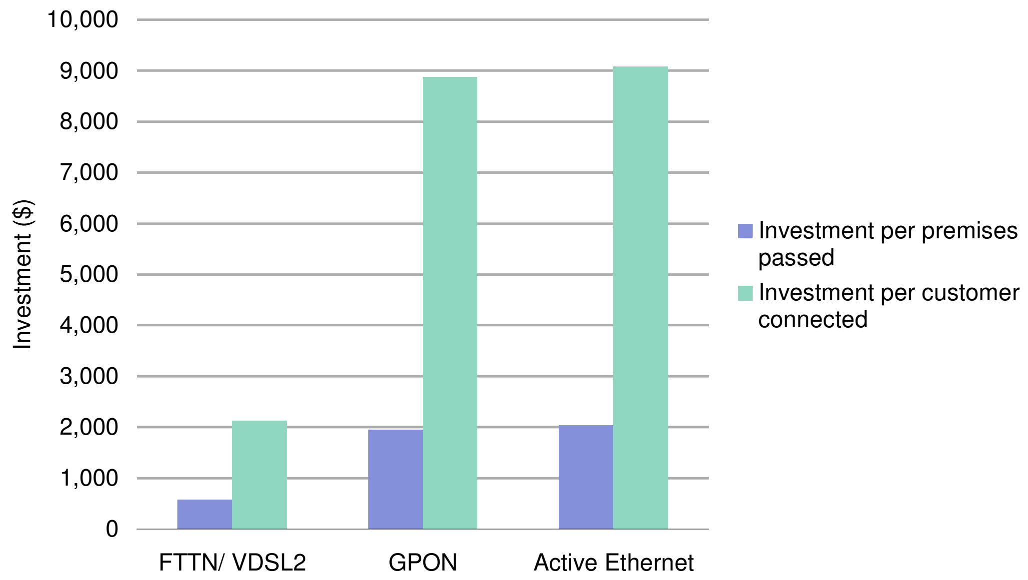

Exhibit 0.2: *Investment per premise passed [Source: Network Strategies]*

So what level of government investment might make our business models workable? For each of the technologies, we treated the level of government investment in a Public Private Partnership (PPP) arrangement as a grant and assumed that the payback period of the private investor's contribution to the network should be fifteen years or better. When we examine the government investment required to enable a 15-year payback (Exhibit 0.3) we see that while the private contribution is similar across scenarios, much less government investment is required for the utility expansion scenarios than the greenfields deployment. (Note that Layer 0 and Layer 1 were not included because this model does not calculate the revenue of a Layer 0 or Layer 1 network.)

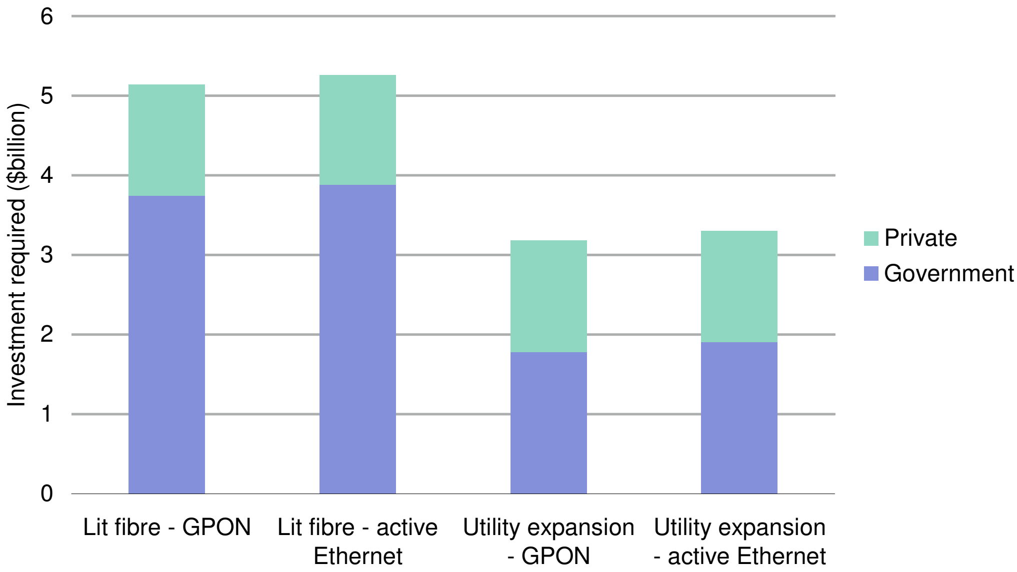

Exhibit 0.3: *Government investment required, by business model [Source: Network Strategies]*

From our results we note that a full overlay FTTP network will cost more than $5.0 billion. Government investment of about 75% would be required for an operator to obtain a payback within 15 years at the 'premium' take-up scenario. A FTTN/VDSL2 network based on Telecom's copper network would require very little funding to achieve payback within this period, but Telecom would require a much shorter payback period and as already noted this type of service may not deliver the required speeds to many homes.

The utility expansion model appears extremely financially attractive compared to a completely new overlay network. As already noted, the lower total investment requirements of the utility model are driven by the fact that the cost of the network is very sensitive to the structure costs (trenches, ducts and overhead poles).

Our modelling establishes that without public sector intervention the significant level of required investment is beyond that of any commercial operator expecting a payback within a short- to medium-term time horizon. One of the main advantages of the PPP approach is that public sector goals may be achieved with the assistance of private sector expertise. In

New Zealand there is considerable evidence that local Government has a key role to play in PPPs from a number of sources, including existing and emerging initiatives, engagement in application processes for public broadband funding and its role in facilitating infrastructure deployment processes.

Our business modelling indicates that the utility expansion approach has considerable potential for the widespread deployment of high-speed fibre-based broadband networks in New Zealand, similar to networks in Denmark and Sweden. To be more specific in the New Zealand context, it is the electricity lines companies that offer this potential as these entities have existing resources and infrastructure that offer synergies with the telecommunications business that could ultimately lower deployment costs. There are already examples of lines companies engaging in expansion of their businesses into telecommunications in New Zealand which could in fact be regarded as pilot projects. In general these projects are still in their infancy with limited deployment as yet. Furthermore, it was clear that public investment may have a key role in making the business case succeed in areas in which a commercial case for rollout cannot be established, and it may lead to faster deployment than would otherwise have been the case. This applies to both areas in which lines companies are already active and areas in which lines companies have not as yet extended into the telecoms business.

The modelling also illustrated the need for a long payback period due to the significant capital costs and the uncertain and potentially slow uptake. In New Zealand most of the lines companies are owned by consumer trusts. Assuming that there is strong local belief in the importance of broadband to the area’s economic and social well-being and development, this ownership structure would tend to be sympathetic to longer payback periods. Furthermore, in the electricity business assets typically have long lives and long payback periods, suggesting that the type of investment involved in broadband fibre deployment would fit well with the lines companies’ traditional business models.

Broadband Strategy Options for New Zealand

Final report for InternetNZ

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NETWORK STRATEGIES

1 Introduction

This report contains the results of the final stage of our research into broadband strategy options for New Zealand. We investigate workable models for a New Zealand Broadband Infrastructure (NZBI) consistent with InternetNZ's six key principles with respect to broadband strategy:

- The NZBI must be structured in such a way to ensure service providers can fairly compete to deliver services to end-users.

- The NZBI must be funded in such a manner that providers can offer affordable services to the majority in each end-user category (e.g. families, businesses, schools etc). For the purposes of the strategy, the 'majority' should be considered to be a target figure of 75%.

- The strategy must enable NZBI to be rolled-out to the majority of end-users within a timeframe that enables New Zealand to be a leader rather than a follower within this area of technology.

- The bandwidth available and affordable to the majority of end-users should be unconstrained for the current and foreseeable future. Current thinking is this would mean 100Mbit/s for domestic users and 1Gbit/s for commercial users.

- The development of the strategy should not be constrained by existing or proposed political policies, although pragmatically it is recognised that politics will affect its acceptability to the government of the day.

- The NZBI should avoid excessive duplication to ensure efficient usage of installed infrastructure and to maximise the infrastructure spread achievable from the funding available.

From our earlier research[3] it was apparent that different business models and intervention models for fibre deployment have been applied in a variety of markets around the world. In particular it was clear that:

- incumbent operators tend to deploy high-speed fibre broadband only when faced with effective infrastructure competition
- in a number of markets, infrastructure competition is not feasible, except possibly in certain, typically highly populated, areas
- open access to networks is seen to be crucial to ensure consumers obtain the benefits of competition in the absence of infrastructure competition
- some legal or regulatory intervention may be required to remove barriers to broadband expansion
- the choice of intervention model should be driven by factors specific to the local market, including (but not restricted to) the level of competition, the legal/regulatory environment and strength of local organisations.

We found that due to the lack of infrastructure competition for high bandwidth services in New Zealand, Government should consider an infrastructure provider or wholesale provider model. In terms of business models we identified that the following two models may be suitable in the New Zealand context:

- **public-private partnership** – with a number of different variants, and with different levels of participation
- **utility business expansion** – local utilities have already entered this market in New Zealand.

These models would be most likely to be successful over the entire target coverage area (namely 75% of the population). Other models (such as co-operatives) would be more

3 Network Strategies Limited (2008), *Broadband Strategy Options for New Zealand: Stage One Research and Analysis*, 20 September 2008.

suited to addressing small pockets of demand, where there are gaps in coverage not likely to be addressed in a timely fashion. This report examines in detail the public-private partnership and the utility business expansion models.

Following this Introduction, this report includes:

- the approach used for the second stage of the project (Section 2)
- an update of key initiatives proposed for New Zealand (Section 3)
- an examination of the public-private partnership approach (Section 4)
- an examination of the utility business model approach (Section 5)
- a discussion of technology and architecture options for a fibre network (Section 6)
- an analysis of the New Zealand market (Section 7)
- the results from our business case analysis, including discussion of the underlying assumptions (Section 8)
- recommendations and a roadmap for the next steps toward implementing the NZBI (Section 9).

In the Annexes we list the various people and organisations that provided us with assistance in our research, include a glossary of terms and abbreviations used, provide details of currency exchange rates used within our analysis and list successful expressions of interest for the Broadband Investment Fund.

2 Approach

2.1 Overview

To understand the economics of very high-speed broadband deployment in New Zealand requires detailed techno-economic modelling of technology and network costs (both capital and operating expenditure), and potential revenues. We have undertaken such modelling for the NZBI based on:

- an analysis of potential technologies and network architectures that would achieve InternetNZ objectives
- a market / service / economic analysis.

Our technology analysis considered the different network architectures that the NZBI could take, in addition to the effects they would have on the services provided and the future flexibility of the network.

The market analysis involved reviewing the potential market segments for broadband services, using judgemental demand forecasting to estimate the number of service customers by type and how this may vary over time.

Exhibit 2.1 illustrates our overall approach.

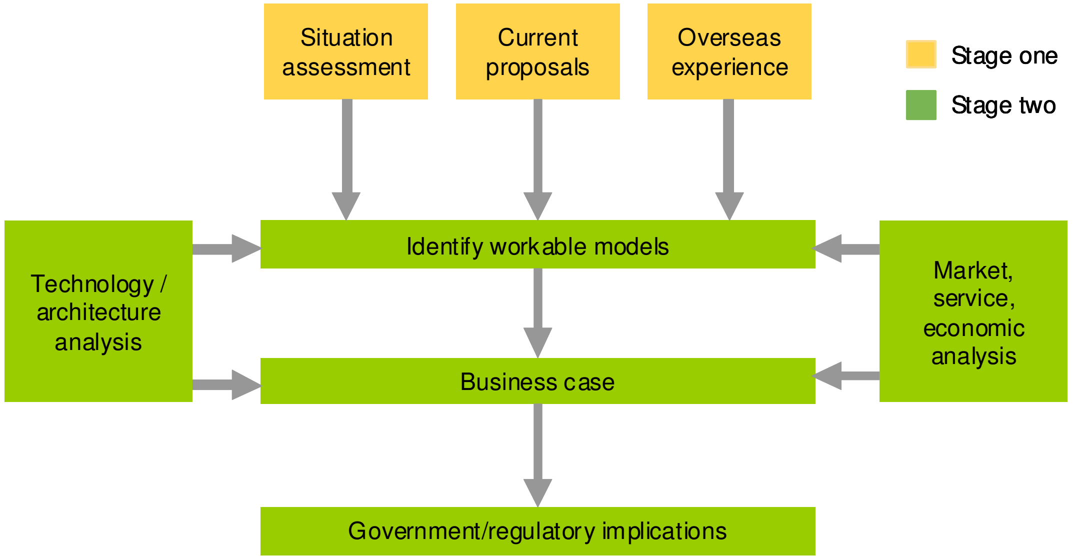

Exhibit 2.1: *Overview of project approach [Source: Network Strategies]*

We have adopted a high-level approach that seeks to scope ballpark costs based on average unit costs that would be appropriate for New Zealand. A sensitivity analysis has also been undertaken to identify key inputs and assumptions, and thus sources of any potential risks. In addition we compared the indicative costs against benchmark costs per home passed from overseas. While such costs will be influenced by local characteristics – in particular duct costs and population densities – they are a useful check on the results of our high-level cost model.

2.2 Stakeholder consultation

Our preliminary research for this project was based on desktop research with the review of a vast amount of literature within a relatively short space of time. This did not afford us the opportunity to undertake any discussions with third parties, either to obtain further or very up-to-date information about current proposals or initiatives or to raise key issues with relevant stakeholders. However, for this final stage of the research we have had an opportunity to engage in some stakeholder consultation, including some limited personal visits and telephone interviews encompassing the Ministry of Economic Development, the Local Government Association, the Commerce Commission and a representative selection of existing initiatives (including PPP arrangements and utility companies). This engagement has provided valuable information, input and feedback for the report and we acknowledge all participants in Annex A. We note that in ideal conditions the stakeholder consultation exercise would have extended further but this would have involved a further extension of the study timetable.

2.3 Currency conversion

Where we have quoted benchmark figures from overseas in the report we have used Purchasing Power Parity for currency conversion. Purchasing Power Parity is used widely by international and national telecommunications (and non-telecommunications) bodies that undertake international price comparisons. It is the ratio of the cost of a basket of goods in two countries, each calculated in that country's own currency unit. These costs reflect labour and other input costs, profit margins, indirect taxes and also, indirectly, capital costs. The use of Purchasing Power Parity enables the conversion of prices to a common currency unit, and at the same, adjusts for average cost differences between countries.

The rates that have been used within this report are provided in Annex C.

3 Analysis and update of current initiatives and proposals

3.1 Digital Strategy

The Digital Strategy 2.0, released at the end of August 2008, aims to support digital development in New Zealand over the next ten years. A significant part of this strategy involves broadband infrastructure investment, the majority of which will be administered through the Broadband Investment Fund (BIF), as detailed below. A number of targets for broadband connectivity have been set in the Digital Strategy 2.0.[4]

By 2010

- New Zealand to rank in the top half of the OECD for broadband uptake, speed and coverage.
- All future networks co-funded by government to be open access.

By 2012

- 80% of users to have access to broadband connections of 20Mbit/s or higher, and 90% have access to 10Mbit/s or higher.
- All education institutions to have access to a high-speed national education network.
- Open-access urban fibre networks operating in at least 15 towns and cities.

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4 Ministry of Economic Development (2008), *The Digital Strategy 2.0*, 28 August 2008.

- Terrestrial broadband coverage of 93–97% of the population, and more affordable satellite services for remote locations.
- Additional international submarine cable.
- Have plan in place to provide broadband connections of at least 1Mbit/s for the remaining 3% of population.

By 2018

- 80% of homes or premises to have access to fibre, or equivalent high-bandwidth capable technology
- 90% of users to have access to broadband connections of at least 20Mbit/s.

The Digital Strategy 2.0 includes a demand aggregation initiative for the state sector, in particular health and education, to encourage private sector investment. Starting in October 2008, up to four regional pilots are to be undertaken involving primary and secondary healthcare providers, schools and tertiary education institutions.

National Environmental Standards for telecommunications facilities are being developed, along with the Utilities Access Amendment Bill, to improve the local consent process to encourage rollout of broadband infrastructure. Additional spectrum for wireless broadband access is also to be allocated.

The Digital Strategy also proposes a Digital Content Innovation Cluster, to boost New Zealand production of applications in e-learning, e-health and gaming. The aim of this is to drive demand for broadband and improve productivity and competitiveness of key industries. Over next two years the Digital Development Council is to lead a new initiative, Connected New Zealand, to support small and medium enterprises to invest in digital technology. There shall also be a national network of digital hubs, providing community Internet access in public places.

Broadband funding

It was announced in June 2008 that more than $1 billion would be spent over ten years, focussing on high speed connections for high speed users.[5] Around half of this amount (for the first five years) was committed in the May 2008 budget (Exhibit 3.1), which includes:

- the BIF, with a budget of $340 million to be made available over five years,[6] and comprising the Urban Fund ($250 million in operating funding for high speed connections for businesses and key public users in urban areas), the Rural Fund ($75 million in operating funding to extend the reach of broadband in underserved areas) and $15 million in capital funding to improve New Zealand's international connectivity via the deployment of a new trans-Tasman cable
- further funding of $160 million for connectivity in the health and education, with an extra $10 million for other new Digital Strategy initiatives.

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5 Cunliffe, D. (2008) Fast forward to the future, speech to the 9th Annual Telecommunications and ICT Summit, 23 June 2008. Available at http://www.labour.org.nz/portfolios/communications_and_information_technology/speeches/23062008_fast_forward_to_the_future__david_cunliffe.html

6 Ministry of Economic Development (2008) *New Zealand's Digital Pathway: A Fast Broadband Future, Broadband Investment Fund: Draft Criteria and Proposed Process for Consultation.*

Component	*Item*	*Estimated spend ($ millions)*
New funding for Budget 2008	Accelerating Broadband Investment (operating)	325.0
	Accelerating Broadband Investment (capital)	15.0
New Budget for Other Digital Strategy initiatives	Community Partnership Fund	6.0
	Digital Strategy Refresh Implementation	0.5
Existing Public Sector Connectivity Spend	Health Connectivity Spending	60.0
	Education Connectivity Spending	45.5
	REANNZ	7.8
	GSN	50.0
Digital Strategy Refresh New Initiatives	Digital Development Council	2.9
	Implementation of Telecommunications Framework (Including Commerce Commission Enforcement)	22.7
	Nextspace graphics cluster	4.0
	Delivering Digital NZ	4.2
	Aotearoa People's Network	5.8
	Anti-Spam Regulation	4.5
Total		553.8

Exhibit 3.1: *Five year broadband expenditure details [Source: Budget 2008]*

Funding from the BIF will be allocated to projects that meet the programme's criteria, and it is anticipated that any legal entity (including network operators, local authorities and community organisations) will be able to apply. Aggregation of applications will be permitted, with no more than 40% of the total funding to be spent in any single year; however, if regions needing additional economic stimulus present acceptable proposals then more of the funding may be brought forward to the first year.

Urban Fund Seed funding will be provided as operating grants to projects that address government objectives and meet the required criteria. In particular, a minimum co-investment of an amount equal to the funding is required, with higher levels of investment preferred.

The priority in urban areas is to encourage the delivery of high bandwidth services to businesses and key public users – such as health organisations, tertiary organisations, schools and other public and municipal entities – in a way that supports competition and future investment in high bandwidth technology to the home.

The government has determined that the most appropriate way to support these objectives is to provide seed funding for the deployment of open-access passive infrastructure (ducting and dark fibre) in urban centres and surrounding suburbs. Funding recipients must provide (at a minimum) wholesale access to the passive infrastructure for any third parties. Entities may also provide services to end-users, however the selection criteria are intended to prevent the emergence of vertically integrated monopolies.

Rural Fund

The priority for rural areas is to extend the reach of broadband into underserved regions, and so the focus of the Rural Fund will be to deploy broadband to communities, businesses and users in the health, education and government sectors. The chosen mechanism is a contestable and technology-neutral process with sufficient flexibility to support the deployment of backhaul links, broadband access for the 'last mile' and pull-demand initiatives (for the health and education sectors).

Eligible areas will have no existing or planned terrestrial broadband (with minimum of 1Mbit/s). An interim network design objective of 5Mbit/s / 1Mbit/s is being considered for terrestrially-based rural broadband projects – whereby projects should achieve 'high' coverage of 1Mbit/s and 'significant' 5Mbit/s coverage.

This proposal offers the most funding that specifically addresses rural areas rather than focussing on the 75% of the population living in the largest urban areas.

It should also be noted that the programme does not directly fund FTTH projects, however applicants must demonstrate the potential of the infrastructure to be extended to provide fibre to the home in the long term

Considerable effort has been undertaken in development of the draft application process, including the evaluation criteria and in particular the assessment of project viability.

BIF application status

The first round of BIF applications closed at the end of September 2008, with 19 full applications and 56 expressions of interest submitted.[7] Of the expressions of interest submitted, 36 were invited to submit full applications, due in February 2009. The full applications are still being evaluated, with decisions expected in December 2008. The applications were for networks covering a wide geographical spread of cities, provincial and rural regions. Of the successful expressions of interest 13 were for urban areas, 22 for rural and one application covered both rural and urban areas.[8] The successful applicants are listed in Annex D.

3.2 National Party

National's policy is to spend up to $1.5 billion of public money over six years funding an open-access FTTH (fibre to the home) network that will reach 75% of the population.[9] This figure includes the country's 22 largest cities and towns, down to the size of Blenheim.[10]

A key feature is that the roll-out will be rapid, with 'business premises, schools, health facilities and the first tranche of homes' reached within six years. This investment will be subject to five key principles:[11]

7 Ministry of Economic Development (2008), *Media Statement – Good response to call for broadband funding applications*, 13 October 2008.

8 David Cunliffe (2008), *Broadband Investment Fund oversubscribed*, 6 November 2008.

9 National Party (2008) *Better broadband for New* Zealand, 2008 Policy Summary. Available at http://www.national.org.nz.

10 Estimated population 29 700 as at 30 June 2008 (Statistics New Zealand).

11 National Party (2008) *Better broadband for New Zealand*, 16 July 2008. Available at http://www.national.org.nz.

- the investment does not 'line the pockets of' or give undue advantage to existing broadband network providers
- open-access
- avoids excessive duplication of the network
- providing affordable 'worldclass' broadband services to 'everyday Kiwis'
- the public-private partnership remains focused on New Zealand's economic future and not the legacy assets of the economic past.

National expects that the private sector will contribute a further $1–1.5 billion to meet the total cost of the network.[12] National will also double the Broadband Challenge Fund to $48 million, to be used in rural areas. It is envisioned that services to rural areas will be a mixture of fibre, satellite and wireless technologies.

It is clear that further planning will be required to flesh out the detail of the National Party proposal but we note that InternetNZ's guiding principles are consistent with the National Party principles as listed above.

3.3 New Zealand Institute

The New Zealand Institute (NZI) has a proposal for an entity that it calls 'FibreCo',[13] to have monopoly rights over deploying and operating the fibre access network, providing access to its network to a single wholesale transmission provider, at a regulated price. FibreCo will be funded by private investors, along with some government funding, and will purchase the assets of existing network operators.

A hierarchy of three levels of provider is proposed:

- NetCo, which provides unlit fibres in the access network
- wholesale transmission provider, which provides the access network electronics, to be a wholly commercial company

12 http://businessday.co.nz/blogs/bottomline/2008/06/23/williamson-v-cunliffe-at-the-hyatt-ballroom/

13 New Zealand Institute (2008) *Delivering on the broadband aspiration: a recommended pathway to fibre for New* Zealand, April 2008. Available at http://www.nzinstitute.org.

- several competing retail service providers.

NZI's proposal seeks to achieve coverage of at least 75% of the population – claimed to include all towns with population greater than 20 000, which will extend to the towns of Pukekohe, Taupo and Timaru, all of which are smaller than Blenheim – by 2018. Based on Statistics New Zealand population estimates for 2008, this will encompass 74.7% of the total population.

NZI estimates that NetCo's required investment will be $4 billion to $5 billion. The total cost of the access network is estimated at $6 billion, comprising $2 billion for active components (switching and amplifications, to be installed by the wholesale transmission provider), and $4 billion for passive components (for example duct, cables, sites). The additional $1 billion required over NetCo's investment would come from government funding. The breakeven point is determined to be $3000 of investment per premise, and it is estimated that between 200 000 and 300 000 out of 1.3 million premises will be able to be provided commercially, costing less than the breakeven point. The government funding would be required for the premises where the investment required is greater than $3000.

In our preliminary report we noted that NZI's calculation of the breakeven point for the investment is very superficial and contains a number of questionable assumptions, including:

- timing of the achievement of the 67% take-up assumption
- low opex assumption
- assumed rate of return is not a commercial rate of return
- asset life assumption may not be correct.

In addition to the above we believe that monthly charges for end users have been underestimated. Monthly revenue for NetCo of $50 per customer is assumed; however, because the wholesale transmission provider (which does not obtain public funding) must recover $2 billion of investment, (which would consist largely of transmission equipment, having a much shorter lifespan than fibre and duct), then using NZI's methodology it must have a net revenue almost as great as that of NetCo. When the costs of the retailer are included then the required monthly charges for the end user are likely to be far in excess of $100 per month for a breakeven point of $3000 per home passed.

Given the above, we believe that NZI has under-estimated the breakeven point, which means that significantly more government funding would be required if this approach were to be adopted.

With respect to the proposed business model we see a number of difficulties. NZI suggests a multiple stakeholder model for FibreCo, with equity being held by central and local government, utilities, telecoms operators, service providers and investors. The participation of the private sector in funding implies that a commercial rate of return would be necessary. The rate of return applied in the proposal's financial analysis however is considerably below what private sector investors might expect. Furthermore, the assumption that existing network owners would divest of their infrastructure, while not out of the question if a commercial price were to be offered, is fraught with difficulties. Of major concern is the need for Chorus to undergo structural separation before its infrastructure could be sold. Our understanding is that this would be a complex and time-consuming exercise, and would take years rather than months to achieve. This would mean a considerable delay which would be at odds with InternetNZ's principles of being a leader rather than a follower in terms of timeframe.

3.4 Telecom

As part of the Operational Separation Commitments (to be fully implemented by December 2012), Telecom has committed $1.4 billion to deploying fibre to the node systems (cabinetisation) providing 10Mbit/s or better ADSL2+ access capability to virtually all lines in areas that it defines as Zones 1, 2 and 3.

Cabinetisation

Telecom's cabinetisation plan involves deploying 3600 new cabinets over the next four years.[14] These cabinets will be either new installations or will replace some of the existing

14 Mark Ratcliffe (2008), *Telecom New Zealand investor briefing day presentation*, 10 April 2008. Available at http://www.telecom.co.nz/binarys/chorus_briefing_day.pdf

8800 cabinets which already have appropriate short copper loop connections to their distribution serving areas.

The design of new cabinet areas is based on the rule that 99% of lines served from the cabinet will be engineered to have a maximum line attenuation of 60dB (measured at 1024kHz) at the customer's external termination point.[15] In practical terms this equates to ensuring that the copper run distance between the cabinet and the termination is less than about 2.4km of standard urban/suburban access network cable (0.4mm diameter copper).

Backhaul to the new cabinets will eventually be all fibre optic, mostly pulled or blown into the existing 9000km of cabinet feeder cable duct,[16] but with some additional trenching required where no duct exists.

The committed timing for implementation of cabinetisation is:

- 30 June 2010 – more than 1500 distribution cabinets installed or equipped with operational ADSL2+ or equivalent DSL capability
- 31 December 2010 – more than 2200 distribution cabinets installed or equipped with operational ADSL2+ or equivalent DSL capability
- 31 December 2011 – 99% of lines in Telecom's Zones 1, 2 and 3 engineered to have a maximum line loss of 60dB measured at 1024kHz at the customer termination point.

Details of the schedule for cabinet upgrades and planned new cabinet coverage areas can be found on Telecom's Chorus website.[17] Telecom's rollout over the next three years is expected to be:[18]

- financial year 2008/09 – 738 new cabinets
- financial year 2009/10 – 1177 new cabinets

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15 Telecom New Zealand (2008), *Telecom separation undertakings*, 25 March 2008

16 Telecom Wholesale (2007), *Telecom Wholesale customer briefing*, 22 November 2007. Available at http://www.telecom.co.nz/binarys/telecom_cabinetisation_briefing_22_nov_2007.pdf

17 http://www.chorus.co.nz/cabinetisation-notices

18 Paul Reynolds (2008), *Telecom Corporation of New Zealand NZ Companies Day presentation*, March 2008, available at http://www.telecom.co.nz/binarys/paul_abn_mar_08.pdf

- financial year 2010/11 – 1166 new cabinets.

