



Connectivity Report

Status of Inter-regional Connectivity

RESEARCH AND EDUCATION ADVANCED NETWORK NEW ZEALAND LTD
Rooms 407-411, Level 4, Railway West Wing, Featherston Street, Wellington 6011
POSTAL PO Box 3325, Wellington 6140, New Zealand
TELEPHONE +64 4 913 1090 FACSIMILE +64 4 916 0064
WEBSITE www.reannz.co.nz

Contents

Audience	3
Reference Documents	3
Version control	3
Review and Approval	3
Distribution	3
Scope	5
Disclaimer	5
Summary	5
Approach & Assumptions	6
Identification of Population Centres	6
Identification of Fibre Optic Providers	6
Mapping Connectivity	6
Route Distances	7
The Cost of Connectivity	7
Local Fibre Companies (LFCs)	7
Definition of Terms	7
Networks Examined	9
Inter-regional Network Providers	9
<i>Telecom New Zealand</i>	9
<i>TelstraClear</i>	9
<i>FX Networks</i>	9
<i>TheLink</i>	10
<i>Digital Nation</i>	10
Access to Networks.....	10
Points of Presence	12
Lighting the Fibre	12
South Island.....	13
North Island	14
Possible Routes	14
Route Distances	18
Fibre Deployment Costs	19





Audience

The intended audience for this document are:

- REANNZ staff members
- REANNZ Board members

Reference Documents

No documents are referenced.

Version control

VERSION	DATE	REASON FOR UPDATE	AUTHOR
0.2	21/7/2009	Initial	J Horrell
0.3	23/7/2009	DH typos	D Clough

Review and Approval

This document has been approved for release by the following:

NAME	ROLE	ORGANISATION	DATE
D Clark	Chief Executive	REANNZ	21/7/2009

Distribution

This document has been distributed to the following persons or parties:

NAME	ROLE	ORGANISATION
Public release		

Important Statements and Disclaimers

The following statements and disclaimers apply in respect of all information contained in this document.

Distribution control

This document is issued under the Creative Commons Attribution – Non Commercial – No Derivative Works 3.0 New Zealand license.



You are free to Share (to copy, distribute and transmit the work) under the following conditions:

Attribution. You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work)

Contact for further information

Donald Clark
Chief Executive
Research and Education Advanced Network NZ Ltd
+64 4 913 1090
Donald.clark@reannz.co.nz



Scope

- Identify the major population centres and centres where KAREN connectivity is viewed as desirable.
- Identify the available interregional and intra-regional networks capable of supporting KAREN connectivity to current and future KAREN members.
- Develop a map based network model to define network requirements for servicing centres of potential interest to KAREN.
- Obtain, from the published technical standards, the optics this network model is based on in terms of cost and speed capability.

The information presented in this report has been used in the following:

- Use the developed model to calculate the cost of a 10 year and 15 year network between the 25 centres, also calculate the residual value of this network at +5 and +10, years. Create two iterations, one for today and one with an understanding of future fibre build development
- Calculate the operating cost / annum.
- Quantify the outcome in terms of CAPEX and OPEX

Disclaimer

We have made significant efforts to ensure that the information in this document is publicly available or readily inferred from public data. If there are any concerns about information contained in this document they should be directed to REANNZ Operations Manager.

Summary

All of New Zealand's main population centres and current KAREN points of presence can be connected to each other by existing fibre optic networks. Infrastructure competition for providers ranges from one supplier to four suppliers with Telecom New Zealand and TelstraClear being the dominant network providers.

Approach & Assumptions

Identification of Population Centres

The Ministry of Economic Development (MED) have identified the 25 main population centres in New Zealand that covers 75 percent of New Zealand's population. These population centres will have research and/or education facilities that could take advantage of a KAREN connection.

With the nature of New Zealand's research sector, KAREN has PoPs outside of the main population centres, such as Invermay outside of Dunedin. Current PoPs were included as points KAREN needs to touch.

Identification of Fibre Optic Providers

Recent work has seen the majority of network providers display their network coverage in the National Broadband Map (broadbandmap.govt.nz.) This has provided a useful starting point for identifying where networks within New Zealand run. For those providers who have not contributed information the link between towns can be ascertained from service offerings. If connectivity between two sites is available at gigabit speeds then the assumption is that fibre optic connectivity between the sites can be made.

Mapping Connectivity

Providers of fibre optic networks will often have different geographic routes between places. This may mean two providers will take two different routes between a town. It may also mean the same provider takes two different routes between towns.