Resulting geographic coverage (Zones 1 to 3)

In the Separation undertaking documentation,[19] the Telecom Zones are defined:

> Zones 1, 2 and 3 means the Telecom line density zones known as Zone 1, Zone 2, Zone 3a and Zone 3b and generally used by Telecom to describe those urban density areas of New Zealand served by telephone exchanges with a total line count of greater than 500 lines, and which at 30 June 2008 together include not less than 80% of total Existing PSTN Lines.

Before the 30 June 2008 deadline, Telecom was required to provide the Minister with a list of the exact population areas included in Zones 1 to 3. To our knowledge, the detailed Zone boundaries have not been made publicly available, but the Chorus website provides a list of towns which are included in the upgrade.[20]

We note that Telecom has previously stated[21] that there is not a good correspondence between its own internal zoning criteria (based on typical network costs) and the Statistics New Zealand definitions of urban and rural boundaries. For this reason, it is possible that some Zone 1 to 3 Telecom areas may be designated 'rural' using Statistics New Zealand definitions.

Lines outside Zones 1 to 3 are allocated to Zone 4 (Telecom rural, around 20% of lines). Although Telecom has made no specific commitment to providing broadband infrastructure to support these lines, we note that from an MED press release of March 2008[22] that additional assurances have been obtained from Telecom concerning Zone 4:

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19 Telecom New Zealand (2008), *Telecom separation undertakings*, 25 March 2008

20 http://www.chorus.co.nz/f68,9481/9481_Town_list_by_regionFINAL8.9.08.pdf

21 Telecom New Zealand (2007), *Submissions on UCLL and Co-location draft Standard Terms Determinations*, 29 August 2007, http://www.comcom.govt.nz/IndustryRegulation/Telecommunications/StandardTermsDeterminations/UnbundledLocalLoopService/ContentFiles/Documents/Cross-telecom1.pdf

22 Ministry of Economic Development (2008), *Telecom Separation a Fact - Minister for Communications and Information Technology media statement*, 31 March 2008 http://www.med.govt.nz/templates/MultipageDocumentTOC____34436.aspx

> Telecom's level of investment in Zone 4 rural lines will not be less than (but may be greater than) the gross contributions that Telecom receives through the Telecommunications Service Obligations subsidy

Commerce Commission estimates of the gross TSO cost for the past few years are only partially completed at the time of writing this report, but are likely to be in the region of $50 million to $70 million per annum.

Already, many lines in Zone 4 areas have access to exchange- or cabinet-based DSLAMs through Telecom's commercial deployment or through government/community sponsored projects such as PROBE. Although such connections are technically designated to be broadband and can achieve high DSL access line speeds (up to 7Mbit/s), backhaul may be provided using one or more 2Mbit/s carriers on copper or wireless transmission systems. Unlike lines in Zones 1 to 3, future Zone 4 broadband access has no guarantees concerning copper line attenuation, DSLAM type (may be conventional ADSL) or backhaul capability.

Comment on upgrading the FTTN network beyond 2012

The planned FTTN network could be upgraded for higher speed broadband and wider coverage through:

- further copper loop shortening with the placement of remote fibre fed cabinets within current distribution areas (similar to the AT&T Video Ready Access Devices – VRADs)
- FTTP
- expansion into Zone 4 areas.

Further loop shortening and FTTP scenarios are likely to be significantly more expensive than the current cabinetisation rollout. A key cost factor in both options will be the deployment of underground fibre cables in distribution areas with no existing ducting. Telecom has around 130 000km of distribution cable nationwide, and this is typically direct buried (i.e. underground cables placed directly into the ground without ducts).[23]

[23] Telecom Wholesale (2007), *Telecom Wholesale customer briefing*, 22 November 2007. Available at http://www.telecom.co.nz/binarys/telecom_cabinetisation_briefing_22_nov_2007.pdf

Unless alternative techniques emerge, to overlay the Zone 1 to 3 distribution areas with fibre will require:

- many kilometres of new trenching in the lowest cost terrain possible (such as grass where available)
- drilling under roads, footpaths and driveways where required
- re-instatement of road surfaces and kerbs when trenched or damaged.

Rolling out the FTTN architecture into Zone 4 areas would also require significant runs of new trenching as existing ducted cable runs are likely to be fewer than in urban areas.

3.5 Other proposals

3.5.1 New Zealand Fibre Fund

The New Zealand Fibre Fund concept was developed in 2006, and is a model for funding the development of many open broadband networks throughout the country. Initially, the fund is envisaged as having four roles:

- broker and consolidator of loans
- manager of an application process
- provider of collaborative knowledge and support for open-access networks
- brand owner and marketer of the NZ Fibre Fund.

The fund will initially be accountable to the New Zealand government, as the seed funder, whilst later accountability will be split amongst the seed funder, the successful applicants, the funders and the open network community. The fund will use a revision of the broadband challenge application process to evaluate applications. The application process will require the funder and applicant to work together to develop a strong business plan to lead towards sustainable and profitable operations.[24]

[24] Digital Strategy (2008), *The New Zealand fibre fund*, 22 April 2008. Available at http://wiki.digitalstrategy.govt.nz/(S(kwgc3h550eg4hf3urotoj1eq))/The%20New%20Zealand%20Fibre%20Fund.ashx

This proposal appears to seek to address the funding requirements of multiple open-access networks with a type of partnership arrangement between funder and potential provider. It assumes that only seed funding from Government will be necessary and that commercially viable operations will emerge on the basis of this. A key assumption is that community-minded investors with long-term (25 year) timeframes and relatively modest required rates of return (for example, pension funds) would regard passive infrastructure as a secure investment.

This model implies that there is very little risk associated with the deployment of passive infrastructure and that once it is in the ground it will be utilised and, if not profitable in the short-term, it will serve investors well in the long-term. However our business modelling and research indicates that substantial amounts of investment will be required in New Zealand for the passive infrastructure to cover 75% of the population, and there are risks and uncertainties associated with this level and type of investment that may be incompatible with the risk profile of the risk-averse investors that would typically subscribe to a pension fund or similar investment vehicle. Consequently we have some reservations as to whether a significant level of private capital could be raised using this approach.

3.5.2 TUANZ

TUANZ has proposed the need for the development of a Digital Network Architecture before progressing towards deploying a national next generation network, which will encompass several broad dimensions:

- business – how to make broadband capability available on a commercial basis to industry
- management – define service levels
- security – protect national interests from cyber threats
- technical – the physical and logical layers of the network and integration of various regional networks.

TUANZ stresses the importance of having national guidelines for interoperability and interconnection to ensure that various regional networks that are currently being built can be integrated into a national network. TUANZ has called for the incoming government to arrange a meeting with the new Minister and all the telecommunications industry stakeholders to review TUANZ's recommendations, plan a way forward for broadband in New Zealand, and allocate responsibilities.[25]

3.6 Current local government involvement in broadband networks

There are many instances of both central and local government providing financial assistance towards development of broadband networks, for example through PPPs, and public utility expansions, as discussed in Sections 4 and 5; however, direct financial investment or assistance is not the only role for local government. There are also non-financial ways for both central and local government to aid in broadband development, for example through facilitation of process with legislation, and through providing access to civil works such as ducting networks.

3.6.1 Legislation

The Resource Management Act has been held up as a stumbling block for deployment of broadband networks. The Local Government Association suggests that councils are unfairly being blamed for slow progress due to their implementation of the RMA, whereas it believes there are problems with the legislation itself. There currently seems to be a lack of standards for carrying out infrastructure work and what equipment can be placed.

The Digital Strategy 2.0 outlines two legislative tools for improving standardisation of broadband infrastructure: the National Environmental Standards for telecommunications facilities (NES),[26] and the Utilities Access Amendment Bill.[27] The NES will outline national standards for permitted activities under the RMA, thus removing the regulatory

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25 TUANZ (2008), *Towards a National Digital Architecture*, 3 November 2008.

26 Ministry for the Environment (2008), *National environmental standards for telecommunications facilities*, available at http://www.mfe.govt.nz/laws/standards/telecommunication-standards.html.

27 David Cunliffe (2008), *Address to Local Government Broadband Forum*, 20 February 2008, available at http://www.beehive.govt.nz/speech/address+local+government+broadband+forum.

inconsistencies that currently exist across district plans, by devising a set of nationally consistent regulations. The NES will allow construction and operation, on the road reserve, of certain telecommunications equipment that conforms to specified height, size, density and noise limitation requirements. These specifications will override any existing district plans, although the district plan may specify more detailed terms and conditions within the NES requirements (for example, colour of cabinets). The Utilities Access Amendment Bill to be introduced is intended to provide network operators with certainty in dealing with multiple local authorities, clarifying access to motorways and rail corridors for infrastructure work.

The New Zealand Utilities Advisory Group is leading the development of a National Code for governing access to the transport corridors, with the Draft Code launched in February 2008.[28] The Code is being developed in conjunction with all the utilities, local authorities, Transit and ONTRACK. This is an industry-led initiative, designed as a coherent code to manage utility access to road and rail, in place of the multiple pieces of legislation that currently relate to utilities in roads. The Code will cover the following principles:[29]

- right of access by utilities to the corridor for infrastructure work
- right of corridor managers to apply reasonable conditions on access to ensure safe and efficient operation of corridor
- defining roles and responsibilities of all associated parties
- promotion of planning and liaison between parties to improve efficiency in infrastructure works
- maintaining the integrity of the corridor through creation of transparent quality assurance procedures which must be followed
- providing a safe worksite and minimising public disruption
- encouraging collaboration in good faith between parties.

28 NZ Utilities Advisory Group (2008), *National Code*, available at http://www.nzuag.org.nz/national-code/.

29 Local Government New Zealand and Telecommunications Carrier's Forum (2008), *A broadband friendly council*, available at http://www.lgnz.co.nz/library/files/store_020/ABroadbandFriendly.pdf.

3.6.2 Broadband Friendly Protocol

The Broadband Friendly Protocol[30] is being developed between the members of Local Government New Zealand and the Telecommunications Carrier's Forum to provide guidance for councils to facilitate development of high-speed broadband networks in their regions. A number of options have been identified for councils to promote broadband investment, which are covered in the Broadband Friendly Protocol:

- **New subdivision development**: councils develop engineering codes that developers need to apply when building a new subdivision. There is the potential for councils to encourage the inclusion of FTTH into greenfields developments, by requiring developers to install future-proofed telecommunications equipment in new projects.
- **Ducting policies**: councils may require that ducting be installed in new subdivision work and maintenance upgrades, or may choose to install open-access ducting themselves whenever the opportunity arises.
- **Council procurement policies**: councils have the opportunity to use their collective bargaining power to improve coverage and gain more competitive pricing in telecommunications services.
- **Use of council owned infrastructure**: providing availability to council infrastructure such as buildings, ducting, poles, land and disused pipes to broadband suppliers can reduce the cost of entry to new players, encouraging competition.
- **Shallow or micro-trenching**: councils are currently reluctant to allow micro-trenching, but are considering its potential.
- **Building access and wiring**: the lead-in access to buildings represents a significant cost component of the FTTP network. Councils could establish joint ownership arrangements for lead-in to commercial buildings and can ensure that adequate ducting is provided in all residential new developments.
- **Incorporating telecommunications into the District Plan and the LTCCP**: currently there is no consistent policy regarding ensuring the provision of telecommunication services to all new subdivisions and infill housing developments.
- **Creating public-private partnerships**: creation of partnerships with suppliers to encourage broadband investment, providing subsidies or underwriting projects, or

30 Local Government New Zealand and Telecommunications Carrier's Forum (2008), *A broadband friendly council*, available at http://www.lgnz.co.nz/library/files/store_020/ABroadbandFriendly.pdf.

assisting projects non-financially, for example by providing access to community owned infrastructure.

- **Establishment of industry collective purchasing agreements**: demand aggregation can be useful for establishing a degree of certainty of the initial customer base for a new network.
- **Installation of open-access ducts**: some councils see open-access ducting as a useful means to reduce the cost of deploying fibre networks for new operators, especially to encourage laying of networks in regions that are not deemed to be commercially viable.
- **Creating a core fibre network**: councils may choose to deploy their own core networks, leasing fibre to network operators for their exclusive use.

3.6.3 Direct investment by local government: Christchurch City Networks Ltd

One model that was not considered in our preliminary research is that of Christchurch City Networks Ltd (CCNL)[31]. Announced in December 2006, this company was formed to construct an open access fibre network in Christchurch. CCNL is a wholly owned subsidiary of Christchurch City Holdings (CCHL) – the investment arm of the Christchurch City Council (CCC). Note that the Christchurch Council has retained ownership of key infrastructure within Christchurch, electricity network, port, airport etc. The formation of CCNL was led by the CCC and Canterbury Development Corp, and received some funding from the Ministry of Economic Development. The network, to date, has a total cost of $10.7 million, with the Ministry of Economic Development contributing $3.75 million as part of the government's Broadband Challenge programme.

CCNLs network is an underground fibre optic network that utilises single mode fibre optics and is planned to cover 120km by early 2010, using air blown fibre technology. CCNL provides point to point dark fibre connections. Value-added services over the C1 network for business use can be purchased through one of CCNL's approved partners – SNAP, Datacom, FX Networks, and Revera – or other service providers or the customer themselves can use the fibre.

31 Christchurch City Networks Ltd (2008), *C1 network: Christchurch's high speed fibre optic network from CCNL*, available at http://www.ccnl.co.nz/broadband/main/.

CCNL provides the council with fibre connections to a large number of community service centres and libraries in Christchurch. Kordia was signed up as CCNL's first connected customer in July 2007. Initially, the focus for CCNL was on securing initial anchor tenants, commercial connections and reselling partners. By early 2009, CCNL expects to cover 55% of all businesses with more than five employees and over 50% of the MUSH locations.[32]

CCNL reported a net loss of just over $300 000 for its first year of operation at its AGM on 28 October 2008. This figure is ahead of forecasts and suggests that positive earnings may be achieved in 2009. CCNL has recently entered into a 15-year contract to supply fibre network capability to NZ Communications, due to launch its mobile network in Christchurch early 2009. An agreement has also been signed with Transpower to deliver a communications and control network for its Christchurch operations.[33]

32 Christchurch City Holdings Ltd (2008), *CCHL profile*, available at http://cchl.thrive.net.nz/content/library/cchl_profile_20071.pdf.

33 Computerworld (2008), *Christchurch City Networks projects positive result for 2009*, 29 October 2008, available at http://computerworld.co.nz/news.nsf/netw/3A90AC635CF19648CC2574F00080D8CA.

4 The public-private partnership approach

Public-private partnerships (PPPs) are voluntary contractual collaborations between public and private partners formed to fulfil certain tasks, with the associated risks shared between partners. In relation to broadband infrastructure PPPs can be useful in cases where the market fails to provide services satisfactorily. This tends to occur in areas that are not seen as profitable for solely private investment. A PPP is a mechanism for central or local government to take a lead in broadband investments, to ensure adequate provision of services, whilst taking advantage of specialist capabilities of the private sector.

There are many variations of PPPs for infrastructure projects with differing levels of financial involvement and assumption of risk by each of the partners, including:

- **traditional design and construction**, whereby the public sector commissions the private sector to build the facility under a contract, typically for a fixed price
- **operation and maintenance contract**, where the private sector operates a publicly-owned facility under contract to the public sector
- **lease – develop – operate** (LDO), where the private sector is awarded a long-term lease to operate – and possibly to expand – a facility
- **build – own – maintain** (BOM), where the private sector constructs, owns and maintains the facility, while the public sector leases and operates the facility
- **build – own – operate – transfer** (BOOT), where the private sector finances, constructs, owns and operates the facility for a specified timeframe after which ownership reverts to the public sector
- **build – own – operate** (BOO), similar to the BOOT model but the private sector owns the facility in perpetuity.

There are some potential concerns around PPPs, in particular whether the government is distorting the market by entering an agreement with a specific industry player, or backing a particular technology, with the suggestion that PPPs are anti-competitive. One way of mitigating the problem of market distortion is the use of technology-neutral competitive tenders when determining which private sector partner to use. Focusing on the desired outcomes of the PPP initiative is also important, allowing flexibility for the private sector to develop their own approach. Another concern relates to whether the government and customers are locked in once the private sector partner has been selected, with the need for flexibility having to be reconciled with the desire for certainty on part of the private partner. Three approaches can be taken to address this concern:

- separate parts of the PPP project, for example having different companies build and operate a network
- consult industry beforehand regarding ownership, divesture and replacement rules, to be included in the PPP contract
- limit the service contract to a number of years, after which it the public partner determines whether to continue with the chosen private partner, or whether a new tender is to be conducted.[34]

4.1 New Zealand PPP broadband network examples

North Shore Education and Access Loop (NEAL)

NEAL is an urban fibre network in North Shore City which will connect schools in the area at speeds of up to 1Gbit/s. The network was built by Vector Communications, in partnership with the North Shore City Council and with funding from the Broadband Challenge Fund. The network can also be used to provide high-speed broadband to connected schools through separate commercial contracts with ISPs.[35]

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34 InfoDev, ITU (2008), *ICT regulation toolkit: public-private partnerships.*

35 Vector Communications (2008), *North Shore Education and Access Loop.* Available at http://www.vectorcommunications.co.nz/NEAL/default.asp.

The Loop

The Loop is a virtual fibre loop leased from Network Tasman around the centre of Nelson, to connect schools in the region at speeds of 1Gbit/s at no cost. There are spurs running to Motueka, Marlborough and Picton. Schools not within the range of fibre, but less than 10km and within line of sight of a connected school, will have a dedicated 15Mbit/s point-to-point radio connection.[36]

Smartlinx 3

Smartlinx 3 has deployed an open-access (2Mbit/s – 10Mbit/s symmetrical), broadband network for Porirua and the Hutt Valley. Smartlinx3's shareholders are members of the local community, including the Hutt, Porirua, Upper Hutt City Councils, local businesses and the Hutt Mana Charitable Trust.

The fibre-based network reaches points of presence in Porirua, Lower Hutt and Upper Hutt. There is also a point of presence in Wellington, allowing connectivity to other networks including CityLink. Wireless is being used to widen the coverage of the network, while additional fibre is still being built within the cities. Internet access is obtained through one of the ISPs connected to the network.[37]

Internet service costs through Xtreme networks include an installation charge of $750 for wireless connection, or $1499-$1999 for direct fibre connection. Monthly plans for wireless range from 2Mbit/s with a 5GB data cap for $169 per month, to 10Mbit/s with a 15GB data cap for $578 per month. Data plans for fibre connection range from 10Mbit/s with a 5GB data cap for $498 per month to 1Gbit/s with a 15GB data cap for $1898 per month. For all plans a $0.05 per MB charge applies for exceeding the data cap.

36 The Loop (2008), *The Loop learning network*, available at http://www.theloop.school.nz/.

37 Smartlinx 3 (2008), *Real regional broadband*. Available at http://www.smartlinx3.co.nz/Home.aspx.

4.2 Overseas examples of PPP broadband networks

Alberta SuperNet, Canada

The province of Alberta has a 13 000 km open-access wireless and fibre optic network, dubbed the SuperNet,[38] which provides high-speed connectivity to 429 communities. All of the province's more than 4200 learning facilities, health centres, libraries and government locations are connected. The network is owned through a public-private partnership between the Government of Alberta, Axia NetMedia and Bell Canada. The project was initiated by the provincial government, whilst Bell was responsible for construction, and Axia designed, helped build and operates the network. Residential Internet access utilising the SuperNet is also provided to over 86% of Alberta's population through more than 30 ISPs.

The provincial government is investing CAD193 million (NZD246 million) over three years to build the network's Extended Area, which the government will own on completion. Bell is investing CAD102 million (NZD130 million) on building the Base Area, which they will own on completion. They will also invest a minimum of CAD20 million (NZD25 million) to build the Extended Area Network. Bell is to be responsible for any additional costs related to the build. The choice of Bell to build the SuperNet avoided the problem of the provincial government backing a monopoly provider, as although Bell is the largest telecommunications operator in Canada, Telus dominates the SuperNet region. Having Axia as the operations and access manager for both parts of the network also ensures competing service providers will have equivalent access to the network. The Alberta SuperNet is designed to be self-sustaining, with revenue collected from government customers and commercial customers to be used for operational costs and capital maintenance. The federal government has not contributed any funding to the project.[39]

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38 http://www.albertasupernet.ca/

39 IEEE Spectrum Online (2004), *Winner: across the great divide, the Alberta SuperNet is a model for the broadband future – everywhere*, January 2004, http://www.spectrum.ieee.org/jan04/3912.

The Base Area consists of 27 larger communities where competitive high-speed Internet access already exists. The Extended Area includes 402 smaller communities where connectivity and competition is either limited, or non-existent. The network comprises almost 80% fibre optics, with fixed wireless providing the remaining connectivity in parts of the Extended Area where the terrain is difficult, or where it is not financially feasible to lay cable.

Axia SuperNet[40] provides end customer support and service for government customers, as well as for commercial ISPs.

Homes and businesses can connect to the Internet via the SuperNet only through one of the ISPs. Open access to the network is granted to ISPs with no ISP being able to secure exclusive rights to provide services in any community. If no ISP chooses to provide Internet access in a SuperNet community, then Bell is obliged to provide service upon the reasonable request of a resident or business within that community.

City of Pau, France

Some municipalities in France have taken a leading role in providing FTTH services. For example, in 2005, the City of Pau launched an open-access fibre network intended to connect the city with the main backhaul. The network is owned by the City of Pau, with the project being both publicly and privately funded. The ownership model is a *délégations de service public* (DSP), similar to a PPP. A budget of EUR35 million (NZD58.2 million) was proposed for the first three phases of the network build. Each of these phases took one year and covered about 12 000 households per year. The project aims to connect 55 000 households in Pau in total. By December 2007, 5000 customers had subscribed to the FTTH services.

40 Axia (2008), *The Alberta SuperNet*, http://www.axia.com/open_access_networks/alberta_supernet.asp.

FastWeb, Italy

Italy has the second highest take-up of FTTH services in Europe, exceeded only by Sweden, driven largely by the alternative operator FastWeb.

FastWeb was established in 1999, as a joint venture between e.Biscom and AEM, the largest regional utility in Italy, held by the city of Milan. The group included Metroweb, which was responsible for rolling out the optical fibre network , whilst FastWeb provided triple play services over the network. In 2001, FastWeb bought a network of cable TV ducts, known as Socrate, from the incumbent operator Telecom Italia following an anti-trust ruling. In 2003, FastWeb divested from Metroweb. Since then FastWeb has continued deployment of its fibre optic network. From company launch to March 2006, FastWeb had invested over EUR3.5 billion (NZD6.1 billion) in its fibre network, covering 23 000km and 45% of the population. From 2007 FastWeb's network was further expanded by another 1000km, to reach 50% of the Italian population and covering all main Italian cities.[41] As of 2007 FastWeb had yet to make a profit, with its 2006 net loss amounting to EUR123.6 milllion (NZD215.4 million).

In 2007, Telecom Italia entered into an agreement with Metroweb to expand its fibre-optic network in and around Milan. Telecom Italia will gain access to about 70 000 buildings in Milan, partly through Metroweb's infrastructure, which was originally built by Milan's municipality to support FastWeb during its initial stages. The agreement gives the right to use Metroweb's infrastructure for 15 years (renewable for a further 15 years), and is part of Telecom Italia's plans to develop its next generation network across Italy, starting in Milan.[42]

In May 2007, Swisscom (the Swiss incumbent operator) became the majority shareholder of FastWeb.

Recently, FastWeb has signed an agreement with the Ministry of Communications and Infratel, a company controlled by the national agency for inward investment promotion and

41 FastWeb (2007) *FASTWEB: the Board of Directors approves the network expansion plan*, media release, 8 August 2007.

42 Telecom Italia (2007), *Telecom Italia: agreement with Metroweb to expand fibre-optic network in Milan*, 30 May 2007.

enterprise development, to promote the development of broadband infrastructure throughout Italy, with the goal of removing the digital divide. The aim is to share information on planning interventions in the digital divide areas and to combine efforts towards creating an integrated and advanced broadband infrastructure throughout Italy.[43]

Earlier this year, in one of the first instances of a sharing agreement between an incumbent operator and new entrant regarding fibre deployment, a memorandum of understanding[44] was signed between FastWeb and Telecom Italia to cover:

- joint planning for the realisation of civil infrastructure facilitating cable laying for the development of respective fibre optic networks – for example cable ducts along roads – to favour the development of new generation networks while eliminating further infrastructure duplication
- the exchange, under reciprocal conditions, of rights to use civil infrastructure
- joint study and testing of innovative techniques in civil infrastructure, such as the use of latest generation micro-tubing for laying optical fibre.

FastWeb's reach is being extended further through an agreement with the French satellite operator Eutelsat[45] to provide satellite broadband services to locations outside terrestrial broadband coverage. Eutelsat's Tooway™ service currently provides 2Mbit/s downlink and 384kbit/s uplink, however downlink speeds up to 20Mbit/s will be available from 2010 when Eutelsat's new KA-SAT satellite is launched.

CityNet, the Netherlands

In 2006, a large FTTH project was initiated in Amsterdam, the CityNet, which is aiming to reach 420 000 homes and business by 2013 at a cost of EUR300 million (NZD512 million). The network will be built by Glasvezelnet Amsterdam BV (GNA),

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43 Ministry of Communications (2008), *The Ministry of Communications, Infratel and FastWeb sign an agreement to promote the development of broadband infrastructure throughout Italy*, 7 April 2008.

44 FastWeb (2008) *Telecom Italia and Fastweb sign industrial agreement for new generation network infrastructure*, media release, 23 June 2008.

45 FastWeb (2008) *FastWeb chooses Eutelsat to bring broadband satellite connections to Italy*, media release, 12 November 2008.

which is one-third owned by the Amsterdam City Council, ING Real Estate Investment Management, and five large Amsterdam housing corporations. The network will be operated on an open-access basis by BBned, a subsidiary of Telecom Italia, with over 75 service providers providing services to homes and small businesses. The business plan for CityNet was based on achieving a return on equity of at least 8-10%. The minimum level of take-up and revenue required for GNA to cover its cost of capital would be 40% subscriber take-up, with a monthly wholesale revenue of EUR25 (NZD43) per connection.[46]

CityNet, in cooperation with three local carriers, has recently conducted a three-day test of 1Gbit/s connectivity for residential consumers over its network.[47]

UTOPIA, Utah USA

Utah telecommunication open infrastructure agency (UTOPIA) is an inter-local governmental agency formed by 18 Utah cities in 2002, with the purpose of building, maintaining and operating an open-access FTTP network throughout the region. Utah legislation mandates that municipal networks may offer wholesale but not retail services, to prevent direct competition with private companies. UTOPIA is funded through the fees charged to private service providers using the network, used to repay the USD85 million (NZD136 million) in municipal bonds used to build the system. Several private contractors were utilised to construct various aspects of the network, selected through a competitive tender process. The inter-local agreement is a commitment which allows the reduction of overall cost per subscriber by sharing the costs for facilities such as the Network Operations Centre among all the cities. The revenues per subscriber for less profitable regions can also be increased and balanced by sharing the profits from more financially viable regions.[48]

46 ING Wholesale Banking (2006), *European telecoms – CityNet Amsterdam: fibre-to-the-home is becoming a reality*, 24 February 2006.

47 Broadband DSLReports.com (2008), *Amsterdam tests residential 1Gbps fiber*, http://www.dslreports.com/shownews/Amsterdam-Tests-Residential-1Gbps-Fiber-97642, 11 September 2008.

48 Utah Telecommunication Open Infrastructure Agency (2003), *Utah's public-private fibre-to-the-premises initiative*, 26 November 2003.

UTOPIA projected a take-up rate starting at 5% at year one, and increasing to 55% at the end of year 10. The projected revenue per user was USD58 (NZD93) in year four, rising to USD69 (NZD110) in year ten. The break-even point was projected for 2009, with positive cashflow by 2012.[49]

UTOPIA has been criticised by the Utah Taxpayer's Association, who question the need for local governments to invest in broadband infrastructure. There have also been questions raised about UTOPIA's financial viability – UTOPIA's financial results from 2007 apparently indicate that subscriber numbers and revenues are falling behind what was projected.[50] Suggested reasons include lack of advertising of UTOPIA's availability, consumers not being convinced of the need for faster broadband connections, difficulties in changing service providers, including private telecommunications companies in the region offering lower services to subscribers who ask to have their services terminated.

Stokab, Sweden

Stokab[51] was founded in 1994 and is owned by the company group Stockholms Stadshus AB, which is owned by the City of Stockholm. Stokab is an operator-neutral network owner. The company's business concept has two parts:

- on commercial terms, provide IT infrastructure for all, especially the City of Stockholm, contributing to growth in the Stockholm and Mälar region
- on assignment of the City of Stockholm, administer and develop the City's communications network, including for schools, child care services, leisure and culture.

49 DynamicCity Metronet Advisors (2003), *UTOPIA feasibility study*, 4 November 2003.

50 Utah Taxpayers Association (2007), *UTOPIA's financials*, 26 November 2007, http://utahtaxpayer.blogspot.com/2007/11/utopias-financials.html.

51 Stokab (2008), *Stokab in English*, http://www.stokab.se/templates/StandardPage.aspx?id=306.

Stokab's mandate from the City of Stockholm is to provide "public service on commercial terms", based on the Swedish parliament's decision to create "an information society for all".

The Stokab network comprises 5600 kilometres of cable and 1.2 million kilometres of fibre. Customers are leased connections to the network, obtaining the exclusive right to use a line or entire network structure.

CESAR, Sweden

CESAR is the central system for access lines, designed to coordinate municipal broadband networks throughout Sweden, launched in December 2007. It was produced by the Swedish Urban Network Association in collaboration with Telenor, Tele2, Com Hem, the Swedish National Rail Administration and TDC Song. CESAR is a web-based system for dealing with queries to affiliated municipal networks. The aim is to make it easier to purchase wholesale products from municipal networks nationally, by offering more uniform terms and a comparable supply of dark fibre. [52]

4.3 Key features of PPP broadband networks

Public-private partnerships involving both central and local governments have been utilised for developing broadband networks. Central government has been involved in Canada for extending rural broadband availability, as well as in Australia's proposed National Broadband Network (NBN). Many more regional projects have been undertaken, involving local governments, with a variety of approaches being taken in regards to the PPP model. The approach selected is driven by factors specific to the local market, including (but not restricted to) the level of competition, the legal/regulatory environment and strength of local organisations.

Open access of the network with multiple service providers is the common theme, however, as is using different private partners for various aspects of the project. The public

52 National Post and Telecom Agency Sweden (PTS) (2008), *Dark fibre – market and state of competition*, 18 June 2008.

involvement may be at only the passive infrastructure level of the network or may encompass both passive and wholesale levels of the network.

The UTOPIA project has a relatively large public sector involvement, with the public sector funding the network through municipal bonds, as well as maintaining full ownership of the network. The private sector in this case was simply used to build the network, with several private companies being used, chosen by competitive tender.

The other projects studied had a mixture of public and private ownership. Alberta SuperNet has the base area network now owned by private partner Bell, where the extended network is owned by the public sector. To prevent anti-competitive behaviour, a separate private partner was used to build the network (Bell), from the one that operates the network (Axia). The company chosen to build the network was also not the dominant telecommunications operator in the region.

The FastWeb group in Italy initially comprised of two public-private companies: MetroWeb, builder of the network, and FastWeb, provider of services over the network. The two companies later split with the public partner taking full ownership of MetroWeb, and the private partner full ownership of FastWeb. MetroWeb has since been sold to a private company.

CityNet in Amsterdam also utilised different companies to build and operate the FTTH network, with the network being owned in an even split between Amsterdam City Council, ING Real Estate Investment Management, and five large Amsterdam housing corporations.

5 The utility expansion approach

Utility companies are seen to be well suited for undertaking fibre projects, due to the synergies with their current business. With the companies already owning the rights of way, poles and towers, utilities have the potential to deploy fibre optic networks more economically than other companies, being able to coordinate fibre deployments with their other infrastructure work. Their business economics are also well suited to operating fibre networks, being stable companies that are used to planning long-term infrastructure projects.

There are two options for utility companies when opting to enter the fibre broadband market:

- an integrated passive/wholesale operation in which the utility lays open fibre and wholesales access to service providers
- a vertical integration model in which the utility provides end-user services – this has been used by some municipal utilities in small cities of the US in particular, where commercial carriers have failed to deliver services.

5.1 New Zealand utility broadband networks

In the case of New Zealand, the utility businesses that have deployed fibre networks have all been regional power companies. None of the networks extend to the FTTH level, with services tending to focus on providing high-speed connectivity to businesses, schools and medical facilities.

Aurora Energy

Dunedin City Council-owned Aurora Energy is planning to deploy a pilot fibre network in Dunedin. The network will offer speeds of between 100Mbit/s and 10Gbit/s. If the pilot is successful the network could be extended to FTTP in 10-15 years. Aurora has recently submitted an application to the Broadband Investment Fund, however the intention is to go ahead with the pilot build regardless of whether the application is successful or not. Whilst Aurora is installing the network the Council has agreed to accept a lower dividend from the company.[53,54]

Counties Power

Counties Power provides a fibre optic network serving the Pokeno, Papakura and Pukekohe areas, with connections to other fibre networks. The network operates at speeds of up to 1Gbit/s. The network is open-access, and Internet access can be obtained though a number of ISPs.[55]

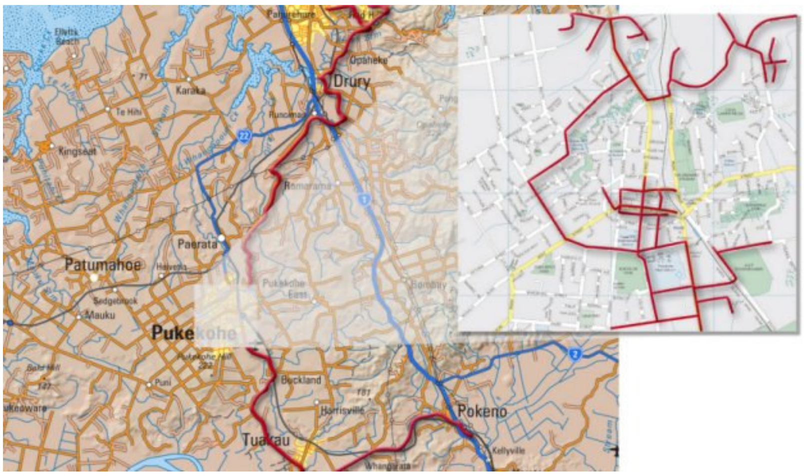

Exhibit 5.1: *Coverage area of Counties Power fibre network [Source: Counties Power]*

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53 Otago Daily Times (2008), *Aurora proceeding with broadband plans*, 21 October 2008. Available at http://www.odt.co.nz/news/dunedin/28260/aurora-proceeding-with-broadband-plans.

54 Dunedin City Council (2008), *Broadband high on the agenda*, 13 November 2008. Available at http://www.dunedin.govt.nz/your-council/publications/factline/broadband.

55 Counties Power (2008), *Fibre optic cable network*. Available at http://www.countiespower.com/fibre_optic.htm.

Counties Power entered the communications business in 2002, when it started the wireless and fibre optic provider Wired Country, subsequently sold to Compass in 2006. In 2007, Counties Power re-purchased the fibre network that it had previously installed, leasing dark fibre back to Compass. A further 40km of fibre was laid at this stage for FX networks, with Counties Power retaining some of that fibre.[56] Counties Power had business options with anchor tenants, making the buy-back feasible.

Counties Power, in conjunction with the Franklin District Council, has submitted an application to the Broadband Investment Fund.

Electra Limited

Electra group company Datacol NZ, which specialises in meter reading, acquired 51% of the fibre optic cable installation and electrical contracting company MultiMedia in July 2007. MultiMedia has since won a three year contract to supply Christchurch City Network's new fibre network.[57]

Electra has recently submitted a successful expression of interest to the Broadband Investment Fund.

Network Tasman

In 2005 Network Tasman built a fibre optic network in the greater Nelson area. Network Tasman has formed a partnership with TelstraClear to offer telephone and high-speed Internet over the fibre network to business customers in Nelson, Richmond, Motueka and Blenheim. Excess capacity on the fibre network can also be leased to customers who wish to link sites directly without needing to go through an ISP.[58]

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56 Counties Power Limited (2008), *Broadband Investment Fund – consultation response*, 27 June 2008.

57 Electra Limited (2008), *Annual report 2007-2008.*

58 Network Tasman (2008), *Tasman fibre network.* Available at http://www.networktasman.co.nz/Tasman_Fibre_Network/Tasman_Fibre_Network.asp.

Tasman has recently submitted two successful expressions of interest to the Broadband Investment Fund.

Northpower

Northpower has built the backbone of a fibre optic network in Whangarei, where 900 businesses, schools and medical sites will be offered voice, data and video services before the end of the year. Businesses will be offered speeds of up to 1Gbit/s, and private users up to 100Mbit/s. Northpower has plans to extend services into residential areas, utilising the extensive networks that it already has in place.

Northpower has signed a partnership with TelstraClear as the first ISP to offer services over the fibre network.[59] Northpower has also submitted an application to the Broadband Investment Fund that would enable it to extend its network deeper into rural areas.

As yet there has been no noticeable competitive response from Telecom though we understand that Whangarei may now be given a higher level of priority in Telecom's cabinetisation process.

Vector

Vector operates a fibre network in the metropolitan areas of Auckland and Wellington. The Auckland network stretches from Manukau through to Albany and Henderson to Pakuranga. The Wellington network is located predominantly in the CBD. Services are provided through Vector Communications' partner companies.[60] In February this year Vector announced plans to extend its Auckland network by more than 300km, with Vodafone as the anchor tenant. Vodafone will use the fibre optic network to enhance its

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59 The National Business Review (2008), *Northland trail blazes fibre optic route*, 2 May 2008. Available at http://www.nbr.co.nz/article/northland-trail-blazes-fibre-optic-route.

60 Vector Communications (2008), *Our network*. Available at http://www.vectorcommunications.co.nz/network/our_network.asp.

mobile phone and broadband services. The network extension will connect 40 of Vector's electricity substations, and will also connect to 41 of Telecom's exchanges.[61]

Vector has recently submitted a successful expression of interest to the Broadband Investment Fund.

5.2 Overseas examples of utility broadband networks

Utility companies have been particularly active in deploying fibre communications networks in northern Europe, Japan and the United States, where municipal utility companies in several smaller cities have built fibre networks.

Denmark

Most of the participants in the retail FTTH market in Denmark are regional utility companies, such as DONG Energy, TRE-FOR, Energi Midt and Syd Energi, however there are also some broadband providers – for example ComX Networks and Dansk Bredbånd. According to the Danish Competition Authority, the utility companies planned to cover around one million households (40%) at a cost of DKK9.5 billion (NZD1.7 billion).

Both public (eg TRE-FOR) and private (eg DONG Energy) utilities have FTTP deployments.

61 Vector Communications (2008), *Vector announces fibre optic network extension*, 14 February 2008. Available at http://www.vector.co.nz/news/253/.

	December 2006	June 2007	December 2007	Market share December 2007
Dansk Bredbånd	0	0	11 768	19.8%
Dong Energy	3 040	5 044	7 900	13.3%
TRE-FOR	1 769	3 593	7 628	12.9%
Energi Midt	2 232	3 446	7 020	11.8%
Syd Energi	3 334	4 885	6 752	11.4%
Midtvest Bredbånd	859	2 508	4 921	8.3%
SEAS-NVE	1 545	2 929	4 805	8.1%
Sydfyns Intranet	2 701	3 596	4 585	7.7%
Himmerlands Elforsyning	264	1 299	3 219	5.4%
ComX	2 673	2 870	2 908	4.9%
Energi Horsens	376	1 026	2 496	4.2%
FTH Bredbånd	1 223	309	0	0.0%
Other	2 049	3 567	7 106	12.0%
Total	22 065	35 072	71 108	100.0%

Exhibit 5.2: *FTTH subscriptions by provider [Source: National IT and Telecom Agency]*

TRE-FOR has deployed an open-access network, and has signed partnership agreements with neighbouring utilities companies Energi Horsens and Oestjysk Energi, offering services under the Profiber brand. Their aim is to provide FTTH to all 400 000 subscribers of the three companies by 2012.

NESA (now part of Dong Energy) built a fibre network after a storm in 1999 destroyed large numbers of its power lines, so the decision was made to bury the network underground. The potential to lay FTTH at the same time was recognised, with the plan being to lay empty microduct pipes with the power cables, with fibre subsequently being blown in. NESA decided not to provide services itself but allowed competing service providers to use its network to supply triple-play services.

The fully privatised TDC is deploying a FTTN+VDSL network, which is expected to pass 400 000 homes by 2009, however the company notes that competition by the utility companies may force it to invest more heavily in FTTN and FTTH.

Iceland

Optical fibre has been deployed in areas of Iceland by electronic communications companies for some time now. High-speed connections are very common in Iceland; there are two separate optical fibre networks, owned by Iceland Telecom and Reykjavik Energy. There is an optical fibre network encircling the entire country, and laying fibre to individual residential buildings has already begun in several locations. There is a high-speed (100Mbit/s) data transmission network linking all upper secondary schools and continuing education locations. There is also a research network linking 16 universities and research institutes with speeds of up to 1Gbit/s.

Sweden

One of the earliest public initiatives was in the city of Vasterås, located 100km west of Stockholm. The municipal authority engaged the utility Mälarenergi (also owned by the municipal authority) to build a Gigabit Ethernet metropolitan network which is owned and operated by the subsidiary company MälarNetCity. Construction commenced in 2000 and was completed in 2007, covering around 83% of households.

MälarNetCity does not provide retail services – the network is open-access, with more than 25 service providers, comprising national providers (including the incumbent, Telia) as well as local companies. There are now more than 45 000 residential customers and over 2500 business customers, and prices are claimed to be among the lowest in Sweden (100Mbit/s symmetric service costs from SEK299 – NZD49 – per month). There is also a city portal which provides access to user content and a marketplace for businesses and organisations. MälarNetCity charges each customer for the cost of connection, including the cost of fibre-optic cable. This cost is financed by the local banks adding the cost to each homeowner's mortgage.[62] There is a tax refund available that a household can claim, with connected homes also tending to have a premium value.[63] Mälarenergi only commences

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62 Blandin Foundation Broadband Initiative (2007), *Live at the speed of light – open access networks: keeping Minnesota communities competitive*.

63 Analysys Mason for Broadband Stakeholder Group (2008), *Models for efficient and effective public-sector interventions in next-generation broadband access networks*, 9 June 2008.

deployment in a specific area when 60% or more of the homes in that area sign up to the service.[64]

There are now 152 city networks in Sweden, reflecting an investment of more then EUR2 billion[65] (NZD3.1 billion). The networks pass three million homes (around two thirds of all households), and 95% of those networks offer dark fibre.

Norway

In 2007 Norway's largest power utility company, Hafslund, contracted PacketFront – a specialist developer of open access fibre networks – to build an open access FTTH network in Østlandet.

Hasflund will initially offer IPTV and other broadband services to selected housing cooperatives in Oslo. NetNordic, a partner of PacketFront, will be responsible for the integration of the FTTH network, whilst Datametrix will install the core network.[66]

Japan

Several Japanese electricity companies have deployed FTTH networks, with one particularly successful example being the Tokyo Electric Power Company (TEPCO). TEPCO decided to leverage its fibre network that was originally built for internal communications needs, starting to lease dark fibre in 1999. By 2004 it had 39 customers leasing 13 000km of network. In 2002, TEPCO started extending its core network to the last mile. The network architecture is point-to-point Ethernet, with neighbourhood substations used as POP locations, which define the point of handover between the core and access networks. TEPCO undertook market studies to determine when specific areas

64 Bill St Arnaud (2006), *CAnet – news: Real world example of customer owned last mile*, available at http://emperor.canarie.ca/pipermail/news/2006/000281.html, 7 June 2006.

65 Ericsson (2008) *Open networks*, International Conference on Broadband, Athens, 7 June 2008.

66 PacketFront (2007), *Norway's largest power company chooses PacketFront for fibre to the home (FTTH)*, 25 May 2007, http://www.packetfront.com/en/news_events/press_releases/2007/0008.html.

were ready for deployment, with drop cables installed on demand. Within multiple dwelling buildings TEPCO deployed fibre to the basement, then used VDSL over the existing copper within the buildings. This solution offered a best effort service of up to 54Mbit/s, compared to the 100Mbit/s of the full FTTH network.[67]

In 2006 TEPCO and telecommunications operator KDDI agreed to integrate their FTTH networks, with KDDI acquiring TEPCO's network in exchange for shares. This was a strategic decision designed to improve KDDI's ability to compete with incumbent NTT.[68]

United States

There are many municipal utilities in the US, which have been or are in the process of deploying FTTH networks in their cities. These deployments tend to be in outlying cities and towns, in response to a perceived lack of adequate broadband availability through commercial operators. Building high-speed broadband networks is seen as a way of encouraging industry and jobs to these regions. Examples of municipal utilities investing in fibre broadband networks include Jackson Energy Authority in Tennessee, Morristown Utility Systems in Tennessee, Gainesville Regional Utilities in Florida, Danville Utilities in Virginia and Dalton Utilities in Georgia. Below we outline two such networks: Bristol Virginia Utilities' OptiNet, and that of Chelan County Public Utility District.

Bristol Virginia Utilities (BVU) moved into fibre in the late 1990s, when Virginia law stated that municipalities may only lay fibre for internal purposes, although fibre could be leased to a carrier to provide services for a one-time fee. There was interest shown by a carrier, and BVU started deploying fibre in 1999 and built a data centre for governmental use. The carrier deal did not eventuate, so BVU formed a new division OptiNet and fought the legal system to become a pioneer of municipally-owned FTTH networks, providing

67 Broadband Properties (2005), *Tokyo Electric Power: Japan's FTTH powerhouse*, March 2005.

68 KDDI (2006), *KDDI, TEPCO agree to integrate FTTH business*, 12 October 2006, available at http://www.kddi.com/english/corporate/news_release/2006/1012/index.html.

services from 2003. BVU now works with other municipalities to help set up fibre networks.[69]

The funding for the BVU network came from federal and state funds, with the municipality investing USD30 million (NZD48 million), and the project receiving more than USD30 million (NZD48 million) in grants. There are currently 350 miles of backbone fibre and 450 miles of fibre access infrastructure, with 15 points of presence. The services backhaul to a pair of data centres, where voice, video and data services are housed for redundancy. The fibre network comprises both BPON and GPON architectures, capable of providing 622Mbit/sec download / 155Mbit/s upload and 2.4Gbit/s download / 1.2Gbit/sec upload respectively. The fibre has been deployed both overhead and underground, with direct burial and directional boring used for underground installation.

Currently 15 997 premises are passed by the network, and there are 1207 business and 7927 residential FTTH subscribers. BVU offers voice, video and data (triple-play) residential services, and triple-play plus advanced Web and voice services for businesses. The take-up rates range from 56% for video (32.7% for digital video), 42.8% for data and 54% for phone services.[70] BVU OptiNet has succeeded in drawing businesses to Bristol, with two large companies moving to the region on the merit of the network, adding about 700 jobs with an significantly higher average salary than would typically be found in the area.[71]

Chelan County Public Utility District (PUD), in Washington has been building FTTH infrastructure since 1999. Washington state law requires that municipalities lease access to their broadband networks, so about 15 ISPs provide services to residents. The construction of the fibre network has been financed partly through income generated from wholesaling excess electricity from Chelan County PUD's hydroelectric dams to neighbouring regions. As of 2007, the PON network services about 50% of Chelan County's residents (about 20 000 people), with the aim of making fibre available to 95% of residents by 2012, and

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69 LastMILE Online (2007), *Birthplace of FTTP: Bristol, Va muni fibre pioneer*, 17 August 2007, available at http://www.lastmileonline.com/index/webapp-stories-action?id=103.

70 Broadband Properties (2008), *Municipal FTTH deployment snapshot: City of Bristol, Virginia BVU OptiNet*, September 2008.

71 LastMILE (2008), *Pioneering spirit: Bristol, Va., trailblazing muni FTTH*, March 2008.

achieving take-up rates of 27–41%.[72] The average monthly revenue per user for residential services in 2007 was USD30 (NZD48), with 5408 end users subscribing to services.

Chelan County PUD regularly reviews the progress of network build and financial position, including projecting the effects of continuing with different build-out strategies.[73]

5.3 Key features of utility broadband networks

Both public and private utility companies have invested in fibre networks, which in most cases are run on open-access principles.

In the case of private utilities, primarily power companies are deploying fibre communications networks. These deployments tend to arise from either expanding the internal communications networks used by the company, or through taking advantage of the synergies with the company's existing infrastructure, for example laying fibre at the same time as rebuilding or repairing parts of the power network.

In the case of public utility companies there tends to be more of a public good view taken when deciding to invest in fibre, with fibre networks often being deployed by the municipal utility where it is perceived that the region is not being adequately serviced by commercial operators.

In New Zealand if lines companies wish to deploy fibre for telecommunications services then a Resource Management Act (RMA) consent must be obtained for that specific purpose (since an existing RMA consent for electricity cannot be applied to telecommunications). Apart from this requirement, in New Zealand there is no specific

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72 Freepress (2008), *Chelan County PUD*, http://www.freepress.net/communityinternet/chelan.

73 Chelan County PUD Fibre Optics (2008), *Presentations*, https://fiber.chelanpud.org/euedu/about_Us/PUD_Fiber/Presentations/.

electricity legislation or regulation which would prevent or inhibit lines companies from using their infrastructure to provide telecommunications services.

6 Technological and architecture options

6.1 Modern broadband access technologies

There are a number of access technologies available that are suitable for delivering broadband services now and in the near future:

- **Copper twisted pairs:** This is Telecom's traditional PSTN, with copper cables used for the entire access network between the exchange and the end user. Broadband is provided using a DSL variant such as ADSL or VDSL, which requires a DSLAM in the exchange, plus a DSL modem in the customer's premises. DSL speeds are limited by the distance and the quality of both the copper distribution network and the household wiring (both of which are often old and deteriorating). Because the PSTN was designed for voice, it may contain taps, coils and pair gain systems that multiplex multiple voice circuits onto a single pair, all of which may reduce the quality of DSL services or prevent it from working entirely.

- **FTTN (fibre to the node):**[74] FTTN is a combination of fibre and copper twisted pairs – fibre is rolled out to an active cabinet that serves a neighbourhood. Copper extends from the cabinet to the customer, with a DSLAM in the cabinet providing broadband. The greatly reduced copper loop allows much higher DSL speeds. Telecom announced the 'cabinetisation' of its network in late 2007 as part of its separation undertaking,[75] which includes the installation of around 3600 active cabinets fed by fibre throughout

[74] Also referred to as **FTTC (fibre to the cabinet)**

[75] Telecom Wholesale (2007), *Telecom Wholesale customer briefing*, 22 November 2007. Available at http://www.telecom.co.nz/binarys/telecom_cabinetisation_briefing_22_nov_2007.pdf

New Zealand. FTTN provides an economic upgrade to the PSTN, because many of the fibre feeder cables can be easily pulled into existing ducts, without the need for new trenching, the most expensive part of cable installation.

- **FTTP (fibre to the premises):**[76] With FTTP, fibre is rolled out directly to the premises, meaning no copper cables are required in the network. This represents the ultimate solution – broadband speeds of hundreds of megabits per second and more can be achieved. FTTP requires the installation of fibre cables past every home and business in the coverage area, optical terminals in both the exchange and in the customer's premises, and generally requires new house wiring. Thus it is by far the most expensive solution, although it is also considered the most future-proof as upgrading generally requires simply replacing the optical terminals. There are a number of FTTP technologies, such as active Ethernet, PON (passive optical network) and its variants (such as GPON – gigabit PON; EPON – Ethernet PON); GEPON – gigabit Ethernet PON) and P2P (point-to-point).

- **WiMAX:** WiMAX is a broadband wireless access (BWA) technology that replaces the cabled access network with a wireless solution. Spectrum for the use of WiMAX (and other BWA technologies) in New Zealand has been made available in recent years. WiMAX is relatively inexpensive to deploy because it does not require any distribution network cabling, however the total bandwidth available to users is limited (while it may be able to provide a 100Mbit/s connection rate, it may not be capable of providing a satisfactory data throughput if the number of connected customers is high), and services that are available on wired networks (such as video) may not be available on a wide scale. WiMAX may be more suitable for areas where the take-up rate is low, either as a competing technology or in more rural areas.

- **Mobile:** mobile technologies such as HSPA (high speed packet access), HSPA+ (evolved HSPA) and LTE (long term evolution) are evolving from current mobile technologies. Vodafone and Telecom are both expected to deploy these technologies,

76 Also referred to as FTTH (fibre to the home).

starting with HSPA, in the near future.[77,78] They have similar characteristics to WiMAX.

- **HFC (Hybrid fibre-coaxial):** The HFC architecture uses a combination of fibre and coaxial cable to provide video and broadband services. The fibre cable extends from the operator's exchange or head-end to cabinets (optical nodes), with coaxial cables connecting the optical nodes (cable modem termination system) to customers' premises. HFC, used by TelstraClear in Wellington, Kapiti and Christchurch, is a good alternative to the FTTN technology. TelstraClear offers connection rates of up to 25Mbit/s on its network in Christchurch, and up to 10Mbit/s in Wellington and Kapiti.

- **Satellite:** Satellite is used as a technology of last-resort because of the high costs – particularly the high setup costs. It is often very used in remote areas that have a need for broadband. Satellite also suffers from problems caused by high latency, although modern systems can reduce these effects. Satellite operators that provide services to New Zealand include IPSTAR, Inmarsat and Optus.

Alternative technologies include other terrestrial wireless systems and broadband over powerlines.

6.2 Characteristics of broadband access technologies

The characteristics of each of the technologies listed above are summarised in Exhibit 6.1 below. The characteristics relate to how suitable the technology is to meeting the requirements of the goals of providing coverage to about 75% of the population.

- 100Mbit/s: can the technology provide 100Mbit/s connectivity in the downlink to consumers within the next ten years?

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77 The New Zealand Herald (2008) *Vodafone commits to $500 million mobile investment*, 4 June 2008, available at http://www.nzherald.co.nz/technology/news/article.cfm?c_id=5&objectid=10519985

78 Computerworld (2008) *Telecom to roll out $574 million 3G network by June*, 15 October 2008, available at http://computerworld.co.nz/news.nsf/netw/F6B479AA4690B8A2CC2574E2007221D3

- 1Gbit/s: can the technology provide 1Gbit/s connectivity in the downlink to businesses within the next ten years?
- Universal: can the technology be expected to provide a satisfactory[79] data throughput when providing universal coverage? That is, can services provided to all customers who requires them?
- Video: can the technology be used to provide video services?
- Future-proof: can the technology be updated or upgraded in the medium-term or long-term future?
- Price: a rough indicator of the cost of rolling out a network with that technology, from inexpensive ('$') to most expensive ('$$$').

Characteristic	*Copper*	*FTTN / VDSL2*	*FTTP*	*WiMAX*	*Mobile*	*HFC*	*Satellite*
100Mbit/s	×	✓[1]	✓[2]	✓[3]	✓[4]	✓[5,6]	✓
1Gbit/s	×	×	✓	×	×	×	×
Universal	✓	✓	✓	×	×	×	✓
Video[7]	×	✓[8]	✓	×	×	✓	✓
Future-proof	×	×	✓	×	×	?	×
Price	$[9]	$$	$$$	$$	$$	$$	$$$

1 FTTN bandwidth is shared on the cabinet backhaul; level of sharing is dependent on the bandwidth deployed by the operator

2 Bandwidth sharing is dependent on the technology – see Exhibit 6.2.

3 Bandwidth is shared with other users; total bandwidth available is dependent on spectrum available

4 Bandwidth is shared with other users; total bandwidth available is dependent on spectrum available

5 DOCSIS 3.0

6 Bandwidth is shared between all users on the cable modem termination system (CMTS)

7 Broadcast quality

8 Video-on-demand but not broadcast video

9 Assumes copper is already available

Exhibit 6.1: *Suitability of broadband technologies for coverage of 75% of population [Source: Network Strategies]*

79 While we have not defined what satisfactory means in this context, it is clear that some of the listed technologies are less suited to providing universal coverage than others.