In mapping the connectivity a schematic map that shows the connectivity between towns has been shown. This map does not display the absolute geographic route between centres, and where two fibre optic providers are shown on the map providing connectivity they may be taking completely different geographic paths.

The maps produced are topological maps and are intended to show the relative, rather than absolute positioning of fibre optic network suppliers and the centres that they connect to.





Route Distances

As different networks take different routes between centres the approach used to identifying distances between centres was to take distances from the state highway and roading networks. While being an imperfect approach it provides a very realistic figure, useful for planning. All of New Zealand's fibre optic networks follow the state highway system in some way.

The Cost of Connectivity

Many network providers factor distance into what they sell connectivity for, whether as a managed service or dark fibre based. Distances between the centres have been evaluated and provided as a proxy for connectivity costs. It also allows an understanding of what building a new network or network extension would cost. Costs of connectivity are not directly provided.

By way of example Telecom Wholesale employ step based pricing on products, with the steps defined on the geographic location. Generally speaking, across town connectivity will be at the lowest pricing step and long haul connectivity at the most expensive pricing step.

Local Fibre Companies (LFCs)

This analysis assumes that end user connectivity to any KAREN PoP can be achieved using local open access fibre optic networks. This is an important assumption to highlight as KAREN as a network does not provide end user connectivity but provides a point of presence a local user can connect to. It is also worth noting that LFC owned fibre while not highlighted in this report may be used to get from one side of a town to another and could provide a small portion of any interregional network.

These networks are being called LFCs as the terminology and language aligns with that being used by the Government as part of their broadband investment initiative.

Definition of Terms

Intra-regional Networks

Intra-regional networks are those networks that service an immediate geographic area. They move data around a region; a useful analogy is they are the bus and light rail network. In the same way a bus stop is close to

where people want to get on, intra-regional networks are close to those who want to get onto networks.

Inter-regional Networks

Inter-regional networks are the long haul fibre optic networks that connect cities and towns together. They move data between regions; a useful analogy is they are the rail network. In the same way a rail network can take people between towns, inter-regional networks take data between towns. In the same way a passenger on the rail network will intend to get to somewhere past a rail station and use a bus or car to get there, the intra-regional data will need to be transited across an inter-regional network.

Inter-Island Networks

This refers specifically to the linking of the North and South Islands of New Zealand. Out of the proposed LFC networks all are on the North or South Islands. All other islands of population significance are serviced by radio or satellite communications.

Indefeasible Rights of Use

Indefeasible rights of use (IRU) is the unrestricted right to use the capacity of a network for a set timeframe. These rights of use can be treated as an asset in a lot of circumstances and are not an uncommon financial instrument in the telecommunications industry.

LFC

Local Fibre Company – this refers to inter-regional fibre providers and the terminology aligns with that being used for the government’s Broadband initiative.





Networks Examined

New Zealand has several competing fibre optic networks which provide different types of service. Broadly the networks can be divided into inter-regional and intra-regional networks.

Only networks that have deployed fibre optics have been examined as they are the only networks that can reliably provide the high bandwidth required for connectivity over long distances.

Inter-regional Network Providers

Telecom New Zealand

Telecom New Zealand (TNZ) is the dominant provider of fibre optic inter-regional backhaul in New Zealand. As well as being the dominant provider, they uniquely service some areas where no other fibre optic provider exists. Examples of where this is very evident include the West Coast and Gisborne. The majority of TNZ fibre optic cable is owned and operated by Chorus an operating division of Telecom with structural and accounting separation from the Telecom Group.

TelstraClear

TelstraClear have New Zealand's second largest fibre optic network and is the network that carries KAREN at present. KAREN geographically spans from Dunedin to Auckland and the TelstraClear Network geographically spans from Invercargill to Whangarei. The TelstraClear Network provides connectivity between the North and South Islands.

FX Networks

FX Networks are actively building fibre optic networks through New Zealand and now have over 1600 KM of physical network spanning from Auckland to Christchurch. This aggressive growth may suggest further expansions south, possibly to Dunedin and beyond.

FX Networks are openly selling IRU connectivity across their network. There are portions of their network where it follows some rail routes that IRU connectivity is not available. This is due to the number of fibre pairs physically available. This portion of the network is still available for purchase as a managed service (Layer2 or Layer3) and could be used to provide redundancy.



TheLink

TheLink operate networks in Nelson and Marlborough. They only sell dark fibre with pricing based on pricing zones. The pricing between the two LFC towns of Blenheim and Nelson is not widely published on their website. TheLink is of particular notice to a KAREN style network in that TheLink's owners, the lines company 'Network Tasman', have made available to TheLoop a fibre pair which is running a schools network across the top of the South Island. For KAREN to service the education market they only need a point of presence in Blenheim or Nelson. This is not true of the research market.