6.3 Modelled access technologies

Of the technologies from Exhibit 6.1 above, we have selected FTTN with VDSL2 and FTTP as the suitable technologies for the 75% coverage business case models discussed in Section 8. FTTP is the only technology that that meets all the requirements; FTTN with VDSL2 (augmented with FTTP to provide 1Gbit/s services where required) is a useful compromise between meeting the requirements and cost. While not selected for this exercise, other technologies such as WiMAX and mobile may be suitable for the remaining 25% of the population. Indeed, satellite may be the only suitable solution in some remote areas. However we have not investigated coverage in these areas.

Three common FTTP technologies are:

- GPON (gigabit passive optical network)
- active Ethernet
- P2P (point-to-point)

A comparison of the FTTN/VDSL2 characteristics and the FTTP architectures is shown in Exhibit 6.2.

	FTTN/VDSL2	*GPON*	*Active Ethernet*	*P2P*
Maximum distance[1]	Up to 80km (fibre component)	Usually 10–20km	Usually 80km (star configuration)	Up to 80km
Maximum downlink	100Mbit/s (for up to 500m copper length)	Currently 1.2Gbit/s[2]	Typically 1Gbit/s-10Gbit/s[3]	Typically 100Mbit/s–1Gbit/s[4]
Maximum uplink	50Mbit/s[5]	Currently 622Mbit/s[2]	Typically 1Gbit/s-10Gbit/s[3]	Typically 100Mbit/s–1Gbit/s[4]
Cost characteristic	Makes use of existing copper access network	Large number of splitters; spare capacity must be built in from start to allow for future growth	Requires powered equipment in field	Higher exchange costs (due to large number of ports) and higher fibre costs
Reliability	Extremely dependent on quality of copper cables	No management of equipment. Failure will affect all users on fibre.	Equipment can be actively managed. Failure can be mitigated with route management.	Failure will only affect users on compromised fibre.

1 Approximate. Actual maximum distance will depend on factors such as equipment used and fibre type.

2 Shared between all users on fibre.

3 Shared between all users on aggregation ring (between exchange and aggregation router). Maximum individual customer speed generally 100Mbit/s–1Gbit/s.

4 Dedicated between user and exchange, but shared with other customers beyond the exchange

5 Common VDSL2 switch uplink limit.

Exhibit 6.2: *Characteristics of FTTN and FTTP technologies [Source: Network Strategies]*

P2P is generally the most expensive FTTP option. The additional costs come from the significant increase in the fibre feeder cables. To help reduce these costs, additional nodes may be deployed to move the exchange equipment closer to the customer and reduce the length of feeder cables. In its extreme form, the node can be moved to the customer's neighbourhood – a similar architecture to the modelled active Ethernet architecture, in which the individual fibres to the customers may be unbundled and made available to Layer 1 access seekers. (In this example active Ethernet can be considered a 'cabinetised' version of P2P – similar to the relationship between a pure copper network and FTTN).

Except for certain scenarios, we have assumed each network is a wholesale network, selling lit fibre 'Layer 2'[80] capacity to retailers.

We have selected GPON and active Ethernet as suitable FTTP technologies for this study, so the three access technologies modelled are:

- FTTN with VDSL2 – an extension of Telecom's access network
- GPON
- active Ethernet.

These modelled technologies are described in more detail in the following sections.

6.4 FTTN plus VDSL2

A fibre to the node architecture would most likely be used when the network is based on Telecom's existing network and planned cabinetisation rollout (described above). This scenario takes Telecom's plans one step further: rather than using ADSL2+ (with a theoretical maximum of 24Mbit/s), it uses VDSL2 which has a theoretical maximum data rate of 250Mbit/s. However like any DSL, the data rate degrades with the length of the copper cable; to provide a service of 100Mbit/s the length must be no longer than 500m. To reduce all copper cables to less than 500m, a significant number of additional cabinets must be deployed. Existing ADSL2+ cabinets need to be upgraded to VDSL2.

VDSL2 is not able to provide the 1Gbit/s service; for customers that require this data rate, fibre will need to be rolled out directly to customers requiring 1Gbit/s services.

6.5 GPON

The PON (passive optical network) is a fibre network that does not use any powered electronic equipment between the exchange and the end user – distribution is achieved by splitting the fibre's beam optically. The key advantage of the PON is the splitters are

80 Ethernet services.

passive, saving on power, housing and maintenance costs. A disadvantage is the signal is broadcast to all customers on the fibre, which introduces privacy issues, solved with encryption. Maximum transmission distance is also shorter than other options such as active Ethernet because of losses in the splitter, and the lack of regenerators.

There are a number of derivations of the PON:

- BPON (broadband PON): BPON supports a higher bandwidth than PON
- GPON (gigabit PON): GPON introduced support for Ethernet
- EPON (Ethernet PON)/GEPON (gigabit Ethernet PON): an IEEE standard for Ethernet over PON.
- WDM-PON (wavelength division multiplexing PON): a new version of PON that uses different wavelengths to provide services to different customers.

PONs generally consist of two levels of splitters – the first splits a feeder fibre into typically up to 16 to 32 distribution fibres, and the second splits into two to eight fibres (with up to a maximum of 128 drop fibres per feeder, although 32 or 64 are more commonly used in practice), from which individual premises are fed.

In this business case study, we have chosen GPON to be included as a technology option. GPON is a popular technology for residential service provision, and is used by Verizon, BT, AT&T, and many other operators.

A GPON would be an entirely new network, although it may amalgamate with existing fibre networks where suitable. Thus the design for the network is not constrained to Telecom's existing architecture, and can be designed as efficiently as possible. For example, GPON nodes (the operator's points of presence) are located in the most suitable locations in each town or city – they are not constrained to existing Telecom exchange sites.

6.6 Active Ethernet

Active optical networks use powered devices to switch signals on the fibre network. In active Ethernet, the devices are switches and routers. The use of the active routers provides a number of advantages over GPON:

- because the active devices regenerate the signal, active optical networks can transmit over longer distances than GPON and P2P, and can have more flexible configurations
- the network can be better managed due to the active components (routers), which help the operator to keep track of network faults
- can use a ring structure which provides more robustness.

However, this configuration is more expensive to install and operate.

Because of the ability to manage the routers and its robustness, active Ethernet is often used to provide business services that require higher reliability.

6.7 Technology issues

In this section we discuss some of the issues that need to be considered when planning a broadband network:

6.7.1 Micro-trenching and micro-ducts

There exist a number of methods of deploying fibre: direct burying, installing in ducts laid in trenches, direct moleploughing, drilling directly under the surface of the ground, and using overhead poles. In recent years a new option has appeared: micro-trenching. Micro-trenching is an all-in-one solution that also requires micro-ducts and micro-fibre.

Micro-trenching replaces traditional deep and wide trenches with a narrow trench that is sliced in the surface of the road. It makes use of micro-ducts with narrow, vertical cross-sections (12mm by 30mm for example, rather than circular), in which the cables sit above each other, and very small diameter fibre cables (for example 24 fibres in a 4mm diameter cable, and 72 fibres in a 6.1mm cable[81]).

The traditional trench, which accommodates standard 100mm ducts and large diameter cables, requires breaking into the road surface, digging the trench with heavy machinery (avoiding existing services), placing the duct, backfilling the trench, and the reinstatement of the road surface. It is a time-consuming and expensive exercise. On the other hand, the micro-trench does not penetrate the surface of the road. It is backfilled with grout, concrete or similar substance. Once backfilled, micro-trenches may be practically invisible.

While micro-trenching may be significantly cheaper than traditional trenching, it is not necessarily a universal remedy, and there are a number of problems that must be overcome, such as road movement, road resurfacing and other utilities:[82]

Road movement	The surface of the road can move with the weight of the traffic. Even quite small movements can be sufficient to crush or otherwise damage the cable. To reduce movement, cables are installed along the edge of the gutter of the road, where the curbing will add strength.
Road thickness	Micro-trenches are at least 100mm deep, and thus the road surface needs to be at least that thick, however in New Zealand this is rarely the case. Cutting into the base of the road will seriously reduce the benefits of micro-trenching as extra measures are required to ensure water does not penetrate the road base.
Road resurfacing	When roads are resurfaced, the fibre must be physically removed from its micro-trench, and reinstalled afterwards. This reduces the cost benefit of this system.
Other utilities	The trenching saw may "slice through storm water drains, gas pipes

81 TeraSpan (2007), *Innovation in fiber deployment*, available at http://www.teraspan.com/node/185

82 See Dominion Post article, *The saw that could save us $2b*, 14 July 2008, available at http://www.stuff.co.nz/4617846a28.html and http://www.teraspan.com/system/files/u6/8_NW_InfoTech_The_Saw_that_could_save_us__2b.pdf

and electricity cables before operators even knew they were there”[83] – although in general drains, pipes and other cables are usually well below the surface of the road.

Other options are to install micro-fibres in footpaths and grass, which have the benefit of removing the requirements of traffic management.

Roads exhibit a great amount of variability – thus micro-trenching should not be relied upon, but used when the conditions are appropriate. However, it is not clear how compatible micro-fibre and splices are with traditional fibre technology.

6.7.2 House wiring

Premises connected to a FTTP network must have high quality wiring to get full benefit out of the high speed connection: category 5 Ethernet cable is generally considered the standard for 100Mbit/s data rates. For 1Gbit/s data rates, category 6 Ethernet cable is standard.

6.7.3 Copper network quality

As noted above, Telecom’s copper cable network is old and deteriorating; cables suffer from water damage, joints fail and insulation breaks down. Many pairs are unable to be used for even voice; spares are used in their place. Cables may contain taps and coils that affect the quality of DSL or prevent it from working entirely; these must be removed.

In addition, when the concentration of DSL services in a cable is high, interference between pairs may reduce the maximum attainable speed.

Therefore a network that uses the copper network – such as FTTN with VDSL2 – will not be able to provide a service at the theoretical data rate to all potential customers, with some

83 *Ibid.*

not being able to receive any service at all. In practice, the modelled maximum of 500m may need to be reduced.

6.7.4 Core network infrastructure

The technologies discussed here are entirely within the access network (between the exchange and the end user). We have not considered the core network, which connects exchanges to each other and the outside world. If the access speed for customers is going to increase from the current typical 2–10Mbit/s to the target of 100Mbit/s or 1Gbit/s, there needs to be a corresponding increase in the capacity of the core network, otherwise customers will not receive the benefit of their increased access speeds.

The cost of upgrading the core network would be significantly less than the cost of upgrading the access network. The core network between most of the cities and towns considered in this study is competitive, with a number of players operating backbone (long haul) networks commercially in many regions of the country.

7 Market analysis

7.1 Affordability will be crucial to service take-up

A wholesale broadband venture will fail unless sufficient retail customers take up a service that uses the wholesale product. The challenge is for the retail service providers to develop offers that will engage the addressable market.

While the primary retail offering will be high-speed Internet access, retail service providers will seek to differentiate their products in order to capture market share – from existing lower speed broadband services and from each other.

New Zealanders were some of the earliest adopters of the Internet, but the market does appear to be reaching saturation. As at December 2006, the residential market was fairly evenly segmented into households with broadband, households with dial-up access and households with no Internet (Exhibit 7.1). Since that time, broadband has experienced strong growth, but the total Internet market has increased only slightly (Exhibit 7.2), which suggests that the broadband market is largely being driven by subscribers switching from dial-up services. We estimate that just over half of New Zealand households now have broadband services. In regards to the business market, there is little room for further growth – as at August 2006, 91% of businesses[84] (excluding micro businesses – those with five or fewer employees) had Internet access.

84 Statistics New Zealand (2007) *Information and Communication Technology in New Zealand: 2006*, 22 November 2007.

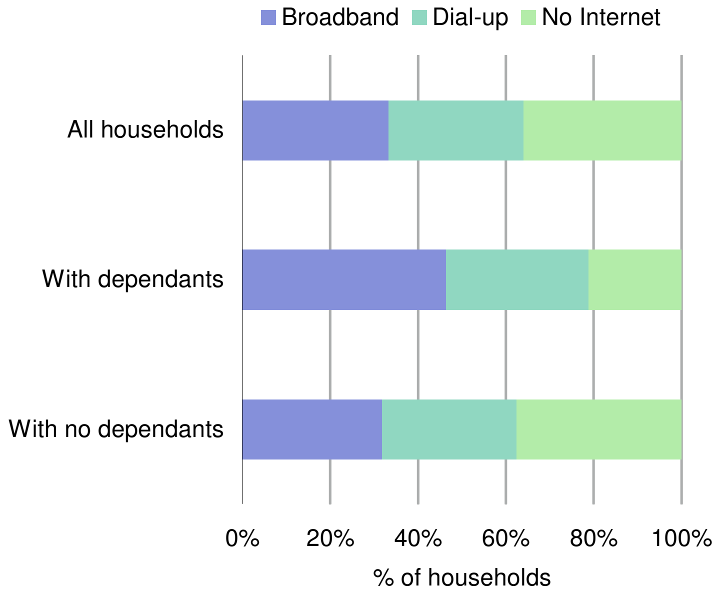


Exhibit 7.1:
Household take-up of Internet access, December 2006 [Source: Statistics New Zealand]

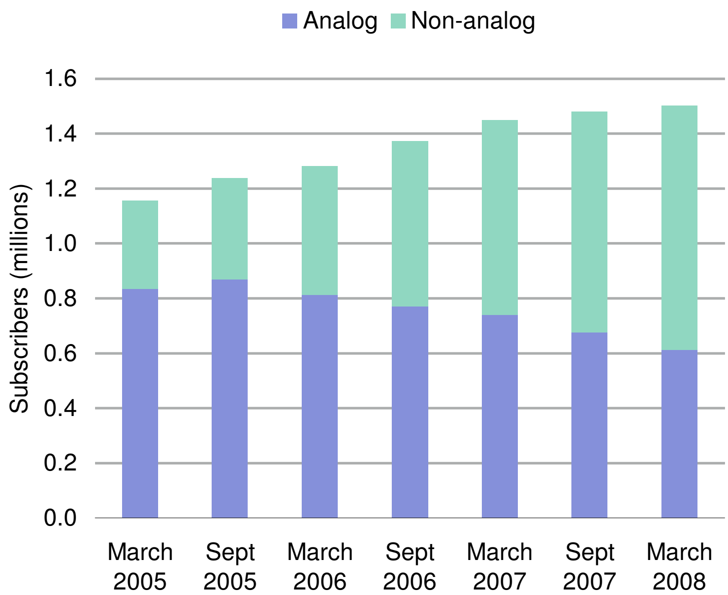
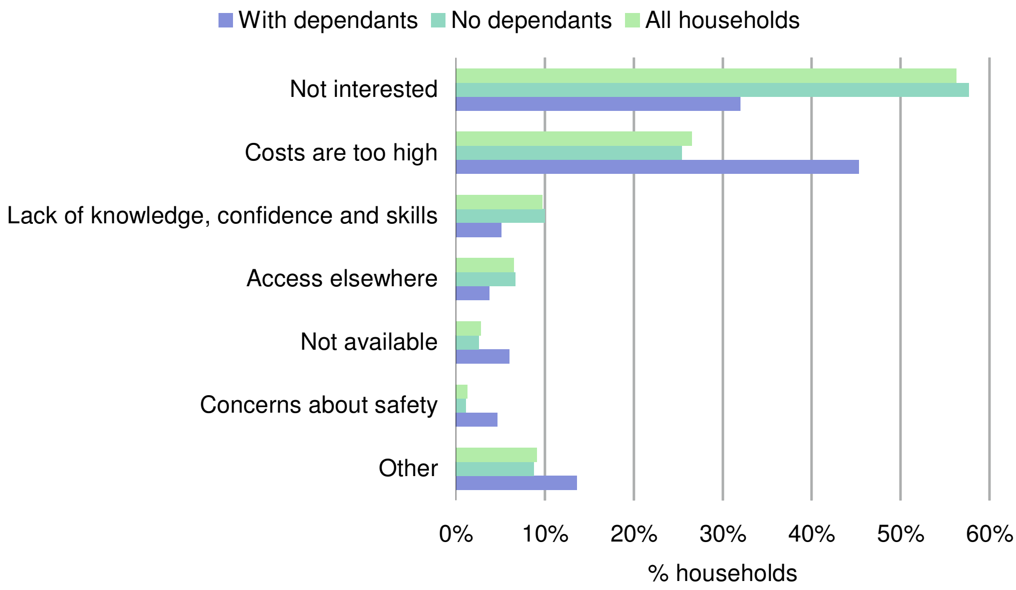


Exhibit 7.2:
Internet services in New Zealand, March 2005 to March 2008 [Source: Statistics New Zealand]

Will the market segment without broadband take up fibre?

There remains a sizable market segment with no Internet access. In December 2006, nearly 60% of households without access to the Internet claimed they had no interest in subscribing to a service; over one-quarter of households claimed that the cost was too high (Exhibit 7.3).



Note: Households could nominate more than one reason for not having Internet access.

Exhibit 7.3: *Reasons for households not having Internet access, December 2006 [Source: Statistics New Zealand]*

Of those households that had only dial-up Internet access, just over half claimed that high costs were the main reason why they had not subscribed to a broadband service, and around one-third felt that dial-up was sufficient for their needs (Exhibit 7.4).

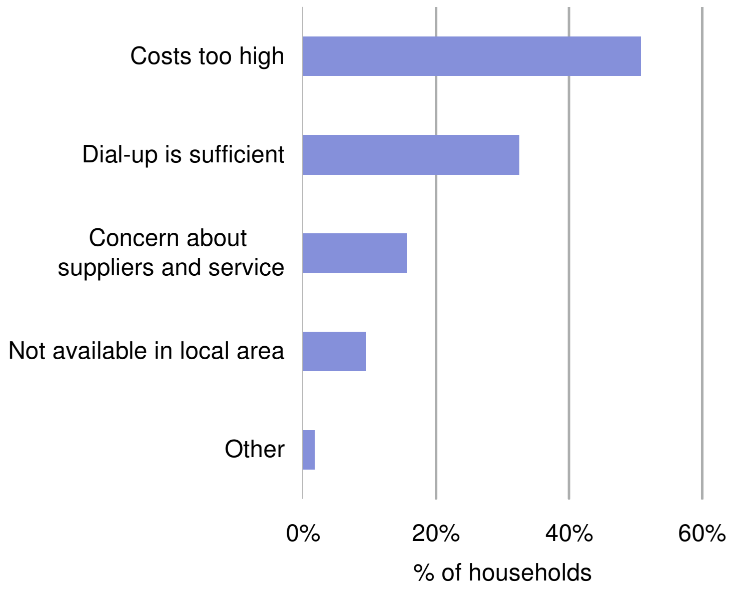


Exhibit 7.4: *Reasons for households with only dial-up Internet not having broadband access, December 2006 [Source: Statistics New Zealand]*

Note: Households could nominate more than one reason for not having broadband access.

This evidence therefore suggests that it would be a significant marketing challenge for a premium-priced high-speed broadband service to gain market share within households currently without Internet access or still using dial-up services, where the key issues are cost and lack of interest in broadband services. One strategy to capture interest would be to offer a heavily discounted service for an initial period – for example OnsNet, the co-operative venture in the Netherlands, offered free access for the first year after which monthly fees were charged.[85]

Another strategy would be to bundle various other service offerings, such as telephony, pay TV and video on demand. This may entice potential subscribers to take-up broadband in conjunction with other offerings perceived to be of value – if the total price of the bundle is less than the sum of the individual service prices – or the retail service provider could offer bundles without the Internet component.

85 Network Strategies (2008) *Broadband Strategy Options for New Zealand: Stage one – research and analysis*, September 2008.

As for encouraging existing broadband subscribers to switch to higher bandwidth services, the challenge will be to quantify the value users will assign to the increased bandwidth.

Market penetration – how high?

A key part of developing a feasible business plan for fibre access is to ensure that the take-up assumptions are realistic, given the market conditions. There have been a number of studies examining the propensity to subscribe to broadband services. Depending on the study, and the characteristics of the market being examined, the demographic factors which influence broadband adoption can include:

- age
- gender
- education
- ethnicity
- household type
- income
- occupation.

Given that almost 30% of New Zealand households do not have computers,[86] any business case reliant on fibre take-up in excess of 70% of households would be achievable only if PC ownership can also be increased or if the non-PC owners can be attracted to pay TV or video-on-demand. Note that this segment is likely to be extremely price-sensitive and the cost of computers or other viewing devices may represent a major barrier to take-up.

Penetration rates approaching 70% would require that there was no low-price alternative – even the lower bandwidth ADSL. Yet, as we have seen with dial-up Internet, there is certainly a market segment which continues to retain the least expensive option for Internet access, despite the availability of modestly priced broadband plans.

86 As at December 2006. Source: Statistics New Zealand (2007) *Household Use of Information and Communication Technology 2006*, 27 April 2007.

Views obtained from local industry indicated that take-up of around 30–40% was more feasible. This level appears realistic given actual service adoption levels in other competitive markets:

- across North America, just over 30% of the 12.4 million homes passed have taken at least one service over fibre[87]
- Iliad, the French alternative network operator, expects FTTH to achieve 25% take-up after two years[88]
- France Telecom has achieved 10-15% take-up across the ten cities in which it has FTTH coverage.[89]

There are certainly instances of FTTH penetration in excess of 70% – for example OnsNet in the Netherlands – however these are often community networks, which tend to generate a great amount of local goodwill, or where alternative broadband services are expensive in comparison.

7.2 Retail and wholesale price points

Take-up of the retail services will be strongly influenced by price – as described above, cost is certainly an important consideration in the buying decision, and mass market penetration will not be achievable unless the retail service is affordable.

In general terms, the price points used in broadband pricing do not tend to change markedly over time – instead the plan features are enhanced, so consumers obtain an improved service for the same price. So, over the past few years we have seen speeds and data caps increase and various features – such as antivirus software, online data storage, and modems – included within plans.

87 FTTH Council North America (2008) *North American FTTH/FTTP Deployment Status*, September 2008.

88 Telecommunications Online (2008) *Altnets complain about France Telecom's FTTH advantage*, 27 February 2008.

89 *Ibid.*

New Zealand tends to lag the leading overseas broadband markets – in terms of penetration and service features – by around two to three years. So an indication of short to medium term trends for New Zealand plans may be gained from an examination of current plans available in key markets, particularly in Europe.

We examined fibre plans in a number of countries in Asia, Europe and North America, and found that prices exhibit a wide variation, as do service features (Exhibit 7.5). The cheapest plans are in Japan, however these inexpensive plans are available only to customers living in apartments installed with NTT's fibre – price is almost doubled if the customer lives in a detached house. Note that care must be taken when comparing plans, as some apply only to Internet access, while others are bundled with telephony, pay TV and video-on-demand.

Provider	*Country*	*Download speed*	*Data cap*	*Monthly price (NZD)*	*Notes*
Asahi-Net with NTT West	Japan	100Mbit/s	unlimited	38.96	Symmetric service. In apartment buildings with NTT Mansion equipment installed
Profiber	Denmark	1Mbit/s	unlimited	44.62	Symmetric service
Free	France	100Mbit/s	unlimited	51.01	50Mbit/s uplink. Includes 10GB storage, telephony and pay TV
Bredbandsbolaget	Sweden	100Mbit/s	unlimited	54.73	Includes 10GB storage and telephony
Korea Telecom	Korea	50Mbit/s	unlimited	57.65	Symmetric service, three year contract.
KDDI	Japan	100Mbit/s	unlimited	57.95	–
Korea Telecom	Korea	50Mbit/s	unlimited	64.43	Symmetric service, one year contract.
Clix FIBRA	Portugal	30Mbit/s	50GB	66.22	Includes telephony
Verizon	US	10Mbit/s	unlimited	66.39	Requires existing Verizon phone service
FastWeb	Italy	10Mbit/s	unlimited	71.12	–
Profiber	Denmark	10Mbit/s	unlimited	71.60	–
Orange	France	100Mbit/s	unlimited	76.36	Includes pay TV and telephony
KDDI	Japan	1Gbit/s	unlimited	76.82	–
Korea Telecom	Korea	100Mbit/s	unlimited	77.31	Symmetric service, one year contract
Asahi-Net with NTT West	Japan	100Mbit/s	unlimited	77.50	Symmetric service, in detached house.
Verizon	US	20Mbit/s	unlimited	81.83	5Mbit/s uplink. Requires existing Verizon phone service
Clix FIBRA	Portugal	50Mbit/s	100GB	88.37	Includes telephony, and free national offpeak calls
Telenor	Norway	25Mbit/s	unlimited	86.44	Includes online photo album
Verizon	US	20Mbit/s	unlimited	100.36	Symmetric service. Requires existing Verizon phone service
Clix FIBRA	Portugal	100Mbit/s	200GB	110.51	Includes telephony, free calls within Portugal and selected countries

Exhibit 7.5: *Fibre broadband plans, October 2008 [Source: service providers]*

Some overseas operators – for example Korea Telecom, the Norwegian Telenor, FastWeb in Italy and Free in France – retail plans that are technology independent. Thus the service delivered under any specific plan has a bandwidth that reflects the technology used for access, which may be FTTH, VDSL or ADSL.

Other operators that offer both fibre and ADSL services – such as Verizon in the United States and the Portuguese Clix – charge more for fibre plans than for ADSL.

The retail market will switch to fibre services if the price-value proposition is perceived to be acceptable. Clearly if retail fibre plans were priced similarly to lower speed ADSL plans, there would be a strong incentive for existing broadband users to switch to fibre, assuming that it is available in their area. Pricing comparable to ADSL may not be sufficient to entice the non-broadband market to take up a fibre service, unless other strategies – such as heavily discounted introductory periods, or bundling with other services of value to this segment – are applied.

Alternatively, if retail fibre were to be priced at a premium to ADSL, what should that premium be? The answer to this will depend upon market share objectives.

Our discussions with industry players revealed that the price point for residential broadband is perceived to be around NZD50. Note that Telecom's most popular broadband plan – currently claimed on its website to be the 'Go' plan – has a fixed cost of NZD39.95 per month (if the subscriber has a Telecom home line and uses Telecom for toll calling – if not, the price increases to NZD49.95 per month) and includes a data cap of 3GB.

Market research conducted by France Telecom for the launch of its Orange-branded fibre service in March 2007 found that there was a "psychological price barrier" at EUR50 per month (NZD85).[90] Orange's 'la fibre' triple-play service retails at EUR44.90 (NZD76), which at launch was EUR5 below cable competitors' base service.

It is likely that there is a similar psychological price barrier at NZD50 – which suggests that this is the price point for a mass market broadband service (that is, excluding bundled options such as content services or telephony).

90 France Telecom (2007) *From FTTH pilot to pre-rollout in France*, 20 September 2007.

A study for the Auckland Regional Broadband Advisory[91] examining the potential for enhanced broadband access in Auckland found that the amount consumers would be willing to pay increased with income and if there was SkyTV in the home, but was reduced in older households and with households with a high proportion of Europeans. The study estimated that the average willingness to pay for an FTTH service (including telephony and television, which may include pay TV and video-on-demand) was NZD98.50[92] per month. Furthermore, just over 12% of respondents to the study survey indicated that they did not wish to pay for the service, suggesting that a sizable proportion of households are not interested in the service proposition.

In addition the study estimated the average amount business users would be willing to pay for an FTTP service to be NZD109[93] per month, however it was felt that this was an under-estimate of the real value of the service to firms – 15% of survey respondents were prepared to pay NZD275 per month for the service.

These estimates of willingness to pay are subject to a high level of uncertainty, due to the underlying data and the estimation methods explaining less than 20% (in the case of households) and less than 30% (for businesses) of this variation. Furthermore, any pay TV offerings over fibre are unlikely to include rugby (discussed further in Section 7.4) – which has been a key driver for pay TV uptake in New Zealand. We therefore conclude that there is considerable risk associated with the estimates, and that the estimate for household willingness to pay may be greatly overstated.

Note that monthly ARPU for the SkyTV service is NZD62.10, and take-up comprises 46% of households.[94]

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91 Covec (2008) *Open Access Broadband in Auckland: Demand, Costs and Benefits*, report for the Auckland Regional Broadband Advisory, June 2008.

92 Note that a relatively wide confidence interval is associated with this estimate.

93 Similar to the estimate of residential willingness to pay, a relatively wide confidence interval is associated with this estimate.

94 Sky Network Television (2008) *Annual Results 2008*.

Pricing the wholesale fibre product

The relationship between the wholesale price of fibre and that of unbundled copper local loop (UCLL) will influence the relative prices of retail fibre and DSL. In Exhibit 7.6 below we explore the likely pricing strategies for various types of retail providers offering fibre services, in a situation where there is an open access fibre network.

	Relationship of wholesale prices of open access fibre and UCLL	
Retail provider	*Fibre > UCLL*	*Fibre ≤ UCLL*
Incumbent with copper network	If incumbent offers retail fibre service (purchased from wholesale operator) set price as a premium product to minimise existing customers switching	Set retail fibre price to the DSL price or with a small brand premium
Entrant purchasing UCLL	Retail fibre priced as a premium product	Encourage retail customers to swap to fibre, by setting retail fibre to the DSL retail price
Entrant purchasing wholesale fibre (not UCLL)	Retail fibre priced as a premium product, but at a competitive price to capture market share from DSL providers	Set retail fibre service to the DSL price
Incumbent / entrant deploying own fibre	Set fibre prices to be competitive with other providers' offerings	

***Exhibit 7.6**:* *Effect on retail price due to different wholesale price positioning, in a market with an open access fibre network owned by a separate wholesale provider [Source: Network Strategies]*

Clearly, if the wholesale price of fibre is lower than that of UCLL there would be a huge financial impact on an incumbent operator offering UCLL. The larger the difference, the more rapid will be customer migration to fibre services.

Note that it may be viewed as anti-competitive if public sector subsidisation enabled the wholesale fibre price from an open access network to be lower than that of UCLL. Thus the price for urban UCLL ($19.34[95]) should be viewed as a floor price for wholesale fibre.

95 Commerce Commission (2007) *Standard Terms Determination for the Designated Service Telecom's unbundled copper local loop network*, Decision 609, 7 November 2007.

The view of local industry players was that the wholesale fibre price should be within the range $20–30.

There is a great variation in the wholesale prices of FTTP (Exhibit 7.7) – ranging from around $25 to nearly $80 for a small sample of providers. Note that NTT's wholesale price – set by regulation – is relatively high, which, given that retail prices for fibre services are low, suggests that the NTT local operating companies may be subsidising the service, or else the regulated price is significantly above cost.

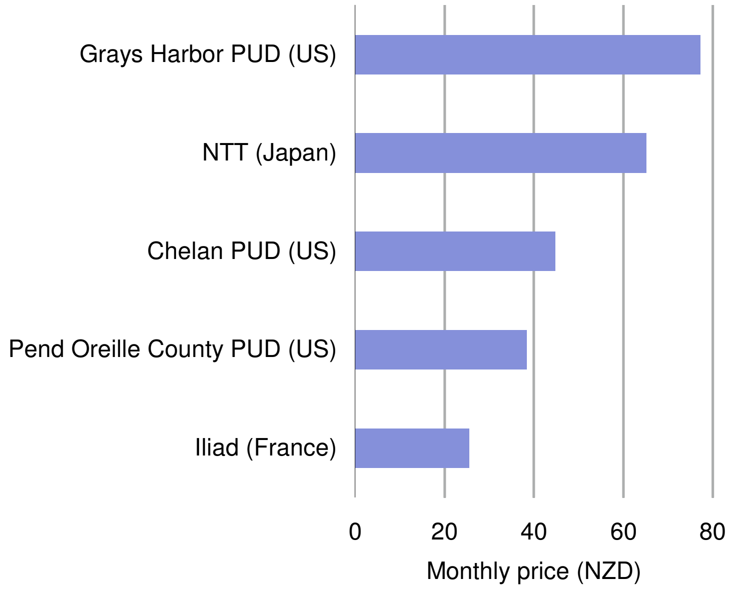

Exhibit 7.7: *Wholesale FTTP loop prices for a sample of providers (NZD) [Source: providers]*

7.3 Data caps: potential to limit economic development achievements

One of the characteristics of broadband plans in New Zealand has been the use of data caps, which apply a usage limit per month, after which – depending on the plan – the subscriber pays a per-Mbyte charge for usage above the data cap threshold, or the service bandwidth is reduced for the remainder of the month.

While a detailed analysis of data caps is beyond the scope of this report, we recognise that they have long been a component of broadband services in New Zealand. As a result, any analysis of the affordability of broadband services must take into account not only the monthly access fees but also any additional cost that may be associated with usage above that covered by any data cap. With the higher bandwidth services available through fibre, consumer usage will be increasing as greater downloads become possible.

The price of international connections is held to be one of the factors which necessitates usage-driven tariffs for broadband in New Zealand. It should be noted that Southern Cross Cable Network recently announced[96] price reductions of at least 44% for its services; furthermore increasing competition and capacity in the submarine cable market may well bring substantial benefits for consumers. We would therefore anticipate that over the next few years data caps will become more generous.

Nonetheless the issue of data caps will be crucial for achieving economic development and consumer benefit goals through affordable high-speed broadband. Subsidised ultra-fast connectivity will be of little benefit to the nation if data caps are modest and subscribers penalised with high charges or service restrictions for usage beyond those monthly limits. Subscribers will quickly learn to make do with less, with the outcomes being:

- subscribers self-limiting their usage – perhaps even to the level at which ADSL services would have been sufficient
- constraining the ability of industry sectors to achieve productivity gains through the high speed applications possible with ultra-high bandwidth services
- imposing constraints or excessive costs on content and application developers
- massive public investment having been made on infrastructure that does not realise its full potential, either as a business venture or as an economic enabler.

We find that the data caps in New Zealand are relatively small in comparison to monthly data allowances for similarly priced plans overseas. Variation across the different countries may be due to a number of factors, including (but not restricted to):

- level of competition in retail broadband services
- competition in the wholesale international bandwidth market
- competition in the wholesale domestic backhaul market

96 Southern Cross Cable Network (2008) *Bold steps to support*, media release, 4 November 2008.

- demographic factors such as population dispersion and density
- user behaviour and propensity to access locally-sourced versus international content.

In an examination of broadband plans priced between NZD40 and NZD60 from a sample of service providers worldwide, we found that most offered unlimited downloads (Exhibit 7.8 and Exhibit 7.9). The plans for both Telecom and TelstraClear had data caps of 10GB – the only plan with a lower cap came from the Icelandic incumbent operator (Siminn), however that plan included unlimited domestic downloads.

Provider	*Country*	*Download speed*	*Data cap*	*Monthly price (NZD)*	*Notes*
Asahi-Net with NTT West	Japan	100Mbit/s	unlimited	38.96	Symmetric service. In apartment buildings with NTT Mansion equipment installed
Asahi-Net with NTT East	Japan	100Mbit/s	unlimited	41.11	Symmetric service. In apartment buildings with NTT Mansion equipment installed
KPN	Netherlands	3Mbit/s	unlimited	43.57	Includes wireless modem
Profiber	Denmark	1Mbit/s	unlimited	44.62	Symmetric service
Tiscali UK / Pipex	UK	16Mbit/s	unlimited	45.23	Business grade service
Swisscom	Switzerland	5Mbit/s	unlimited	45.78	Includes router
Verizon	US	3Mbit/s	unlimited	46.31	Requires existing Verizon phone
eircom	Ireland	3Mbit/s	30GB	46.71	Includes 1GB storage and access to sports channel
Telia	Sweden	8Mbit/s	unlimited	47.72	Includes 2GB storage
TDC	Denmark	8Mbit/s	unlimited	48.39	Includes 1GB storage
Bell Canada	Canada	7Mbit/s	60GB	48.47	Includes wireless modem, unlimited WiFi access
BT	UK	8Mbit/s	15GB	48.69	Includes 5GB storage, wireless router plus 350 minutes WiFi access per month and free national offpeak calls
Telecom New Zealand	NZ	24Mbit/s	10GB	49.95	Requires Telecom line and using Telecom for all toll calling. Includes Flickr Pro account

Note: shaded rows indicate FTTH plans, all other plans are ADSL/ADSL2+.

Exhibit 7.8: *Broadband plans available for a monthly budget of NZD40–50, October 2008 [Source: service providers]*

Provider	*Country*	*Download speed*	*Data cap*	*Monthly price (NZD)*	*Notes*
Orange	France	18Mbit/s	unlimited	50.85	Includes unlimited calls to fixed lines and pay TV
Free	France	100Mbit/s	unlimited	51.01	50Mbit/s uplink. Includes 10GB storage, telephony and pay TV
Telenor	Norway	1.5Mbit/s	unlimited	51.80	Includes 1GB photo album
Internode	Australia	24Mbit/s	10GB	54.03	Includes some unmetered content services
TPG	Australia	24Mbit/s	50GB	54.08	Download limit is 25GB peak, 25GB offpeak. Includes 500 minutes of VoIP calls
Clix	Portugal	24Mbit/s	unlimited	54.70	Includes pay TV, unlimited national telephone calls and unlimited international calls to selected countries
Bredbandsbolaget	Sweden	100Mbit/s	unlimited	54.73	Includes 10GB storage and telephony
TelstraClear	NZ	24Mbit/s	10GB	55.95	Requires TelstraClear line and using TelstraClear for direct dial calling. Includes some unmetered content
Siminn	Iceland	1Mbit/s	4GB	56.97	Includes unlimited domestic downloads, 500MB storage and pay TV
Korea Telecom	Korea	50Mbit/s	unlimited	57.65	Symmetric service. Same price for ADSL (8Mbit/s download, 640kbit/s upload) and VDSL (50/10Mbit/s).
KDDI	Japan	100Mbit/s	unlimited	57.95	–

Note: shaded rows indicate FTTH plans, all other plans are ADSL/ADSL2+.

Exhibit 7.9: *Broadband plans available for a monthly budget of NZD50–60, October 2008 [Source: service providers]*

Data caps are unpopular with consumers. Most users have little understanding of the data traffic volumes generated by their applications and may find that they quickly reach their data cap with use perceived to be relatively modest.

In many overseas markets, broadband services have long had no limits on downloads, although as higher bandwidth services – in conjunction with data-intensive applications such as peer-to-peer file sharing – have become available, overseas ISPs have started to introduce data caps or so-called 'fair usage' policies – but not without strong complaints from users. For example, in October 2008 the US cable company Comcast introduced 250GB data caps for its residential customers to much outcry.[97]

Research conducted in the UK during January 2008[98] found a lack of transparency in regard to usage constraints – 56% of providers surveyed advertised their plans as unlimited, but imposed a fair usage policy. Such fair usage policies were included within the terms and conditions of the broadband contract, which stated that providers may limit the customer's broadband use if it was considered 'excessive' but very few providers defined 'excessive use'.

While Comcast's new data cap of 250GB is extremely generous in comparison with the typical data caps currently applied in New Zealand, it could quickly be achieved if monthly usage included video streaming (high definition requires around 8GB for a two-hour movie) or online backup services such as Mozy, particularly if multiple users or devices share the one broadband connection.

7.4 Can bundling increase service take-up?

Product bundling is a marketing strategy in which several products or services are combined to make a single group or 'bundle'. Bundling can be useful for product differentiation and increasing customer revenue.

Development of bundled services is a complex task and will be critically dependent on the retail providers' objectives and capabilities. A detailed analysis of retail bundling strategies is beyond the scope of this report, however we note that many proposals for potential retail providers are based on 'triple-play' bundles.

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97 See for example, Om Malik (2008) *Comcast Metered Broadband Official – Beware What You Download*, 28 August 2008. Available at http://gigaom.com.

98 uSwitch (2008) *'Unlimited limits' still baffle nine out of ten broadband users*, media release, 23 October 2008.

Combining broadband Internet with pay TV or video-on-demand is a strategy commonly used by providers in overseas markets, particularly where cable companies are competing with ISPs and telecom operators. In New Zealand, most pay TV subscribers currently receive service via broadcast satellite. The dominant pay TV operator, SkyTV, provided services to 46% of homes as at June 2008,[99] and a further 4% of homes have cable TV supplied by TelstraClear. Pay TV uptake is significantly lower than that in many overseas markets (Exhibit 7.10) but future bundling of content services may have an influence on service take-up. Nonetheless, content is likely to have an important role in the development of broadband product differentiation strategies.

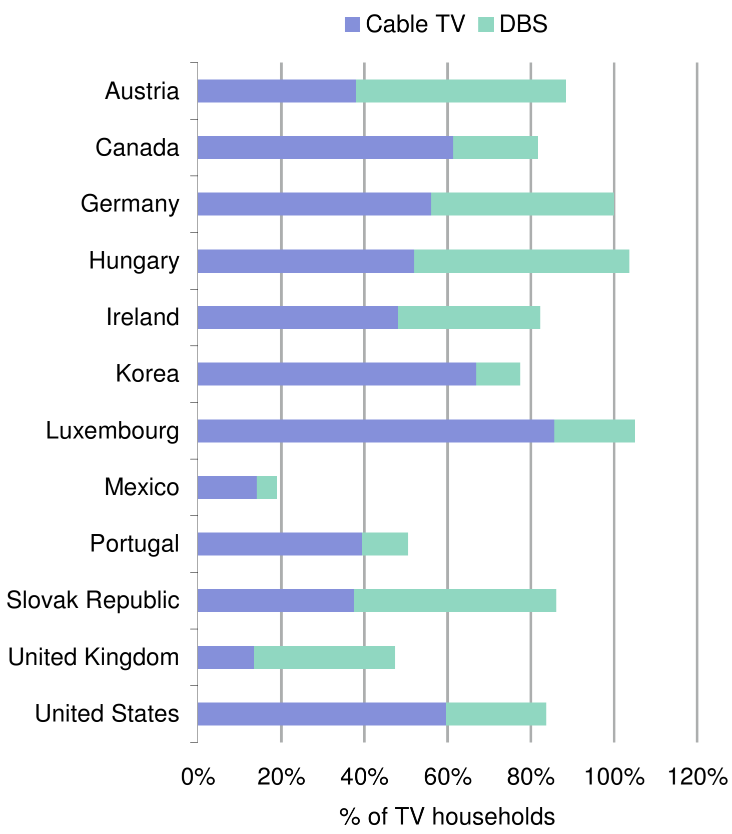

Exhibit 7.10: *Cable TV and direct broadcast satellite subscribers as a proportion of households with TV, 2005 [Source: ITU]*

In order to offer pay TV or video-on-demand services, retail providers would need to negotiate agreements with the content providers. Note that the ability of retail providers to

99 Sky Network Television (2008) *Annual Results 2008*.

compete using content may be hampered if access to certain popular programmes, such as rugby, was controlled by exclusivity arrangements or by the existing broadcasters. Bundles including pay TV will have little attraction – and the budget for broadband services constrained – if consumers need to maintain a SkyTV subscription to watch the rugby.

There is little advantage to be gained by bundling content services that few people want. Furthermore content is expensive – in 2008 SkyTV's programming costs were 32% of revenue, down from 43% in 2003[100] – and small players have little negotiation power with content distributors.

As cable has been deployed only in Wellington and Christchurch, direct competition with the new high-speed fibre service would be limited. However one potential competitive response could see TelstraClear upgrading its cable network to DOCSIS 3.0 and expanding its footprint (discussed further in Section 7.5).

7.5 What type of responses could we see from existing players?

There are a number of potential responses that could occur with the entry of a new player in the New Zealand market. Note that existing players may choose to implement several strategies, so these options are not necessarily mutually exclusive.

Discounting and bundling of lower speed broadband

Service providers will seek to minimise loss of market share through reduced pricing of lower speed broadband and/or bundling with other services. Clearly the lower bandwidth of ADSL services does place them at a disadvantage when compared with fibre offerings, nonetheless heavily discounted ADSL services – particularly in combination with triple- or quad-play bundles – may be a superior value proposition for more price-conscious mass market segments.

100 *Ibid.*

As has been the case with the ongoing retention of dial-up access, there will continue to be a market segment that will prefer an inexpensive option with relatively basic functionality.

Retailing the new entrant's products

Another strategy would see existing service providers aiming to retain customers by launching new high-speed offerings based on wholesale products purchased from the new entrant.

Telia, the Swedish incumbent operator, retails a high speed broadband service that is available on more than 30 of the municipal fibre 'stadsnäts', including those in Stockholm, Falun, Örebro, Malmö and Göteberg, however it is not the only retail service provider on those networks. One example, the Mälarenergi Stadsnät in the city of Västerås, has eight companies, including Telia, that retail services.

Upgrade or deployment of alternative high speed networks

Service providers could deploy their own high speed networks, in direct competition with the new entrant. Such networks would most likely target areas with the greatest potential for return, and where the cost of deployment is lowest – most likely higher density urban areas. A number of cities already have existing fibre infrastructure that would be capable of supporting high-speed broadband access. These network footprints could be extended to increase the addressable market of those service providers.

Examples of this response can be found in Denmark and Slovenia, where a key driver for new network deployment by the incumbent operators – TDC and Telekom Slovenije, respectively – has been the introduction of FTTH services by new entrants.

Separation of the Telecom business will create another wholesale player – and competitor to the infrastructure provider – in Chorus.

FTTH also has the potential of rendering cable obsolete – TelstraClear must decide whether or not to continue to support its cable network. While the cable footprint is limited to Wellington and Christchurch, upgrading to DOCSIS 3.0 would deliver higher bandwidth to consumers and position the triple-play service as a direct competitor to retail offerings based on the planned fibre network. However, it should be noted that the promoted bandwidths for cable services are peak bandwidths – actual speeds achieved by users may be considerably lower, depending on the number of concurrent users.

In October 2008, the US cable operator Comcast launched services based on DOCSIS 3.0, offering speeds of up to 50Mbit/s downstream and 10Mbit/s upstream, as a counter to Verizon's FiOS and other fibre services. Comcast anticipates that in the future speeds of more than 160Mbit/s will become available.[101]

The cable provider UPC was the first European provider to deploy the EuroDOCSIS 3.0 standard, with services of up to 120Mbit/s[102] launched in the Netherlands in September 2008. UPC plans to offer the services to its customers in Austria and Switzerland before the end of the year, and in its other European markets during 2009. J:COM, the Japanese subsidiary of UPC's parent Liberty Global, launched high speed broadband based on DOCSIS 3.0 in late 2007. This service is claimed to deliver downstream speeds of up to 160Mbit/s (10Mbit/s upstream).

Mobile operators may be another source of competition, although the achieved bandwidths may be considerably less than the peak bandwidth that are promoted, as performance will depend on the number of concurrent users. WiMAX is a currently available technology with speeds up to 100Mbit/s. Six companies – Telecom, Vodafone, Kordia, Woosh Wireless, CallPlus and Craig Wireless – hold spectrum suitable for WiMAX in New Zealand, which has the potential to create an extremely dynamic marketplace. CallPlus has already launched WiMAX services in the Auckland area.

In the medium term, LTE is expected to offer speeds up to 300Mbit/s, with deployments rolling out worldwide from 2011.

101 Comcast (2008) *Comcast Begins Rollout Of Extreme 50 Mbps High-Speed Internet Service*, media release, 22 October 2008.

102 This is the downstream bandwidth. Upstream bandwidth is up to 10Mbit/s.

Purchase of new entrant

To gain market power, a service provider could seek to acquire a part or controlling interest in the new entrant.

In May 2008 the Dutch incumbent operator, KPN, acquired a minority interest (41%) in the operator Reggefiber FttH, with an option to increase its stake in the future. Five months later, the arrangement is still awaiting approval by the competition authorities. Reggefiber specialises in the construction and operation of passive layer fibre networks and has developed a number of FTTH initiatives in the Netherlands, including those in the cities of Deventer, Nuenen and Hillegom. KPN will continue to act as one of the many retail service providers on the Reggefiber network. Prior to this acquisition, KPN and Reggefiber commenced a joint FTTH venture in the city of Almere.

8 Business case models

In this section we describe the high-level business case models developed to calculate the cost of different network options. In Section 8.1 we list the business structure scenarios modelled and in Section 8.2 we describe the methodology used. Section 8.3 lists the model assumptions, and Section 8.4 compares some key financial indicators of the different business cases. Finally Section 8.5 compares the models with benchmark results.

8.1 Description of models

As outlined in Section 6.3 we have modelled the following three access technologies:

- FTTN with VDSL2
- GPON (gigabit passive optical network)
- active Ethernet.

The following business models were examined:

- provision of a passive and wholesale infrastructure FTTP by an operator that provides Ethernet services (using either GPON or active Ethernet), and has to build its network from scratch – that is a 'Layer 2' provider selling lit fibre to retailers
- an extension of Telecom's current access network, again wholesaling services to retailers
- a 'Layer 0' (open-access duct) network that provides an open access structure-only (duct) network
- a utility expansion network where a utility uses entirely existing ducts and poles to deploy fibre (and offers Layer 2 services).

'Layer 1' open access (dark fibre) normally requires a point-to-point (P2P) topology, with individual fibres allocated the whole way from the exchange to each customer, to allow competing operators access to individual customers. As noted in Section 6, this is very expensive and has not been modelled, although an unlit GPON topology has been included.

8.2 Methodology

8.2.1 Network coverage

We have assumed that the target network footprint will include all cities and towns with a population of more than 20 000, but excluding CBD areas where there is existing fibre infrastructure that has the potential of providing services to the local population. Fibre services would then be accessible by 3.2 million people (Exhibit 8.1). Our modelled infrastructure provider will deploy services to 1.2 million households, however within the coverage areas this is expected to grow through natural population increase to 1.3 million households over ten years.

City / town	*Estimated population 2008*
Whangarei	51 100
Auckland	1 313 200
Pukekohe	24 500
Hamilton	197 300
Tauranga	116 000
Rotorua	55 600
Gisborne	33 700
Taupo	22 000
Napier-Hastings	122 600
New Plymouth	51 300
Wanganui	39 700
Palmerston North	79 800
Kapiti	39 200
Wellington	381 900
Nelson	58 700
Blenheim	29 700
Christchurch	382 200
Timaru	27 500
Dunedin	114 900
Invercargill	48 000
Total	3 188 900
% of national population	74.7%

Exhibit 8.1: *Estimated 2008 population of cities and towns included in coverage area [Source: Statistics New Zealand]*

This coverage area will also include a sizable business market. We anticipate the target market for services delivered by the infrastructure provider will comprise small to medium enterprise geographic units, that is business sites where there are fewer than 100 employees. Larger sites are more likely to have different requirements for their communications, so we have excluded them from consideration. This leaves an estimated 335 400 business premises within the planned coverage area for our infrastructure provider.

Our modelling of deployment does not consider prioritising specific towns or suburbs. In reality, our infrastructure provider would initially target those areas which market research indicates would have a greater propensity to take fibre services, for example suburbs which have a high proportion of families with children together with high household income. However there may be other influences – such as optimising logistical costs, or priorities being set by the public-private partnership or utility – which may need to be considered when planning rollout.

8.2.2 Wholesale product offerings

We assume that the infrastructure provider will offer two products:

- 100Mbit/s access – target market is households and small business locations (those with less than ten employees)
- 1Gbit/s access – target market is medium business locations (with at least ten and less than 100 employees).

We recognise that the actual requirements of these two market segments would not be quite so definitive – a 1Gbit/s service would appeal to some households or small businesses (for example those within industries such as graphic design, IT applications and digital content development), while a 100Mbit/s may be sufficient for some medium businesses. However, in general terms these assumptions over market segments are sufficient for modelling purposes.

8.2.3 Take-up and pricing scenarios

Our modelling of the infrastructure provider examines three scenarios relating to take-up and average revenue per user (ARPU) per month. The scenario assumptions are summarised in Exhibit 8.2. Note that the year of take-up is relative to the year in which deployment occurred in that location.

	Scenario 1	*Scenario 2*	*Scenario 3*
Take-up amongst homes / businesses passed after rollout			
100Mbit/s – residential	30% after two years	50% after three years	70% after five years
100Mbit/s – business	30% after two years	50% after three years	90% after five years
1Gbit/s	30% after two years	50% after three years	90% after five years
Wholesale ARPU in year 1 (NZD)			
100Mbit/s	56	40	25
1Gbit/s	70	50	31
Price trend (ten years)	2% pa decrease	2% pa decrease	2% pa decrease

Exhibit 8.2: *Take-up and ARPU assumptions for model scenarios [Source: Network Strategies]*

Note that our tariff assumptions were not based on the estimates for willingness to pay that were obtained from a study on enhanced broadband access for the Auckland region.[103] As discussed in Section 7.2, we consider that there is considerable risk associated with those estimates, which were considerably higher than benchmark tariffs from overseas operators and views concerning market price points from industry players.

Scenario 1: positioning as a premium service

The take-up assumption in this scenario is comparable to that experienced in the United States, and the 100Mbit/s wholesale tariff set to a level which would result in similar retail tariffs to those of the Verizon FiOS service.

These prices are considerably higher than the NZD50 retail price point, so expectations for mass market adoption must be considered unlikely unless tariffs fall at a faster rate than in our scenario.

Note that in all three scenarios, the wholesale tariff for 1Gbit/s is set 25% higher than that for the 100Mbit/s service. This is an assumption that was based on an estimate of the

103 Covec (2008) *Open Access Broadband in Auckland: Demand, Costs and Benefits*, report for the Auckland Regional Broadband Advisory, June 2008.

additional costs of providing the 1Gbit/s service over fibre and a review of relative retail costs in other regimes.

Scenario 2: attracting the mass market

The second scenario is an extension of the previous scenario, with penetration continuing to increase over a period of three years, rather than levelling out after two. For this to be feasible, the wholesale tariff is set to a level in which the retail price would be around the NZD50 price point for the 100Mbit/s broadband service (that is, without content or telephony).

This scenario has some associated risk, especially in regards to potential competitive responses from existing players.

Scenario 3: achieving market saturation

The final scenario is one in which virtually all of the addressable retail market takes up a service that is supplied by the infrastructure provider.

As discussed in Section 7.1, just under 30% of households do not currently have a computer and 9% of businesses do not have Internet access, so our assumed saturation levels are set accordingly.

To achieve this high level of take-up the wholesale price is set relatively low – note that the 100Mbit/s tariff is comparable with the EUR15 (NZD25.51) wholesale offering of the French operator Iliad – and the ARPU trend gradually nears the UCLL price over a period of ten years. We expect that this tariff would enable a retail service price of around NZD50 for a bundled 100Mbit/s service – also including telephony and/or content.

The risk associated with achieving this scenario is quite high. Firstly, we anticipate that there will be some extension and/or upgrade of existing fibre or cable infrastructure by other players that will target key parts of our infrastructure provider's coverage area and thus gain some market share. Secondly, we believe that there will be a sub-segment of the market that will be resistant to switching to a fibre service, most likely for price reasons.

8.2.4 Fibre access network design and structure in urban and suburban areas

This section describes the approach taken to determine key fibre access network parameters for New Zealand urban and suburban areas.

The costs of next generation fibre access networks are often described in terms of 'cost per home passed'. To develop such a description, it is necessary to study the network infrastructure (per home) which would be required in typical roll-out areas.

As the technique and amount of trenching required to implement a fibre access network is a key driver of costs, it is useful to understand trenching distances for typical areas in New Zealand as a total distance and on a per-home basis. Trenching costs for placing fibre to a premises can often be reduced or avoided by using existing ducting, but we note that in New Zealand, existing copper access (distribution) cable is typically direct buried (without duct) and that duct sharing cannot generally be expected.

Our approach to determining appropriate trenching distances has been to design networks for a sample of New Zealand urban and suburban areas. These designs were then extrapolated to provide the full 75% population coverage required by this study.[104]

Sample areas were chosen to include dense urban and suburban, lower density suburban and rural urban areas. For ease of design and to facilitate subsequent modelling of VDSL networks, many of the sample areas were made to correspond to Telecom New Zealand exchange areas. In some cases, the exchange area boundaries were modified to exclude the low population (farming) areas which typically bound rural urban centres and which are included in some of Telecom's suburban exchange area definitions.

104 Note that the detailed design process could have been extended to provide the full 75% coverage of New Zealand, but the time required for such a design is beyond the scope of this project.