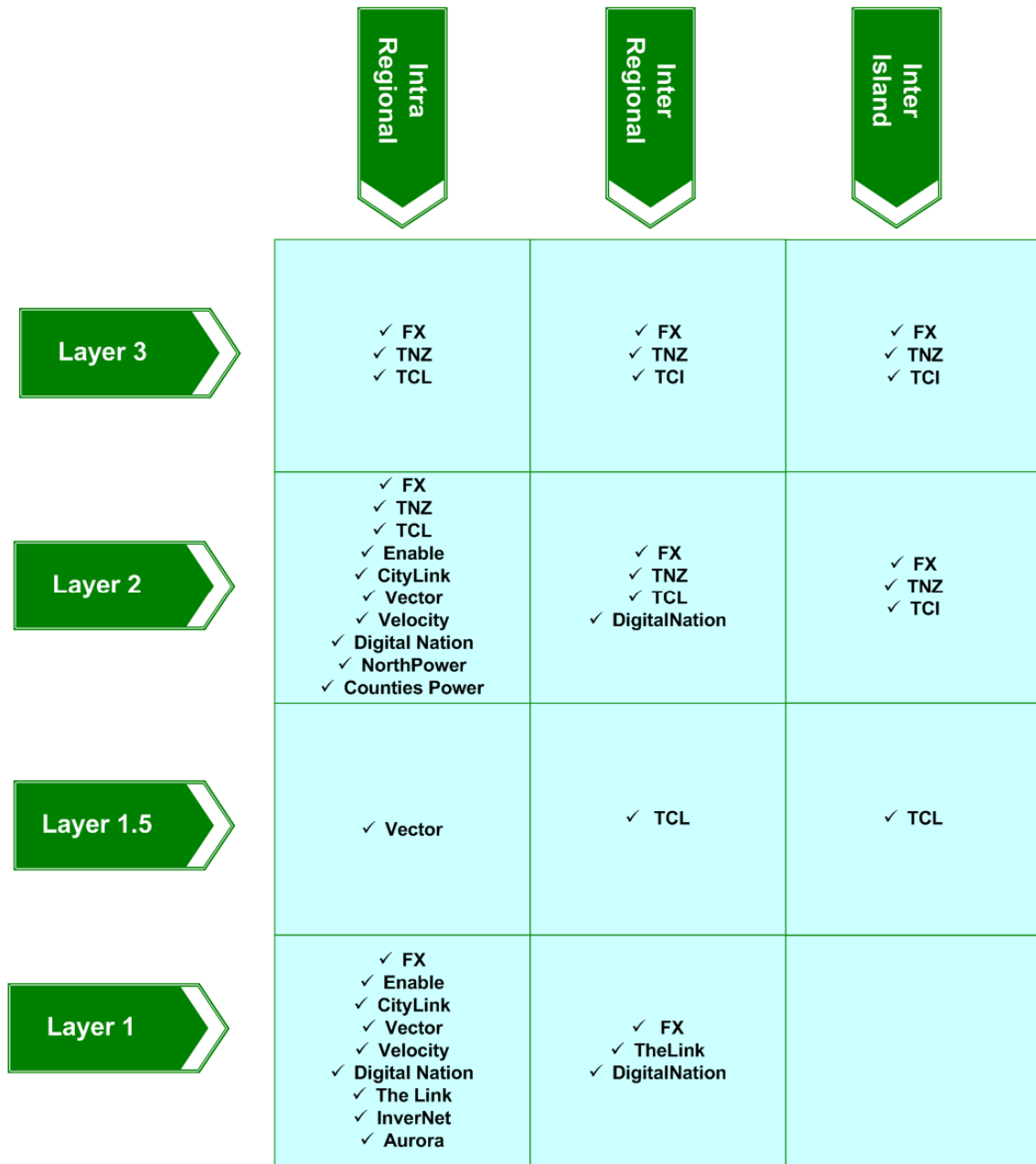
Digital Nation

Digital Nation is a fibre optic network spanning the Manawatu and Tararua. It only touches one of the LFC towns (Palmerston North) which decreases its usefulness. However as a fibre network it is being sold below the rates of competing networks and could fill niches. The use of this network to connect rural schools to KAREN at rates that they can afford, and to allow farmers to partner to lay their own last mile fibre deserves special mention.

Access to Networks

Access to backhaul networks is available in a limited number of ways which is defined by the operator. The different connectivity methods have advantages and disadvantages with some being more favourable for deploying a KAREN style network.