The exchange area boundary information used in this study is available from the Telecom New Zealand's access network division (Chorus) website.[105] An example of the use of this data is illustrated in Exhibit 8.3 below for three Christchurch exchange areas (Papanui, Fendalton and Riccarton). In this representation, the exchange boundaries are displayed as the yellow lines.

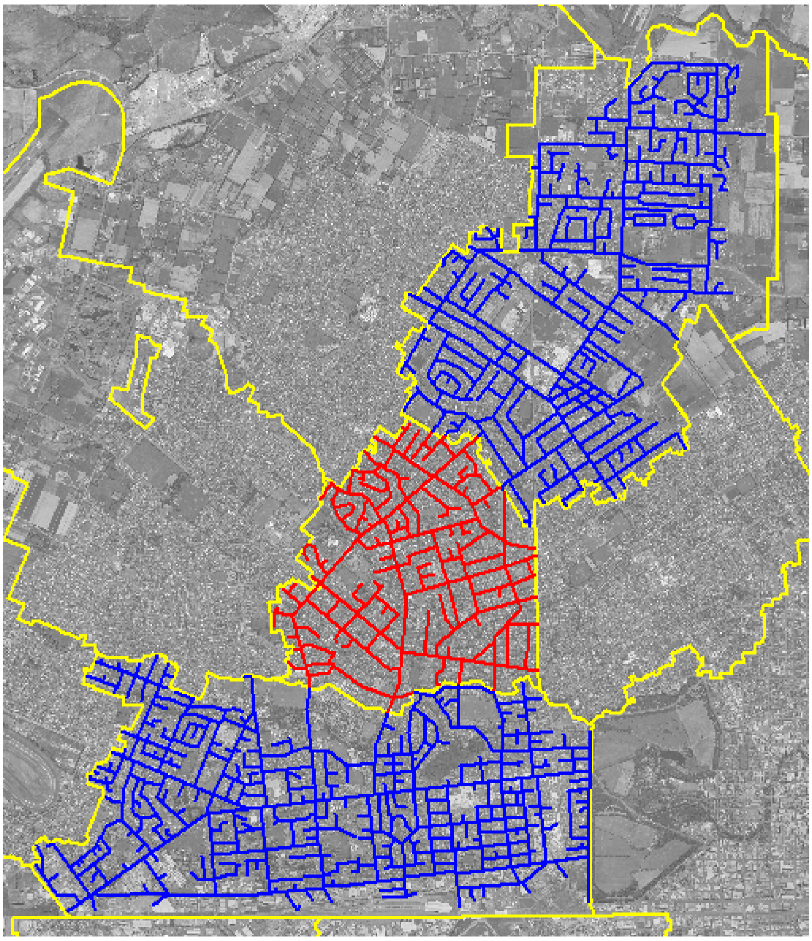

Exhibit 8.3: *Example of exchange area boundaries and road locations [Source: Network Strategies, Telecom New Zealand, Orthophoto M35 – Christchurch 2000/01 (Crown Copyright Reserved)]*

In order to estimate access network (trenching) distances for each exchange area, we have determined the total distance of public roading within the boundaries (represented by the blue and red lines in Exhibit 8.3). Access network cables can be placed on both sides of a road or along one side of a road with frequent underground or overhead road crossings. In

105 http://www.chorus.co.nz/f289,8152/8152_lamas.zip

all cases, the total access network distance in urban and suburban areas is significantly greater than the total road distance. For costing purposes, we have assumed that the access network distance is twice the roading distance for each exchange area (note that this distance does **not** include the 'drop' distance from the access network in the road to the building or premises).

Once access network distances have been determined, we estimate the average distance 'per home passed' (excluding drop) of a new network build. The results for the area types examined are provided in Exhibit 8.4 below.

Typical access network distance per home passed	*Area type*
14 metres	Dense urban/suburban
17 metres	Suburban
21 metres	Urban rural

Exhibit 8.4: *Access network per home passed [Source: Network Strategies]*

To limit cost model complexity we have assumed a weighted average of 17 metres per home passed to represent residential areas and 50 metres per business passed in non-CBD business areas.

In our base scenario, it is assumed that all new fibre structure is placed underground, requiring trenching and ducting. However, as aerial structure may be permitted in some instances, for cost modelling purposes we assume that any aerial routes follow the underground route design.

8.2.5 VDSL2 access network design and structure in urban and suburban areas

VDSL2 network design is highly dependent on the architecture of the existing copper network. Telecom is rolling out a fibre to the node network which could support deployment of VDSL2, but would not provide the coverage and speeds required by this study. In order to expand coverage the network would require:

- additional VDSL2 cabinets in existing conventional cabinet sites

- further penetration of fibre to underserved areas
- VDSL2 cabinets in new locations.

To determine the costs of such an expansion it is necessary to estimate the numbers of new/replacement cabinet sites and typical distances of fibre extensions. Once again, Telecom's Chorus website provides useful background information[106] to assist in this study.

Exhibit 8.5 below shows, in yellow outline, the area covered by a Fendalton (FDN/T) copper distribution cabinet, which is due to be upgraded in Telecom's FTTN rollout. We have estimated the cabinet's location based on local knowledge and marked this with a red spot (these cabinets are often labelled and visible on suburban roadsides).

106 http://www.chorus.co.nz/f289,8204/8204_Planned_Cabinet_Polygon_Shapefiles.zip

Exhibit 8.5:
FTTN cabinet area [Source: Network Strategies, Telecom New Zealand, Orthophoto M35 – Christchurch 2000/01 (Crown Copyright Reserved)]

It can be seen that the cabinet area has an irregular shape, which is the result of roads, natural features (such as streams) and historical PSTN network planning. Assuming that our cabinet location is approximately correct, replacing the cabinet with a VDSL2 node could provide 100Mbit/s service to around 60% to 70% of the addresses within the area. Note that 100Mbit/s requires the copper to be in good condition and it could not be assumed that all addresses within theoretical coverage would achieve that speed. To extend theoretical coverage to the remainder of the cabinet area would require up to three additional sub-cabinets located more than 500 metres from the main cabinet.

Our study of the Chorus cabinet data for a number of cities and towns suggests that, on average, two additional VDSL2 sub-cabinets[107] would be required per upgraded traditional

107 As these would typically be serving only a small number of lines, they would be smaller and less expensive than full FTTN cabinets. The development of such small cabinet- or pillar-based VDSL distribution products is an area of rapid technological progress.

cabinet area. As would be expected, the current FTTN cabinet areas appear to be the furthest from the exchange location in each exchange area, leaving a number of closer cabinets which must also be upgraded for VDSL2. We estimate that there are probably over 2000 traditional cabinets or MDFs which must be upgraded, in addition to the 3500 FTTN nodes.

8.2.6 Modelled costs

We have modelled the investment costs of equipment in the following categories:

CPE and house wiring	For the FTTP network we have modelled the cost of the CPE and house wiring for any connected customers. We have not included the cost of wiring business premises – it is assumed the business or building owner pays this cost. For FTTN/VDSL2 we have modelled the CPE costs but not any wiring costs.
Drop	The drop cost is the cost of connecting the premises to the distribution network. It includes 20m of ducting (trenched in a mixture of concrete, grass and aerial) and fibre between the distribution cable and premises.
Structure	Structure costs are the civil works related to installing fibre, and includes trenches, ducts, manholes and poles (where applicable). Different structure costs are assumed: traditional ducting (under road, footpath and grass berms); micro-trenching (road, footpath and grass), and overhead.
Fibre	The fibre costs cover both the feeder (between exchange and cabinet) and the distribution (between cabinet and customers).
Access point	The access point is the interface between the distribution cable and the drop. For active Ethernet, it includes the edge router, and for

	GPON it is the drop splitter.
Distribution node	The distribution node is the interface between the feeder cable and distribution cable. For active Ethernet, it contains an aggregation router, and for GPON it is the distribution splitter. For FTTN/VDSL2, this is the active cabinet that contains the DSLAM. Included in the capital cost are significant capital costs (capitalised labour and material) for grooming, joining and termination of the remaining copper on the new cabinets.
Exchange equipment	The exchange equipment is the optical line terminals that terminate the fibre.

For each item of equipment we have modelled annual operating and maintenance costs.

Costs were obtained from publicly available data, operators, and our own estimates.

8.2.7 Excluded costs

Costs not included in the business case models are listed below:

- The copper infrastructure (including drop) for the FTTN/VDSL2 network. We have assumed the existing network is a sunk cost. Additionally, we have not modelled any copper operating and maintenance costs, nor renewal costs. This includes household wiring which can have a significant effect on the quality of DSL services. It is assumed that these omitted costs are allocated to existing telephony services – the FTTN upgrade is incremental to the existing network. However we note that the newly groomed copper network is likely to reduce operating costs below historical levels (as it would, for example, remove any ageing pressurised feeder cables from the network). These savings have not been quantified.
- Equipment replacement (for equipment reaching the end of its life)
- Technology upgrades
- Indirect (non-network) costs such as corporate overheads

- Core network costs; we assumed connectivity services will be provided by commercial core network operators on behalf of the service retailer.

8.3 Model assumptions

This section summarises key assumptions used in the modelling.

Network rollout

It is assumed that the network is deployed over a ten year period, with equal rollout in each year. As discussed above, take-up continues to rise after this period.

FTTP rollout

We have assumed that the FTTP technologies (GPON and active Ethernet) do not use any of Telecom's infrastructure: they do not share or build on any cabinets or cabinet backhaul (feeder cable). This allows the FTTP operator to build the network optimally, with nodes in the most suitable locations for the particular network.

We have not assumed any benefit from installing ducts and cables when roads are being resealed. Councils generally reseal roads as required in a piecemeal basis, which would provide little synergy with a network deployment. Furthermore, the cost saving is likely to be minor (only the cost of resealing the trench once filled).

Market take-up

We have assumed the 'premium service' scenario, in which the take-up rate rises to a maximum of 30%, as the default.

Operating costs

The annual operating costs have been modelled as a percentage of initial capital costs. An operating cost, representing operations and maintenance, is applied to each modelled cost.

8.4 Model results

8.4.1 Comparison of different business models

Exhibit 8.6 below illustrates the total investment requirement of the different business models for the 'premium service' scenario with a combination of technologies:

- the lit-fibre (Layer 2) FTTP operator that provides Ethernet services (using either GPON or active Ethernet), and has to build its network from scratch
- the 'Layer 0' provider that provides an open access structure-only (duct) network
- a 'Layer 1' provider that provides unlit fibre in a GPON architecture (rather than a point-to-point topology)
- the utility expansion model where a utility can use existing ducts and poles to deploy fibre for 50% of the network (and offers Layer 2 services). It is assumed that the costs of existing ducts and poles are sunk and thus are not considered in this model.

Note that both Layer 0 and Layer 1 have avoided the use of micro-trenching technology, to provide maximum compatibility for all types of equipment that access seekers may use.

These results show the level of significance of the costs of trenching and installing ducts. Any network that can avoid these costs – such as in the utility expansion model – will realise significant cost savings.

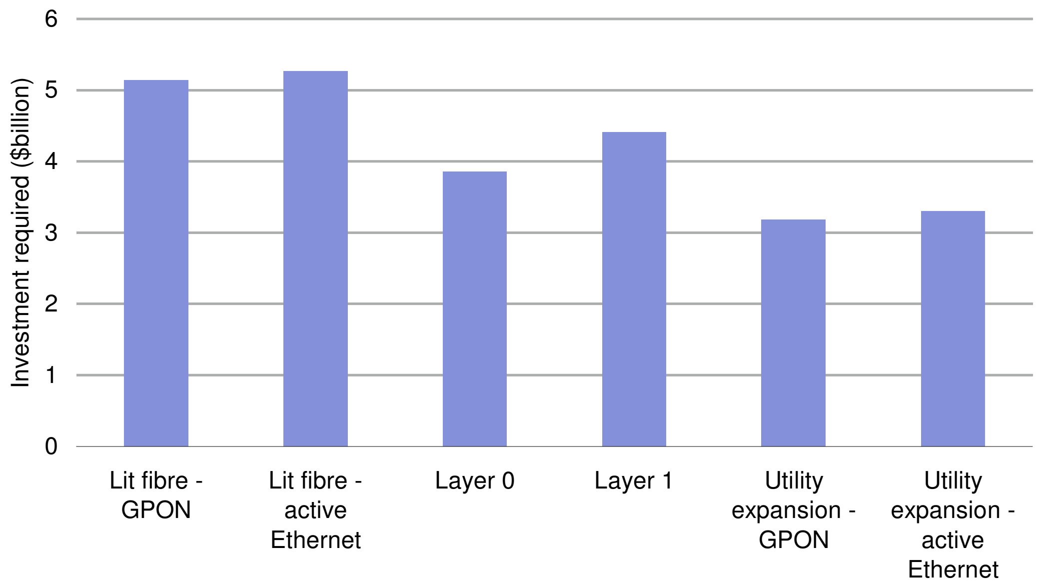

Exhibit 8.6: *Total investment required, by business model [Source: Network Strategies]*

We now assume that a PPP arrangement addresses the above capital investment requirements. For each of these technologies, the level of government investment was treated as a grant and set so that the payback period of the private investor's contribution to the network was fifteen years or better.

When we examine the government investment required to enable a 15-year payback (Exhibit 8.7) we see that a much reduced government investment is required for the utility expansion scenarios. (Layer 0 and Layer 1 were not included because this model does not calculate the revenue of a Layer 0 or Layer 1 network.)

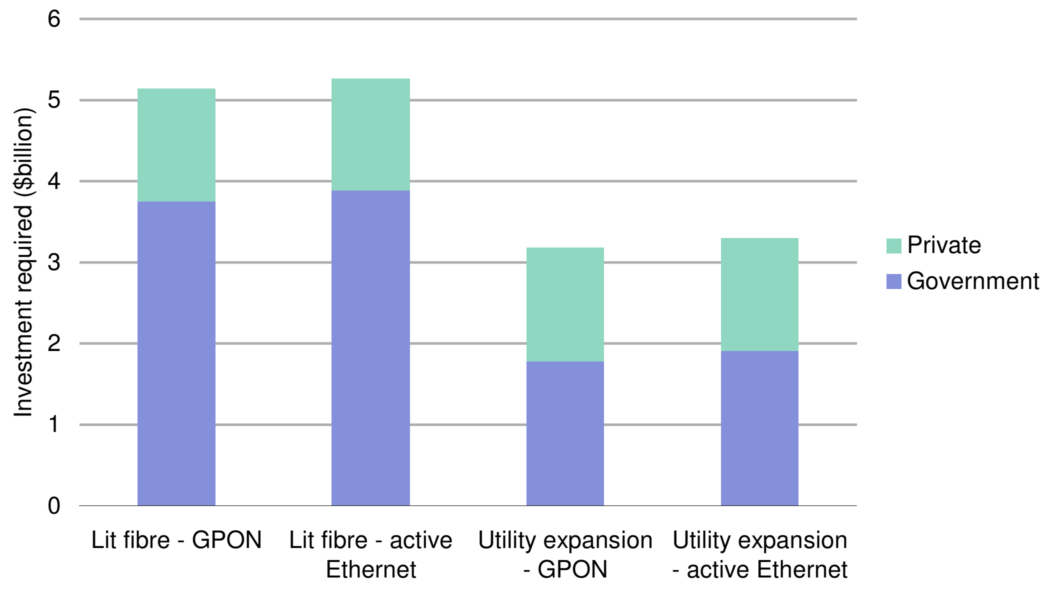

Exhibit 8.7: *Government investment required, by business model [Source: Network Strategies]*

8.4.2 Analysis of the 'lit fibre' scenario

Exhibit 8.8 below shows the total investment required over the life of the business model for each of the three technologies in the 'lit fibre' (Layer 2) scenario and assuming the 'premium service' take-up[108] scenario: $1.2 billion for FTTN/VDSL2, $5.1 billion for GPON, and $5.3 billion for active Ethernet. GPON and active Ethernet are closer than expected because while the active Ethernet electronics are more expensive, GPON requires far more feeder fibre which reduces its cost advantage.

108 See section 8.2.3.

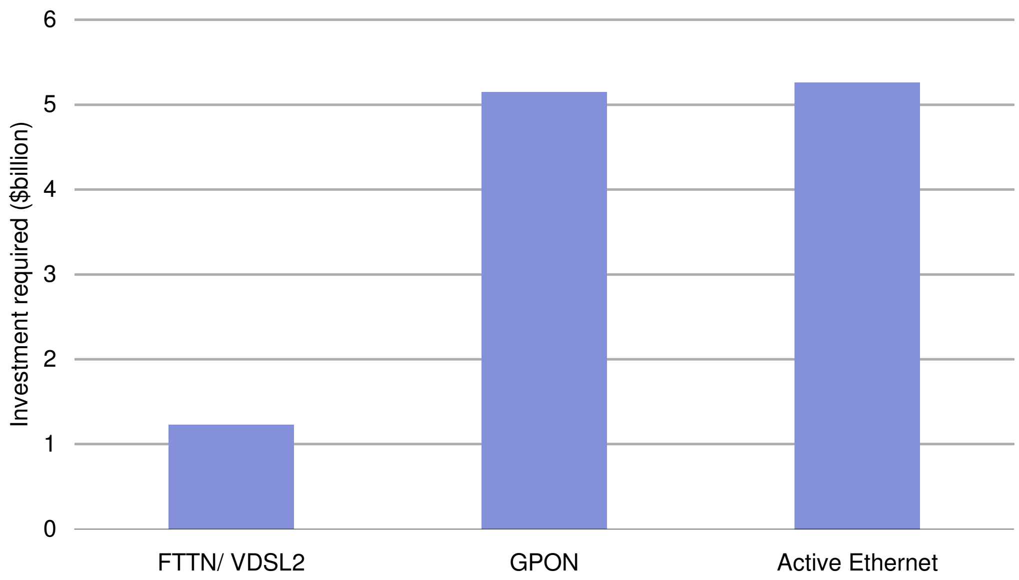

Exhibit 8.8: *Total capital investment requirements for FTTN/VDSL2, GPON and active Ethernet [Source: Network Strategies]*

Exhibit 8.9 below shows a breakdown of the capital investment required for the Active Ethernet business model (the GPON breakdown is similar). The greatest proportion of the costs are the structure costs (trenching and ducts), with the drop costs the second greatest proportion. CPE and house wiring costs are the third highest costs, ahead of fibre and cabinet costs. Exchange equipment costs contribute an insignificant amount to the total.

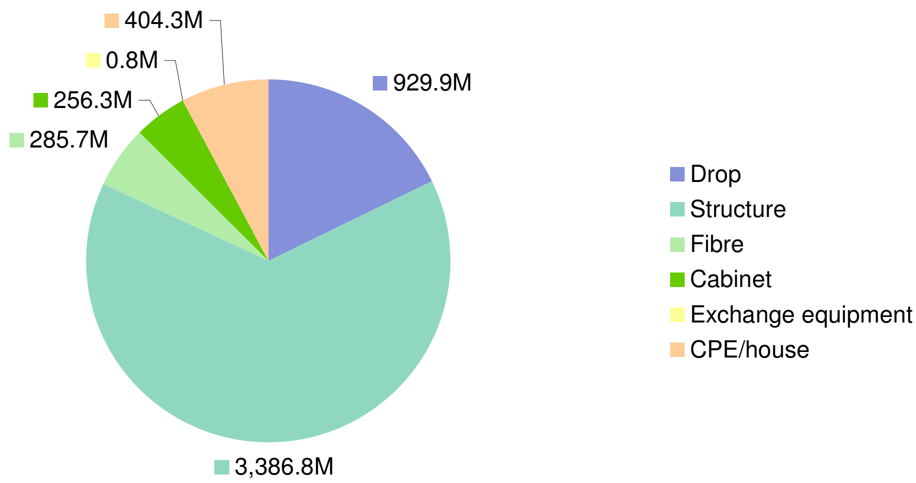

Exhibit 8.9: *Breakdown of total investment costs for active Ethernet [Source: Network Strategies]*

Exhibit 8.10 below shows the NPV[109] (using a 10% discount rate) over time,[110] and Exhibit 8.11 shows the funding required, split into government and private investment. For FTTN/VDSL2, around 8% government investment is required. For GPON and active Ethernet, the government contribution must be between 75% and 80% to achieve a fifteen year payback. This lower level of funding for FTTN/VDSL2 causes the NPV curve to drop below that of the FTTP technologies in the early years.

It is important to note that while a fifteen year payback period may be sufficient for the utility expansion scenario, it will not be sufficient for a commercial operator like Telecom, which would require a payback period of far less than eight years. Furthermore, the revenue in this scenario is most likely to be overestimated because only the marginal revenue that Telecom earns by using this network (over its current planned network) should be included.

109 Net present value – discounted cash flow.

110 NPV between the start of the business and the *x*-axis value, with zero terminal value.

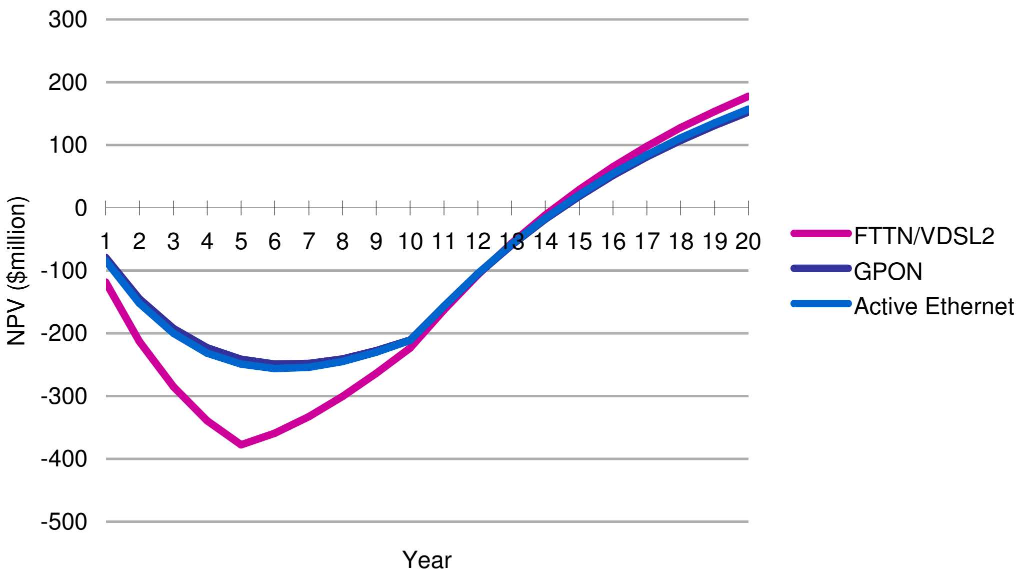

Exhibit 8.10: *NPV over time with public funding, by technology (10% discount rate) [Source: Network Strategies]*

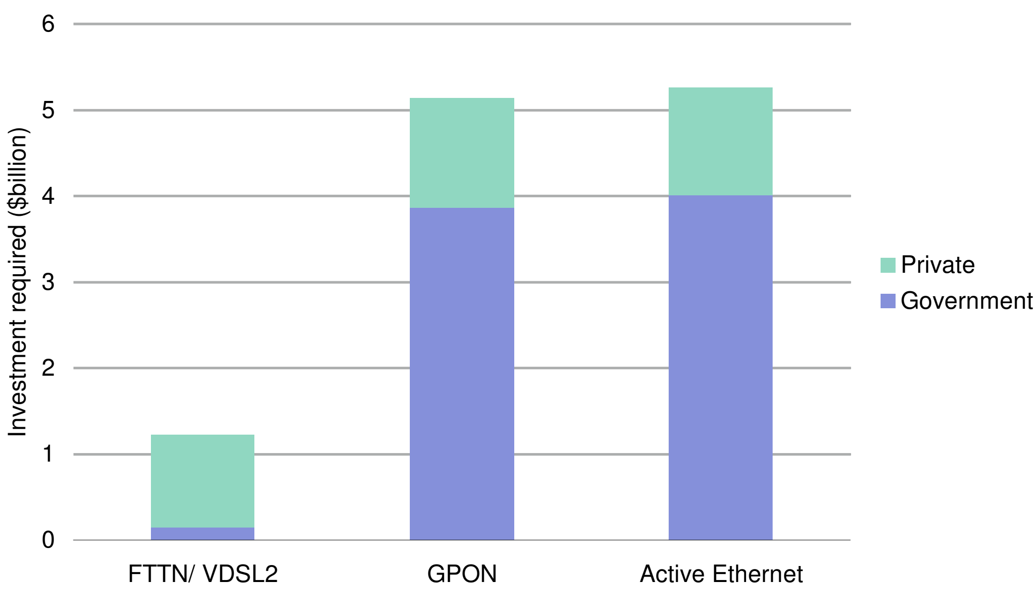

Exhibit 8.11: *Private and government investment required to achieve a 15 year payback [Source: Network Strategies]*

Exhibit 8.12 below shows the components of the cash flow that make up the NPV for the Active Ethernet technology:[111]

- **Revenue:** the revenue increases as the number of customers increase firstly as rollout progresses over the first ten years, then as take-up increases for a number of years after roll-out. In the long term it decreases as the per-customer revenue drops.
- **Government investment:** the government investment is set at about 75% of the total capital investment requirement to achieve a payback period of 15 years. It is treated as a revenue for the NPV calculation.
- **Capital expenditure:** the capital expenditure covers an equal rollout per year for the first ten years, plus connecting homes as customers join the network. After the tenth year, capital expenditure simply covers new customer connections.
- **Operating costs:** operating costs are dependent on the equipment installed, so increase over time as the network grows.
- **Free cash flow:** Free cash flow is revenue plus government investment less capital expenditure and operating costs.

111 The components for GPON are similar.

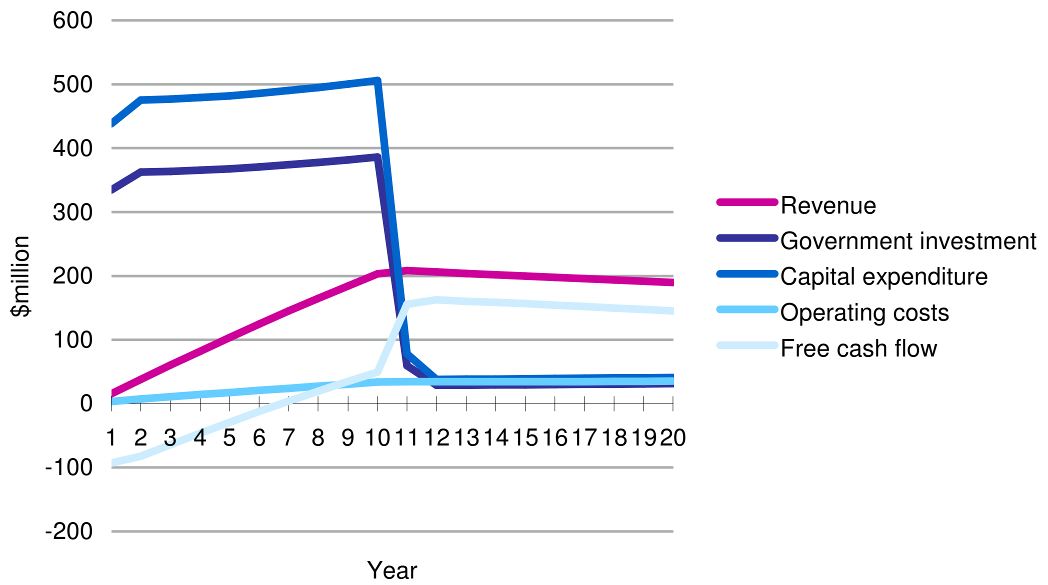

Exhibit 8.12: *Cash flow breakdown of active Ethernet, with a 15 year payback [Source: Network Strategies]*

Exhibit 8.13 shows the investment required per premise passed[112] (excluding per-premise costs), and per customer connected[113] (including per-premise costs), for each technology. The investment per premise passed for FTTP is $1948, which is about four times the cost of FTTN/VDSL2.

112 Network investment divided by the number of premises that are within network coverage

113 Network investment divided by the number of customers

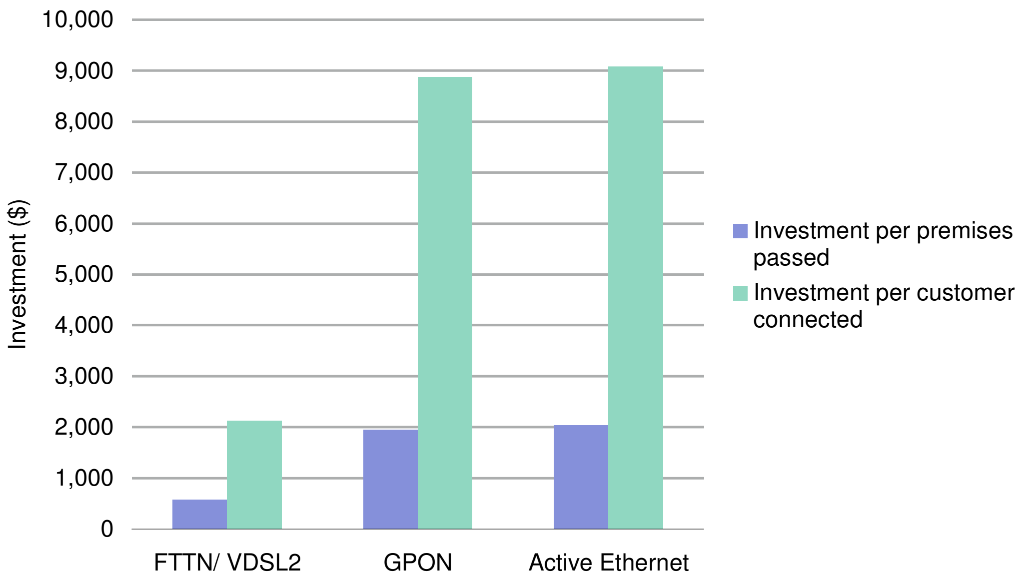

Exhibit 8.13: *Investment per premise passed and investment per customer connected, by technology [Source: Network Strategies]*

8.4.3 Government investment sensitivities

We have tested the sensitivity of the payback period on the level of government investment in Exhibit 8.14 below. If the level of investment in increased to 90% of the total, the payback period drops to below six years, whereas if it is decreased to 70% the payback period is more than 20 years.

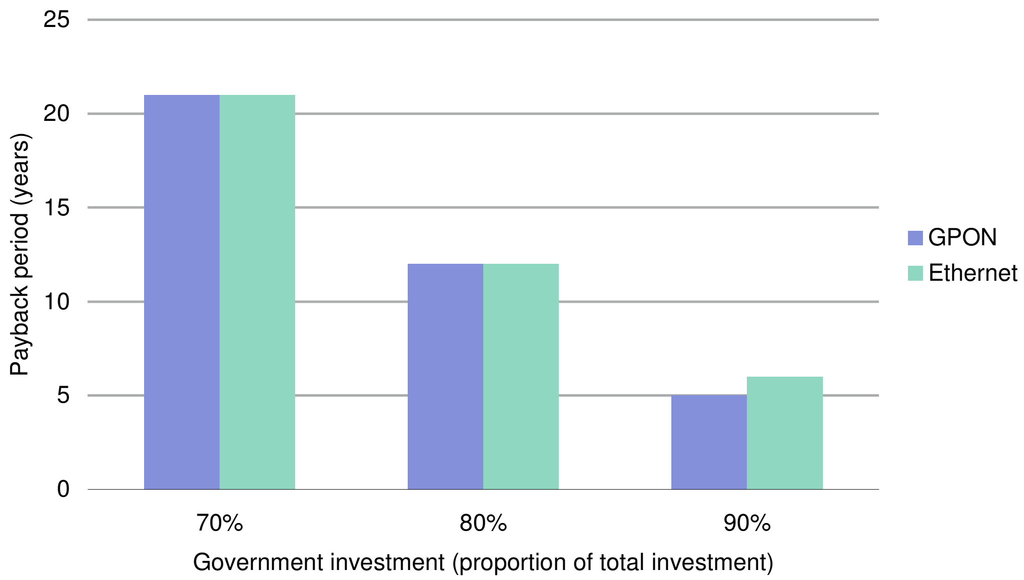

Exhibit 8.14: *Sensitivity of payback period to level of government investment [Source: Network Strategies]*

Exhibit 8.15 below shows the sensitivity of the level of government investment to the discount rate, assuming a fifteen year payback. The FTTN/VDSL2 investment varies from \$12 million for a discount rate of 8% to \$229 million for a discount rate of 12%. The absolute difference between the discount rates is slightly less for the FTTP scenarios: \$3.8 billion at 8%, and \$4.0 billion at 12% for both GPON and active Ethernet.

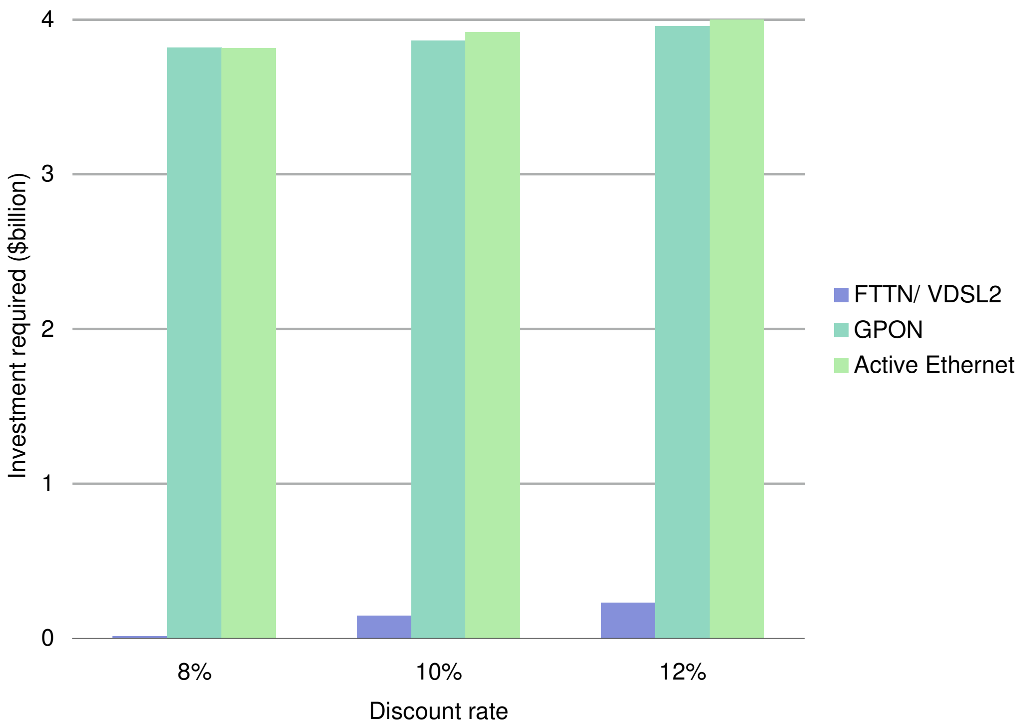

Exhibit 8.15: *Sensitivity of government investment to NPV discount rate, assuming 15 year payback period [Source: Network Strategies]*

8.4.4 Sensitivity to existing structure sharing

In Exhibit 8.6 above, the utility expansion model assumes 50% sharing with existing structure. We discussed the extent of sharing possible with utility companies and we understand that there may be considerable regional differences with more than 50% possible in some cases. Hence we investigate the sensitivity of the investment required to the level of sharing possible below in Exhibit 8.16:

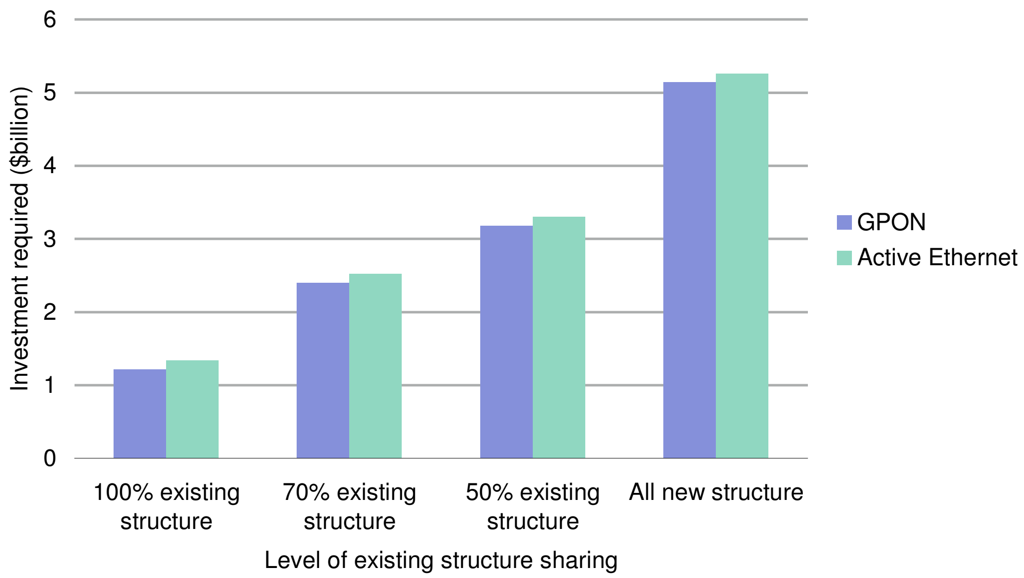

Exhibit 8.16: *Sensitivity of investment required to the level of sharing with existing structure [Source:Network Strategies]*

With 100% sharing (the full utility expansion model), the investment required is $1.2–1.3 billion (depending on the technology). With 70% sharing, the investment rises to $2.4–$2.5 billion, and for 50% sharing the investment requires is $3.2–$3.3 billion. This result highlights the high level of sensitivity of the investment required to the level of existing structure that can be used.

8.4.5 Comparison of take-up scenarios

All of the preceding results used the base case for take-up (‘premium service’ demand level). If we add two higher level demand scenarios (‘mass market’ and ‘market saturation’), we find that the capital investment increases (Exhibit 8.17), almost entirely due to the additional drops and CPE required. However, the NPV (with no government funding) improves as the demand increases (Exhibit 8.18) due to the revenue earned from the additional customers. The trend is particularly noticeable with the FTTN scenario where we have modelled no additional per-customer costs.

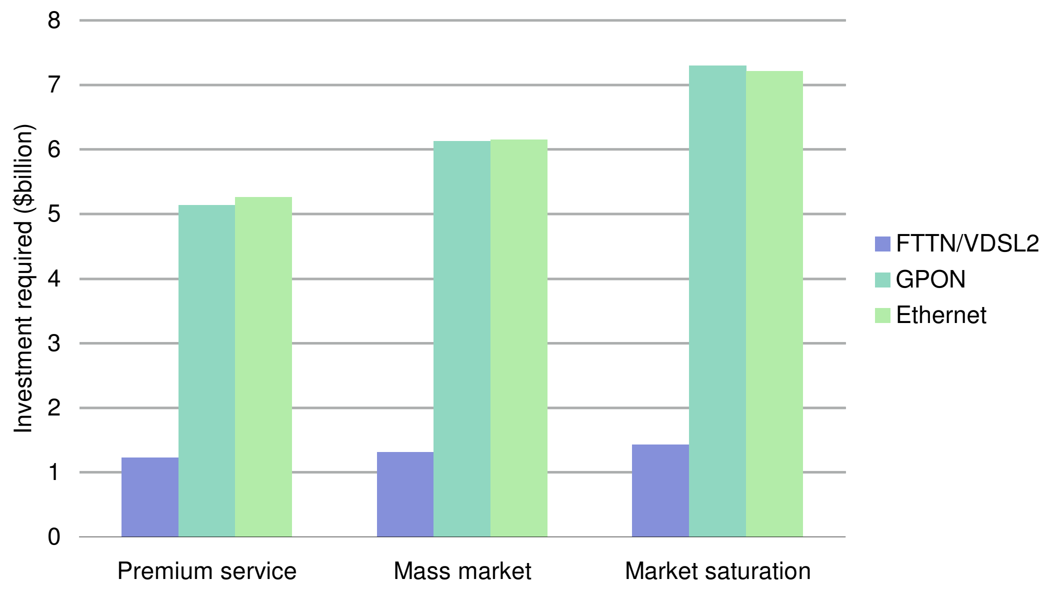

Exhibit 8.17: *Capital investment required for each technology by take-up scenario [Source: Network Strategies]*

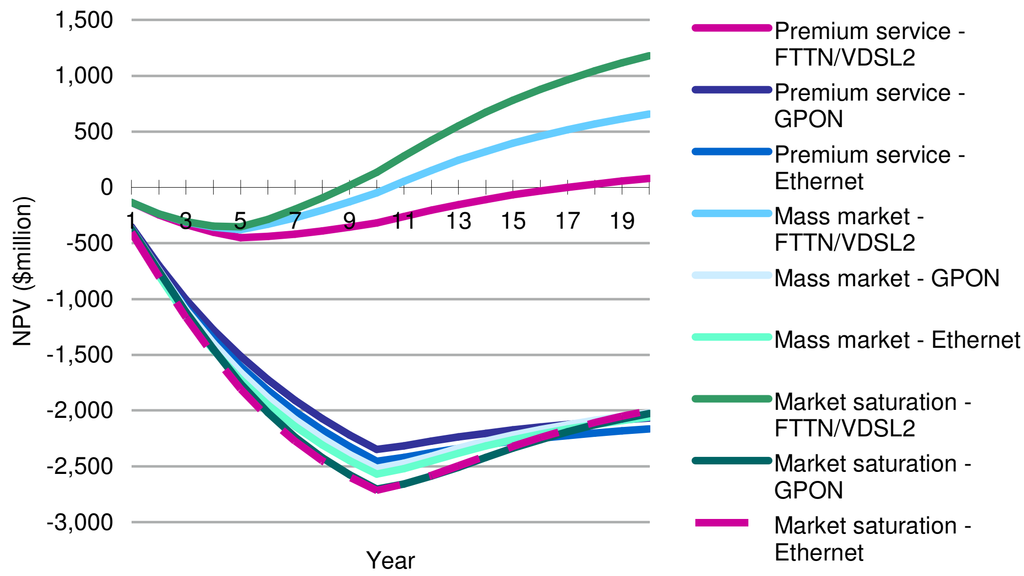

Exhibit 8.18: *NPV by technology and by take-up scenario [Source: Network Strategies]*

8.4.6 Conclusion

From these results, we note that a full overlay FTTP network will cost more than $5.0 billion. Government investment of about 75% would be required for an operator to obtain a payback of its investment within 15 years at the 'premium service' take-up scenario. A FTTN/VDSL2 network based on Telecom's copper network would require very little funding to achieve payback within this period, but Telecom would require a much shorter payback period. While significantly cheaper than FTTP, a FTTN/VDSL2 network is dependent on a legacy copper network that is likely to be unable to provide the required services to a large proportion of homes.

The utility expansion model appears extremely financially attractive compared to a completely new overlay network. The lower investment requirements of the utility model are driven by the fact that the cost of the network is very sensitive to the structure costs (trenches, ducts and overhead poles); any methods that can be used to reduce these costs (such as using existing utility structure) will reduce the demands on government investment. The cost is also very sensitive to drop and CPE costs.

For both FTTP technologies modelled, the cost per premise passed is about $2000.

8.5 Comparisons with existing New Zealand estimates

The New Zealand Institute

The New Zealand Institute's study concluded the cost of delivering FTTP for 75% of the population, with a take-up rate of 67%, is $4 billion for the passive components and $2 billion for the active components.[114] Our estimate for the nearest corresponding demand scenario ('market saturation', with 70% of homes connected) is $6 billion for the passive components (structure and fibre) and $1.2 billion for electronics, including premises costs but excluding core network equipment. We are not able to fully explain the differences in

114 The New Zealand Institute, (2008) *Delivering on the broadband aspiration: A recommended pathway to fibre for New Zealand*, April 2008, available at http://www.nzinstitute.org/Images/uploads/Delivering_on_the_broadband_aspiration.pdf

these estimates due to the lack of published detail on the New Zealand Institute's costing, but we note that:

- $2 billion for the active components is high when compared to international benchmarks (see the discussion above)
- the New Zealand Institute's costing may have not included the costs of drops required to connect premises to fibre passing in the street. This is a fixed cost per premise which becomes a significant proportion of overall costs in high penetration scenarios.

The National Party

The National Party's broadband policy is for $1.5 billion of government investment matched by $1.5 billion of private funding. If the scenario were possible in New Zealand, we consider that the total of $3.0 billion would be sufficient to pay for an entirely micro-trenched FTTP network to 75% of the population, but would exclude network electronics and any per-premises costs, such as drop cost and CPE.

In practice, using current technologies, it is highly unlikely that an entirely micro-trenched FTTP network could be built to serve 75% of New Zealand, due to the lack of suitable paved surfaces in which to place the micro-duct. This leads us to conclude that more than $3.0 billion investment would be required (excluding per-premises costs) as a mixture of conventional trenches and micro-trench would be needed.

We also note that modern micro-ducts using specialised micro-fibres may influence and impose limitations on the network architectures (such as GPON) which could be deployed.

8.6 Comparisons with benchmark results

It is generally agreed that trenching and ducts comprise a large proportion of the costs for FTTH deployment:

- the French regulator (ARCEP) found that 50% to 80% of costs for operators other than the incumbent are due to civil works (structure)[115]
- Alcatel-Lucent estimates[116] that around 60% of FTTH capital expenditure is due to the ducts and trenching, with another 10% due to dark fibre.

In Exhibit 8.9 it can be seen that in New Zealand structure is expected to cost around 65% of the total investment cost (for 30% take-up), in line with these estimates.

This means that local conditions – and, in particular, population density – have a significant influence on costs.

Alcatel-Lucent estimates that the average capital expenditure per subscriber increases from around NZD1800 in dense urban areas to NZD3600 in the suburbs and NZD11 600 for rural areas.[117] Note that these estimates assume a take-up rate of 30%.

The cost of fibre-based broadband deployment in the United Kingdom was recently estimated on behalf of the Broadband Stakeholder Group (BSG).[118] Households were classed by geotype, based on a combination of town size, exchange size and average line length (type a and type b, where b denotes an exchange area with relatively long lines). It was found that costs are lowest in areas with high population densities and where premises are close to the exchange (Exhibit 8.19). Costs are higher for exchanges that serve fewer households and where lines are relatively long. Note that these results exclude the the premise-specific costs of drop, CPE and house wiring.

115 ARCEP (2007) *New regulatory approaches for NGA: FTTH regulation in France*, presentation to the Broadband Stakeholder Group, 9 July 2007.

116 Struthers-Watson, K. (2008) "Building the fibre nation", interview with Jean-Pierre Lartigue, vice-president of Marketing and Communications, Fixed Access Division, Alcatel-Lucent. Reported in *Telecommunications Magazine* 30 September 2008.

117 Struthers-Watson, K. (2008) "Building the fibre nation", interview with Jean-Pierre Lartigue, vice-president of Marketing and Communications, Fixed Access Division, Alcatel-Lucent. Reported in *Telecommunications Magazine* 30 September 2008.

118 Analysys Mason (2008) *The costs of deploying fibre-based next-generation broadband infrastructure*, final report for Broadband Stakeholder Group, 8 September 2008.

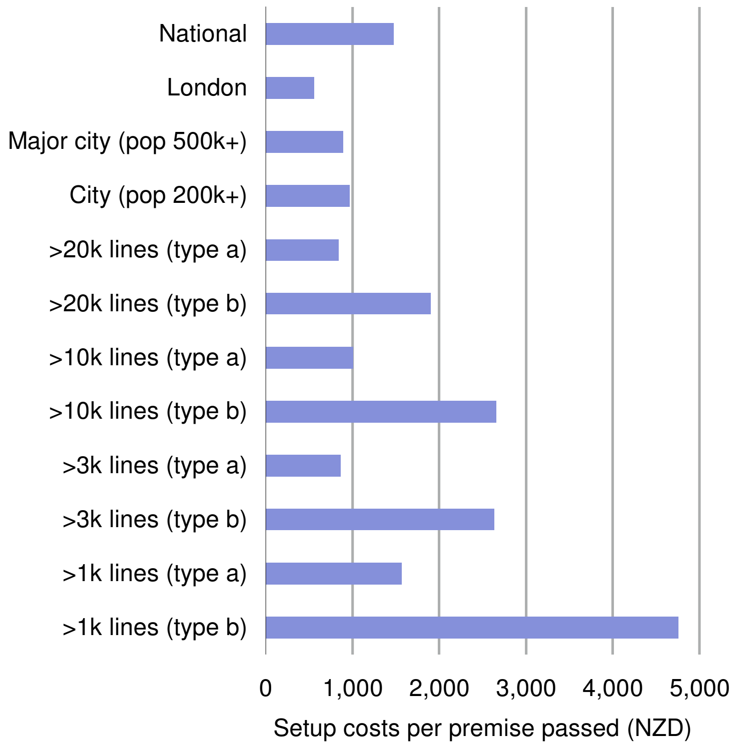

Exhibit 8.19: *Estimated FTTP GPON capital expenditure per premise passed excluding drop, in-home wiring and CPE, by geotype [Source: Analysys Mason for BSG]*

The national estimate of $1474 (which assumes a 31% take-up) compares with our total cost per premise passed $1948. This result is expected because of the higher number of premises per building and the shorter road frontage of buildings in the UK (meaning less fibre required).

9 Achieving InternetNZ's targets

9.1 Which approach is best suited to New Zealand?

Utility expansion approach

Our business modelling indicates that the utility expansion approach has considerable potential for the widespread deployment of high-speed fibre-based broadband networks in New Zealand. We have also seen through our literature reviews that this approach has been a key contributor to broadband deployment in Denmark and Sweden. To be more specific in the New Zealand context, it is the electricity lines companies that offer this potential as these entities have existing resources and infrastructure that offer synergies with the telecommunications business that could ultimately lower deployment costs. This is not the case with other types of utility company as, unlike the situation in some European countries, there appears to be a lack of existing infrastructure (for example, systems of ducts appear to be fragmented) that could be harnessed economically for use in the rollout of a fibre network.

The modelling also illustrated the need for a long payback period due to the significant capital costs and the uncertain and potentially slow uptake. In New Zealand most of the lines companies are owned by consumer trusts (Exhibit 9.1) and, assuming that there is strong local belief in the importance of broadband to the area's economic and social well-being and development, this ownership structure would tend to be sympathetic to longer payback periods. Furthermore in the electricity business assets typically have long lives and long payback periods, suggesting that the type of investment involved in broadband fibre deployment would fit well with the lines companies' traditional business models.

Network company	*Controlling shareholder*
Top Energy	Top Energy Consumer Trust
Northpower	Northpower Electric Power Trust
Vector	Auckland Energy Consumer Trust
Counties Power	Counties Power Consumer Trust
WEL Networks	WEL Energy Trust
Waipa Networks	Waipa Networks Trust
Powerco	Babcock & Brown Infrastructure
The Lines Company	Waitomo Energy Consumer Trust
Unison Network Ltd	Hawke's Bay Power Consumers' Trust
Horizon Energy Distribution	Eastern Bays Energy Trust
Eastland Network	Eastland Energy Community Trust
Centralines (managed by Unison)	CHB Consumer Trust
ScanPower (also manages Centralines)	ScanPower Consumer's Trust
Electra	Electra Trust
Marlborough Lines	Marlborough Electric Power Trust
Nelson Electricity	Tasman and Marlborough (50/50 JV)
Network Tasman	Tasman Electric Power Trust
Buller Electricity	Buller Electric Power Trust
Westpower	West Coast Electric Power Trust
MainPower	MainPower Trust
Orion Group	Christchurch City Council (87.6%)
Electricity Ashburton	Ashburton City Council & local Co-operative
Alpine Energy	Timaru District Holdings, LineTrust South Canterbury, Waimate & Mackenzie
Network Waitaki	Waitaki Power Trust
Aurora Energy (managed by Delta Utility Services)	Dunedin City Council
OtagoNet Joint Venture	Marlborough Lines, Electricity Invercargill & The Power Company
PowerNet	Invercargill City Holdings, Southland Electric Power, Supply Consumer Trust

Exhibit 9.1: *Electricity network companies operating in New Zealand [Source: Electricity Networks Association]*

Our model results also indicate that further economies may be gained through use of existing infrastructure for aerial (as opposed to underground) fibre. In parts of the US, Asia and Europe the visual impact of overhead reticulation is clearly not an issue but certainly in urban areas of New Zealand overhead wires are considered undesirable and this would constrain the possibilities for aerial deployment of fibre. However where lines companies already have aerial infrastructure the addition of fibre for broadband may be possible.

As discussed in Section 5.1 there are already examples of lines companies engaging in expansion of their businesses into telecommunications in New Zealand which could in fact be regarded as pilot projects. Assuming these pilots are enjoying some measures of success this provides evidence that the approach is indeed workable. In the course of the project we have engaged in discussions with representatives of some of these ventures and we encountered much enthusiasm for making the business model work. In general these projects are still in their infancy with limited deployment as yet. Furthermore it was clear that public investment may have a key role in making the business case succeed in areas in which a commercial case for rollout cannot be established and it may lead to faster deployment than would otherwise have been the case. This applies to both areas in which lines companies are already active and areas in which lines companies have not as yet extended into the telecoms business.

PPP approach

One of the main advantages of the PPP approach is that public sector goals may be achieved with the assistance of private sector expertise. As we have already established from our modelling InternetNZ objectives will not be achieved in New Zealand where the business case is required to apply a commercial rate of return. In other words, without public sector intervention the significant level of required investment is beyond that of any commercial operator expecting a payback within a short- to medium-term time horizon. In New Zealand there is considerable evidence that local Government has a key role to play in PPPs from a number of sources, including existing and emerging initiatives, engagement in application processes for public broadband funding and its role in facilitating infrastructure deployment processes. Further discussion of this role follows in Section 9.3.

9.2 The open access model

One of InternetNZ's principles for the NZBI is that it must be structured in such a way to ensure service providers can fairly compete to deliver services to end-users. Open access models will achieve this, and we note also that open access is one of the National Party's fundamental principles for public sector intervention.

From our review of overseas broadband deployment it is also apparent that, recognising the compatibility of open access with efficient outcomes, open access principles are a cornerstone of many networks, and that open access is a typical requirement where there is public sector involvement. In Sweden fibre is recognised as the medium which provides the greatest transmission capacity, however the regulator (PTS) believes that infrastructure-based competition, in most situations, will not be feasible. PTS therefore has identified that its objective is to ensure service-based competition that uses the established fibre infrastructure and to achieve this open access to the fibre networks is essential. However, PTS states that existing fibre networks – including those financed by public funds or owned by municipal authorities – are characterised by a lack of openness, and has a particular concern to ensure that publicly funding initiatives do not distort or impede competition.

So how do we define open access? In general open access implies equal access to infrastructure on non-discriminatory terms and conditions so that all-comers would be offered the same products or services at the same price and equivalent conditions. Multiple providers will support competitive outcomes and dynamic efficiency is promoted.

In terms of the value chain open access is possible via an infrastructure provider model or a wholesale provider model (Exhibit 9.2). The infrastructure provider invests in the passive access infrastructure (that is, assets with very long lifetimes such as ducts and poles, and dark fibre) while the wholesale provider, in addition to this, lights the fibre and invests in systems and CPE (that is, assets with typically a much shorter lifetime). Thus in the case of the infrastructure provider it would be possible to have multiple suppliers at the wholesale and service provision levels, and in the wholesale provider model there would be multiple suppliers at the service provision level. This is in contrast to a vertically integrated provider ('end-to-end') model (incorporating the passive network, the active network and retailing to the end-user).

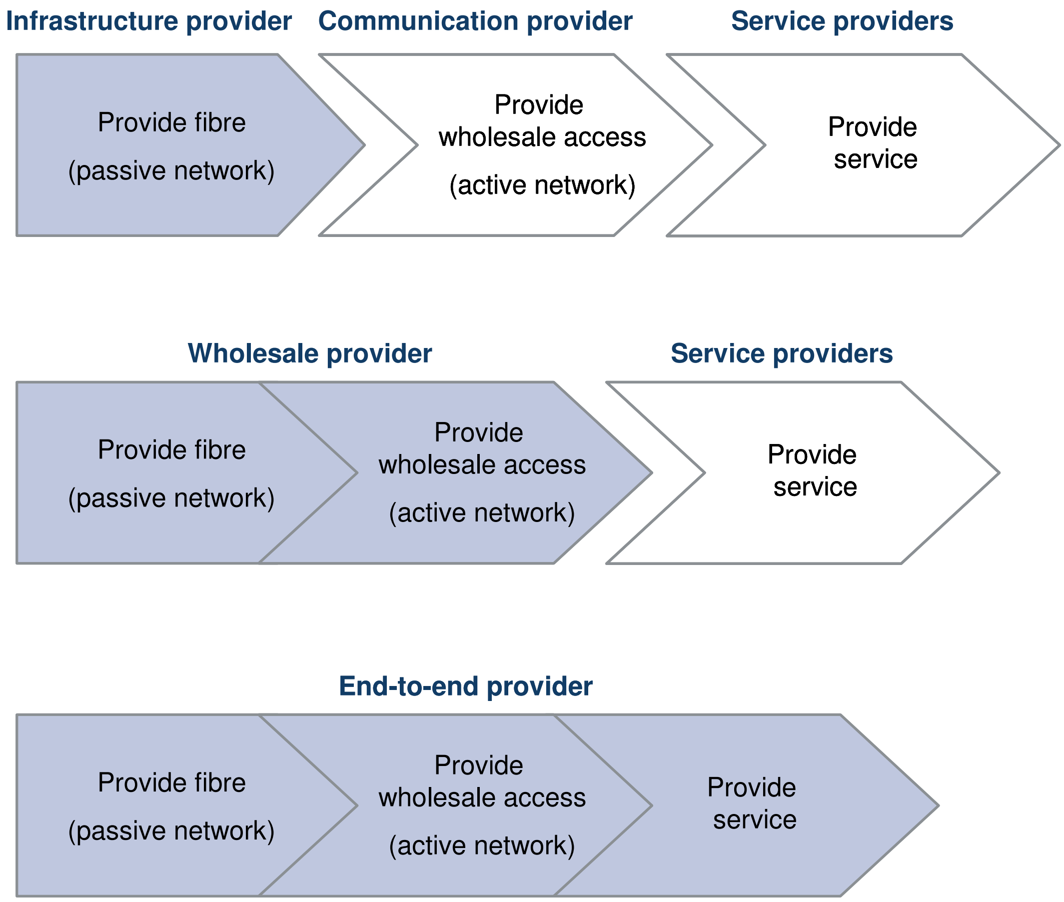

Exhibit 9.2: *Service model value chain [Source: ATKearney]*

There are many examples for these various models of the value chain from other jurisdictions, including:

Infrastructure provider – Singapore's National Broadband Network	An open-access Next Generation National Broadband Network (NBN) is being planned for Singapore, with services to be available nationwide by 2015. The NBN will be capable of symmetric services of at least 1Gbit/s, however the initial provisioning will be for 100Mbit/s.
	The government plans a three-level industry structure:

- passive infrastructure operator (NetCo) – responsible for design, build and operation of the passive infrastructure
- wholesale operator (OpCo) – responsible for the design, build and operation of the active infrastructure
- retail service providers – purchase access from OpCo and compete to provide services to end-users.

NetCo is required to be structurally separate from its downstream operating companies (e.g. retail service providers). OpCo is required to be operationally separate from its downstream operating companies, and in addition must:

- offer fair and non-discriminatory wholesale broadband services to other operating companies and downstream operators through an Interconnection Offer, and the prices and terms and conditions of these wholesale offerings will be regulated
- meet all reasonable requests by any operating company for access to a basic set of wholesale services offered under its Interconnection Offer.

The government grant for NetCo is capped at SGD750 million (NZD1079 million), while the maximum grant for OpCo will be SGD250 million (NZD360 million).

The tender processes for NetCo and OpCo are currently in progress, with the successful NetCo bid expected to be announced in Q3 2008, and OpCo in Q1 2009.

Wholesale provider – MälarNetCity, Sweden

Discussed in Section 5.2, MälarNetCity was the result of Sweden's earliest public broadband initiatives, in the city of Vasterås, located 100km west of Stockholm. The municipal authority engaged the utility Mälarenergi (also owned by the municipal authority) to build a Gigabit Ethernet metropolitan network which is owned and operated by the subsidiary company MälarNetCity.

MälarNetCity does not provide retail services – the network is open-access, with more than 25 service providers, including national providers (including the incumbent, Telia) as well as local companies.

End-to-end provider – Telekom Slovenije, Slovakia

The national incumbent carrier, Telekom Slovenije,[119] has embarked upon a fibre build programme ('F2') that aims to achieve coverage of 70% of the population by 2015. The programme is a key part of Telekom Slovenije's strategy to compete with new entrants and cable operators.

The estimated cost of F2 is EUR450 million (NZD1116 million), which is being part-funded by a EUR100 million loan from the European Investment Bank – the loan is also being used to fund xDSL and WiMAX rollout to areas beyond the FTTH coverage.

In terms of the utility expansion business a common approach in both New Zealand and overseas is to act as a wholesale provider selling to multiple service providers. At the same time there are some examples of utilities selling dark fibre – in other words, operating at the infrastructure provider level only. In general the PPP model without utility involvement tends to be at the infrastructure provision level only. In some cases the business case may rely on participation at the wholesale level, depending on particular regional or local circumstances, and in other cases it may not be possible to attract sufficient interest at the wholesale level. Hence we believe there is scope for both models in the New Zealand market.

It is important to note that there are multiple national and local transmission network providers in New Zealand already, including Telecom, TelstraClear, FX/Kordia Networks. This implies that a competitive market exists in the provision of national transmission services (and indeed these services are not currently regulated by the Commerce Commission) so that at this level competitive prices should be available. Were this not the case then we might expect monopoly pricing at this level to introduce further hurdles for

119 Telekom Slovenije is the leading operator in Slovenia and is 52.53% owned by the Republic of Slovenia. The Slovenian telecoms market has been liberalised.

the provision of competitive broadband pricing in New Zealand. At the same time it is worth noting that in some areas, if such transmission services are limited to only vertically integrated providers then a competitive market outcome may not eventuate. The Commerce Commission in its recent Determination on unbundled local loop network backhaul considered whether two or three backhaul providers on a certain route would be sufficient to ensure effective competition. If only vertically integrated backhaul providers offered services in this market then the Commission considered that there may be an incentive to affect the competitiveness of backhaul-seekers in downstream markets.[120]

9.3 Role of local government

Both overseas and local experience indicates that local authorities have a key role to play in the facilitation of broadband rollout. In our review of broadband initiatives around the world, a constant thread is that local government is a key player. The actual form of participation differs in the various initiatives, but may encompass any combination of the following roles:

- actively contributing within a public-private partnership
- providing public investment for the venture
- acting as anchor tenant for the broadband network
- easing regulations that may be a barrier to fast and efficient roll-out of broadband infrastructure
- managing rights-of-way.

The BIF and its predecessor, the Broadband Challenge Fund, have been instrumental in encouraging local partnerships and the involvement of local government in broadband planning. In some cases there is a financial contribution but in many cases their main contribution lies in their ability to hone systems and processes so that infrastructure deployment may become as rapid and efficient as possible, and opening up effective channels of communication.

120 See Commerce Commission (2008), *Standard Terms Determination for the designated service Telecom's unbundled copper local loop network backhaul (telephone exchange to interconnection point)*, 27 June 2008.

In establishing a case for PPPs in New Zealand in assisting to achieve InternetNZ's objectives, this report implicitly supports the involvement of local government in broadband strategy and planning. However, in terms of the Local Government Act 2002 broadband infrastructure is not classed as core infrastructure. Consequently local councils at present must define their own rationales for involvement in this area. In some areas local economic development agencies are already taking the lead in this regard, recognising the importance of excellent broadband facilities for the economic growth of the region. There is certainly however no consensus on what local councils should be providing. Below we consider some of the options. However we preface our discussion by recommending that in view of the now widespread evidence of the impact of broadband on economic development that Government consider extending the definition of core infrastructure to include broadband infrastructure.

9.3.1 Investor?

In terms of the financial contribution that local government potentially can make to broadband infrastructure, it is important to be realistic. Given the current economic climate there is considerable pressure on councils not to raise rates. Moreover in terms of short-term finance it should be noted that for local government every three years there is a strategic planning process and a strategic funding plan. These plans are very specific for the first three years and then indicative for the following three years. In the current cycle these plans must be available for comment by April 2009 and finalised by 30 June. Councils are obliged to provide core services (of which broadband is not one) and are subject to audit.

9.3.2 Facilitator

As outlined in Section 3.6 a number of initiatives are in train to assist Local Government in facilitating development of high-speed broadband networks in their regions. The Broadband Friendly Protocol identifies a number of particular opportunities that councils have to fulfil an effective facilitation role. Effective communication channels may play a key part in this. A case in point is the opportunities that councils have for informing infrastructure providers in a timely manner when trenches are being opened up for other purposes.

Subdivisions

The Broadband Friendly Protocol discusses new subdivision development. Given that councils develop engineering codes for developers building new subdivisions, there is the potential for the inclusion of FTTH into greenfields developments. In some overseas jurisdictions the provision of fibre is mandatory for new housing developments and subdivisions. For example, the City of Loma Linda in California is deploying a city-wide fibre optic network as part of the Loma Linda Connected Community Program (LLCCP), and the building regulations are to be modified to ensure that developments meet the needs of future communications technologies. All new commercial and residential developments will be required to have a fibre optics interface and copper cabling throughout.[121]

Although this approach would obviously not provide a widespread solution for existing residences in New Zealand, in a longer timeframe there would be a noticeable effect if developers were now required to install future-proof telecommunications equipment in new projects.

9.3.3 Demand aggregator or anchor tenant?

Our modelling has shown that a high take-up scenario is central to the viability of a business case for high-speed wired broadband access in New Zealand. How can local Government assist with this? It may be possible for local Government to commit to being an anchor tenant in proposed local broadband deployments or may assist in facilitating anchor tenant type arrangements. Our interviews with stakeholders indicated that in many circumstances the business case for PPPs was based on an anchor tenant or several anchor tenants.

121 The goal of the LLCCP is to provide high-speed advanced telecommunications services to businesses and residents, to be managed similarly to traditional utilities such as water and sewer. The City is building the fibre network as well as providing Internet services. See http://www.ci.loma-linda.ca.us/asp/Site/LLCCP/AboutLLCCP/Introduction/index.asp

There is also a role for local Government to play in the aggregation of demand. It was clear from our interviews that there was a willingness to deploy infrastructure where local groups were requesting service. Local Government may assist with initiatives to inform residents and businesses of the potential offerings and benefits. This may even extend to people committing in advance to subscribe to services. This will create a better economic case for extending fibre to new areas, and reduce the risk for a new venture. There are numerous examples from overseas of customers committing in advance to take-up services from service providers using soon-to-be deployed infrastructure (see, for example, Chelan County in the US[122]).

9.3.4 Ducting access or rollout?

Councils have the ability to improve the commercial viability of fibre networks, through reducing costs and removing barriers to fibre deployment within their regions. Civil engineering costs represent the largest costs involved in building an FTTH network. These costs can be significantly reduced by councils ensuring that existing ducts can be utilised for deploying fibre, and that ducting is shared among operators. This approach has been key in France, where in Paris the sewer network is accessible for fibre deployment and passes under every building, and in Montpellier where fibre may be deployed through the municipality's own ducts. The essential infrastructure of France Telecom's ducts is to be regulated to guarantee access for alternative operators. The regulator will have to ensure that all operators have access to ducts under equivalent conditions The regulations will include rules to optimise the space and usage of ducts, to ensure that there is non-discriminatory process in the ducts offered, and to have cost-oriented tariffs.

In New Zealand, some councils are also considering the potential of aiding network deployment through making ducting available. Wellington City Council, for example, is currently investigating ways to improve broadband access, considering making use of existing ducting or laying new ducting for fibre optic cable. It is considering making policy and District Plan changes to make council assets such as buildings, poles and unused pipes and ducts available for laying of open access fibre networks. The council will also

122 ChelanPUD (2002), *Chelan County PUD networks 2003 fibre optic build-out proposal*, 23 December 2002, available at https://fiber.chelanpud.org/media/Documents/Presentations/board_12-23-02.pdf.

undertake a micro trenching trial.[123] The Bay of Plenty Councils are investigating rolling out a council-operated open-access duct network for service providers to lay fibre optic cable in. The expectation is that the council will be able to install this ducting inexpensively by coordinating with roading projects.[124]

While making existing ducts available may be financially acceptable with only a marginal cost involved, there may not be a viable case for councils to roll out blank ducting in New Zealand for use in deploying fibre networks. Chorus and Telecom have both stated that they will not use blank ducting provided by councils, due to the risk that other parties using the duct may damage their cable, creating indemnity issues. Telstra also typically avoids sharing ducts. Although traditionally vertically integrated incumbent operators are unwilling to share access infrastructure, this does point to a level of uncertainty about the potential market for the provision of empty ducts.

9.4 Role of central government

Our review of current and pending broadband infrastructure and service offerings indicates that, in the absence of further public investment in broadband infrastructure, improvement in New Zealand infrastructure will be made only on a commercial basis. This will see enhanced services in the larger cities, and either lower-standard (or non-existent) services or high-cost services in other areas. We expect that rural and remote users will not see much improvement beyond the expensive satellite services that are available today.

9.4.1 Investor

The modelling results indicate that there are only limited opportunities for commercial rollout of fibre in many areas, and that to achieve the desired targets within ten years investment from central Government will be essential for both the PPP and (to a much

123 Greater Wellington Regional Council (2008), *Wellington regional strategy – broadband update*, 4 June 2008.

124 Bay of Plenty Councils (2008), *Bay of Plenty Councils broadband newsletter*, 28 March 2008.

lesser extent) utility expansion approaches. Key issues are clearly the magnitude and form of these contributions.

Successful development of the two approaches we have examined in this report would lead to a collection of regional and local networks, similar to the Nordic market where the considerable investment in fibre has been driven by a large number of regional or municipal participants. We note that the nature of the existing BIF programme appears to encourage smaller regional players, rather than a single provider with a nationally consistent approach. While this avoids the potential for monopoly associated with a single provider approach, there is a risk that some regions may miss out on projects that meet the assessment criteria, which could result in an increasing digital divide for any areas left behind. Furthermore there is another risk with the BIF approach that multiple entities apply for funding for overlapping regions rather than pooling resources to achieve a better outcome for the region as a whole and avoiding potential duplication of infrastructure.

Potential approaches include both supply and demand-side interventions. On the supply side:

- allocation of subsidies for open access infrastructure provision on a contestable basis with co-investment provisions (akin to the current BIF initiative)
- tendering of contracts for regional infrastructure provision again with co-investment provisions.

With the first approach the market comes to Government with proposals while in the second approach places more of an onus on Government to set priorities upfront. This more managed approach would potentially avoid overbuilding and give Government more control over achieving targets, ensuring there are no gaps and the ability to coordinate at the inter-regional level. At the same time the subsidy option could potentially become a managed effort by Government if it were, for example, to set up a coordination organisation to ensure that the emerging collection of networks will work together effectively at the regional and national level (for example, addressing issues such as technology standardisation, systems integration and interoperability).

On the demand side interventions could focus on assisting with consumer take-up with the aim of assisting in ensuring sufficient demand emerges in the earlier stages of network deployment, to provide a measure of certainty around demand and assist with the overall project financials. Note that from our consultation exercise it appears that in many instances uncertainty about levels of demand is a significant barrier to project commencement in New Zealand.

It is common in current initiatives in New Zealand to ask for end-users to pay for (or contribute to) the cost of fibre to the property. This up-front cost is likely to amount to well over $1000 per connection. For many potential residential subscribers this would be a significant barrier to take-up and could lead to a deep digital divide. A number of measures to address this issue have been used in some overseas localities: for example, connections fees have been subsidised or charges have not been levied for the first year (for example, a per household Government subsidy was made available in the Netherlands[125]). Another possibility is for Government to assist in financing residential connections via loans with associated tax concessions (as, for example, in the case of Swedish Mälarenergi[126]).

9.4.2 Co-ordinator and facilitator

The significant financial commitments required from partners engaging in both PPP and utility expansion approaches may not be forthcoming if there is considerable regulatory or Government uncertainty. This means that it will be essential for Government to set a clear national agenda for broadband with targets and a definitive approach that addresses both demand and supply-side issues. With respect to regulatory certainty, it is clear that the Commerce Commission from its NGN study is already actively engaging in research to ensure service-level competition in the new IP environment .

One of the benefits enjoyed by large telecommunications operators is their ability to leverage economies of scale in the purchase of equipment. For local PPP-type initiatives the business case for engagement as an infrastructure provider could be made substantially stronger with opportunities to participate in bulk purchasing. Government could potentially

125 See Network Strategies Limited (2008), *Broadband Strategy Options for New Zealand, Stage 1 Research and Analysis*, Section 5.9.

126 See Section 5.2.

have a co-ordination role to play in this via a dedicated unit offering such assistance to PPP partners.

There are other potential coordination roles for a dedicated central unit. One example already described in this report is CESAR in Sweden, a web-based system for dealing with queries to affiliated municipal networks, facilitating the purchase of wholesale products from municipal networks nationally, by offering more uniform terms and a comparable supply of dark fibre.

9.5 Potential bottleneck – skills shortage

We noted from our stakeholder consultation some concern about the availability of skills and capabilities of people to do the required work for infrastructure rollout. We understand that appropriate contractors are fully engaged at present and that their current capacity is to install approximately $150 million per year of infrastructure. There is future work ahead for this same set of skilled labour with the Transpower network which may result in a severe skill shortage. To remedy this situation either more local training programmes will be necessary or overseas skilled labour may be required (and the latter may be unpalatable given current forecasts of rising local unemployment).

9.6 Summary Roadmap

The business modelling for this report has shown that the underlying economics of achieving InternetNZ's objectives of a high-speed broadband network available to 75% of New Zealand's population necessitate a long-term perspective. Given the economic and social benefits that such a network would bring the country and in the absence of a commercial market solution there is a compelling case for public intervention. Open access models are the obvious choice for public intervention as such solutions have been shown to support competitive outcomes. Below we summarise key steps for Government on a Roadmap to a workable NZBI.

Information consolidation

- Revisit existing plans and strategies
- Review the funding requirements of the different approaches explored in this report
- Utilise the information available to Government on current PPP and utility expansion initiatives (for example, via the BIF application process) to refine funding estimates
- Consult and seek feedback from stakeholders on the models explored in this report, and any additional models
- Undertake a risk analysis in order to anticipate potential difficulties
- Review the RMA, given that some stakeholders have concerns that the legislation itself presents unnecessary difficulties for broadband deployment as opposed to assuming that all the problems lie in the implementation of the legislation.

Develop long-term policy

- A clear national agenda for broadband must be set to provide certainty to market participants
  - realistic targets that meet fiscal constraints
  - a definitive commitment that addresses both demand and supply-side issues
- Outline the key elements of a policy framework, including the definition of open access that is to be applied.

Implement policies to achieve objectives

- The definition of core infrastructure in terms of the Local Government Act should be amended to include broadband infrastructure.
- Review availability of appropriately skilled labour for fibre deployment and support and promote suitable training programmes
- Ensure appropriate expertise is available to stakeholders that wish to engage in new ventures associated with broadband deployment (for example local councils and lines companies)
- Investigate ways of assisting in the practical application of the Broadband Friendly Protocol

- Decide on the detail of the supply-side intervention – for example
  - allocation of subsidies for open access infrastructure provision on a contestable basis with co-investment provisions
  - tendering of contracts for regional infrastructure provision again with co-investment provisions
- Consider appropriate demand-side intervention – for example
  - subsidised connection fees
  - favourable loans and/or tax rebates
- Develop appropriate structures for both the demand and supply-side interventions or modify existing structures and implement
- Create a co-ordination unit that ensures a co-ordinated regional approach and avoids any inefficient and excessive duplication of infrastructure. This unit could offer assistance to PPP partners at different potential levels of engagement – this may extend to facilitating bulk purchasing.

Review and refine

- Ensure adherence to open access principles
- Establish a process for regular and ongoing monitoring of projects towards their defined targets
- Monitor changing requirements or changes in the environment and assess the impact on policies
- Take remedial action where necessary.

Annex A: Acknowledgements

Name	*Organisation*
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Peter Ensor	Counties Power
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Murray Jurgeleit	FX Networks
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Susie Stone	Kordia
Colin Drew	Local Government New Zealand
Geoff Swainston	Local Government New Zealand
Reg Hammond	Ministry of Economic Development
Stephen Selwood	New Zealand Council for Infrastructure Development
Peter Macaulay	New Zealand Fibre Fund
Darren Mason	NorthPower
David Haynes	Smartlinx3
Chris Abbott	TelstraClear
Maxine Elliot	Vector
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Annex B: Glossary

ADSL: Asymmetric Digital Subscriber Line, enables speeds of up to 12Mbit/s

ADSL2+: Enhanced standard of ADSL, enables speeds of up to 24Mbit/s

ARPU: Average revenue per user

BIF: Broadband Investment Fund

BPL: Broadband over Powerlines

BOM: Build – own – maintain (type of PPP)

BOO: Build – own – operate (type of PPP)

BOOT: Build – own – operate – transfer (type of PPP)

BPON: Broadband passive optical network

Broadband: A communications channel which carries traffic at a rate higher than dial-up communications – while there is no standard industry definition of broadband speed, the OECD defines broadband to have a minimum downstream bandwidth of 256kbit/s

BVU: Bristol Virginia Utilities

BWA: Broadband Wireless Access

Cat5: Category 5 cable, twisted pair cable standard commonly used for Ethernet networks

CBD: Central business district

CCC: Christchurch City Council

CCHL: Christchurch City Holdings

CCNL: Christchurch City Networks Ltd

CPE: Customer premises equipment

DBS: Direct broadcast satellite (see also DTH)

Dark fibre: unused optic fibres that are available for use (also unlit fibre). Also often used to refer to fibre that is wholesaled unlit.

Dial-up: A communications channel which is established between two modems to allow for the transmission of digital data across the PSTN at a rate of up to 56kbit/s

DOCSIS: Data Over Cable Service Interface Specification, a standard used in HFC networks

DSL: Digital Subscriber Line, family of technologies for data transmission over a telephone line (also xDSL)

DSLAM: Digital Subscriber Line Access Multiplexer

DSP: *Délégations de service public*, French system of management for public services, similar to a PPP

DTH: Direct to Home (satellite)

EPON: Ethernet Passive Optical Network

Ethernet: Family of networking technologies for local area networks

FTTC: Fibre to the cabinet or fibre to the curb (also FTTN)

FTTH: Fibre to the home (see also FTTP)

FTTN: Fibre to the node (see also FTTC)

FTTP: Fibre to the premises (see also FTTH)

GB: Gigabyte

Gbit/s: Gigabits per second

GEPON: Gigabit Ethernet Passive Optical Network

GNA: Glasvezelnet Amsterdam BV

GPON: Gigabit Passive Optical Network

GSN: Government Shared Network

HDTV: High Definition Television

HFC: Hybrid Fibre-Coaxial

HSPA: High Speed Packet Access

IEEE: Institute of Electrical and Electronics Engineers

IP: Internet Protocol

IPTV: Internet Protocol Television

ISP: Internet Service Provider

IT: Information Technology

ITU: International Telecommunication Union

kbit/s: Kilobits per second

km: kilometre

Latency: time delay. Can refer to transmission – the time it takes the signal to reach a satellite and return to earth; or processing – the time taken to digitalise an analogue signal for transmission, and then to reconstitute it at the destination

Layer 0: In the context of wholesaling, a term used to refer to the civil works of the network such as duct pipes

Layer 2: Data link layer – protocol that transfers data between network nodes

LDO: Lease – develop – operate (type of PPP)

LTCCP: Long Term Council Community Plan

LTE: Long Term Evolution

MB: Megabyte

Mbit/s: Megabits per second

MDF: Main distribution frame

mm: millimetre

MUSH: Municipal, university, school, hospital (network)

NBN: National Broadband Network

NEAL: North Shore Education and Access Loop

NES: National Environmental Standards

NGN: Next Generation Network

NPV: Net Present Value

NTT: Nippon Telegraph and Telephone Corporation

NZBI: New Zealand Broadband Infrastructure

NZI: New Zealand Institute

OECD: Organisation for Economic Co-operation and Development

OLT: Optical line terminal

Open access: Network in which physical access is separated from service provision, shared by multiple service providers

P2P: Point-to-point (an FTTP architecture)

PC: Personal Computer

PON: Passive optical network (see also BPON, GPON)

PPP: Public-private partnership

PPP: Purchasing power parity

PSTN: Public Switched Telephone Network

PUD: Public Utility District

REANNZ: Research and Education Advanced Network New Zealand

RMA: Resource Management Act

TEPCO: Tokyo Electric Power Company

TV: Television

UCLL: Unbundled copper local loop

US: United States

UTOPIA: Utah Telecommunication Open Infrastructure Agency

VDSL: Very High Speed Digital Subscriber Line

VDSL2: enhanced VDSL standard, with data rates up to 200Mbit/s

VoIP: Voice over Internet Protocol

VRAD: Video Ready Access Device

WDM-PON: Wavelength division multiplexing PON

WiFi: term for certain types of wireless local area network that use specifications in the 802.11 family

WiMAX: Worldwide Interoperability for Microwave Access – a wireless industry coalition organised to advance IEEE 802.16 standards for broadband wireless access networks

Annex C: Currency exchange rates

In our comparisons of retail prices, we have used purchasing power parity (PPP) rates (Exhibit C.1), which adjust for the relative differences in the prices for goods and services between countries and thus reflect the differing levels of affordability.

Country	*PPP rate*
Australia	1.4276
Canada	1.2092
Denmark	8.5839
France	0.9080
Iceland	108.1570
Ireland	0.9915
Italy	0.8664
Japan	120.3113
Korea	751.4478
Netherlands	0.8862
New Zealand	1.5443
Norway	8.9145
Portugal	0.6973
Sweden	9.0297
Switzerland	1.6531
United Kingdom	0.6658
United States	1.0000

Exhibit C.1: *Purchasing power parity rates, 2007 [Source: World Bank]*

Annex D: BIF – successful expressions of interest

Applicant name	*Fund*	*Geographic area (indicative)*
Auckland University of Technology	Rural	Auckland to Warkworth
Bay City Communications Ltd	Rural	Nationwide
Countrynet Ltd	Rural	Queenstown
Electra Limited	Rural	Christchurch to Dunedin, and Kapiti and Horowhenua
Enterprise North Canterbury	Urban	North Canterbury
Hawkes Bay Rural Network	Rural	Hawkes Bay
Hobsonville Land Company	Urban	Hobsonville
Horowhenua District Council	Urban	Horowhenua District
Kawau Island Residents and Ratepayers Association	Rural	Kawau Island
Lake Taupo Development Council	Urban	Lake Taupo region
Network Tasman	Rural	Golden Bay
Network Tasman	Urban	Marlborough, Nelson, Tasman
New Plymouth District Council	Rural	New Plymouth District
Ngati Hine Health Trust	Rural	Northland
Ngatiwai Trust Board	Rural	Northland
Palmerston North	Combined	Palmerston North Surrounds
Papkura District Council	Urban	Papakura District
Rangitikei District Council	Urban	Rangitikei District
Rodney District Council	Urban	Rodney District
Selwyn Investment Holdings	Urban	Selwyn District
Sounds Community Connect	Rural	Marlborough Sounds
Stratos NZ Ltd	Rural	Nationwide

***Exhibit D.1**: Successful expression of interest applications to the BIF [Source: Digital Strategy]*

Applicant name	*Fund*	*Geographic area (indicative)*
Telecom New Zealand Limited	Rural	Awatere Valley
Telecom New Zealand Limited	Rural	Catlins
Telecom New Zealand Limited	Rural	Fox Glacier to Ruatoria
Telecom New Zealand Limited	Rural	Gisborne to Ruatoria
Telecom New Zealand Limited	Rural	Great Barrier Island
Telecom New Zealand Limited	Rural	Karamea
Telecom New Zealand Limited	Rural	Manawatu
Telecom New Zealand Limited	Rural	North Coromandel Peninsula
Telecom New Zealand Limited	Urban	Otago region
Vector Ltd	Urban	Auckland region
Waimate District Council	Rural	Waimate District
Wanganui District Council	Urban	Wanganui District
Wellington Regional Broadband	1 Rural, 1 Urban	Wellington Region

Exhibit D.1 (cont):*Successful expression of interest applications to the BIF [Source: Digital Strategy]*