Figure 1 - Taxonomy of New Zealand Fibre Optic Networks



For the purposes of this discussion it is assumed that a general understanding of Layer 1 (physical), Layer 2 (Ethernet) and Layer 3 (routed) products exists. Layer 1.5 as described above is used to differentiate out wavelength type products from dark fibre. While Layer 1.5 is technically a Layer 1 product, only a subset of Layer 1 providers offer wavelength products.

Points of Presence

In preparation of this report, assumptions have been made around what sites would be of interest to a KAREN type network. Those assumptions are:

- The 25 major population centres as identified by the Ministry of Economic Development (MED) as part of the Governments intended broadband investment were considered to be of interest.
- Current locations of KAREN PoPs that were not in the 25 major population centres were considered to be of interest.

From the above assumptions the following was derived:

Table 1- Points of Interest for Potential Future KAREN Connectivity

Region	Population	Current KAREN PoP	Current Open Access Urban Fibre	Backhaul Fibre Providers
Auckland	1230606	Yes	Vector, Citylink	TNZ, FX, TCL
Christchurch	360768	Yes	Enable	TNZ, FX, TCL
Wellington	360627	Yes	Vector, Citylink, SmartLinx3	TNZ, FX, TCL
Hamilton Zone	155262	Yes	Velocity	TNZ, FX, TCL
Napier and Hastings	118404		-	TNZ, FX, TCL
Dunedin	110997	Yes	Aurora	TNZ, TCL
Tauranga	108882		-	TNZ, FX, TCL
Palmerston North and Fielding	89922	Yes	Digital Nation	TNZ, FX, TCL
New Plymouth and Hawera	60057		-	TNZ, TCL
Kapiti and Levin	56571		-	TNZ, FX, TCL
Nelson	56364	Yes	TheLink	TNZ, FX, TheLink
Rotorua	53766	Yes	-	TNZ, FX, TCL
Whangarei	49080		NorthPower	TNZ, TCL
Invercargill	46773		InverNet	TNZ, TCL
Wanganui	38988		-	TNZ, TCL
Gisborne	32529		-	TNZ
Cambridge and Te Awamutu	29646		-	TNZ, FX, TCL
Blenheim	28527		TheLink	TNZ, FX, TCL, TheLink
Timaru	26886		-	TNZ, TCL
Taupo	21291		-	TNZ, FX, TCL
Masterton	19494		-	TNZ, FX, TCL
Whakatane	18204		-	TNZ, FX, TCL
Ashburton	16836		-	TNZ, TCL
Tokoroa	13530		-	TNZ, FX, TCL
Oamaru	12681		-	TNZ, TCL
Tekapo		Yes	-	
Invermay		Yes	-	TNZ, TCL
Lincoln		Yes	-	TNZ, TCL

Lighting the Fibre

Most Layer 1 products will be dark fibre and would need to be 'lit' by REANNZ or a contracted party. The active electronics used to light the fibre will affect its performance. There are some important factors that would need to be



taken into account when selecting the product or service provided. There are several products available for the purpose of lighting the fibre and a subset of products are presented for comparison purposes. The products are all small form factor pluggable transceivers (SFPs.)

It should be noted that a wavelength type product is already a 'lit' product and no additional optics are required to provision it.

Table 2 - Comparison of SFPs


Product	Optone SFP-LX-SM-0212	Allied-Telesis - AT-SPZX80	Allied-Telesis - SFP-CWDM-02XX	Cisco DWDM X2
Data rate	1.25 Gbps	1.25 Gbps	2.5 Gbps	10 Gbps
Channels		2	8	32
Tx	5	2	5	-1
Rx	-32	-26	-28	-23
<i>Dynamic Range (dB)</i>	37	28	33	22
<i>Attenuation (dB/KM)</i>	0.3	0.3	0.3	0.3
<i>Connector Loss (dB)</i>	0.75	0.75	0.75	0.75
<i>Headroom (dB)</i>	3	3	3	3
<i>Maximum Distance (KM)</i>	115	85	102	65

South Island

The South Island has 4 separate fibre optic networks providing inter-regional fibre optic connectivity – Telecom New Zealand (TNZ), TelstraClear (TCL), TheLink and FX Networks (FX).

In building a KAREN style network the following points should be considered:

- The Mount John observatory at Tekapo sits out on its own geographically – 371 KM from Invercargill and 182 KM from Christchurch. This inland route may add significant cost to any network without picking up much potential demand. Queenstown while being discussed as a potential LFC has a small education market.
- Redundancy to Nelson via an inland route will go via the West Coast. This may open benefits for the West Coast but add significantly to cost.

- 
- Redundancy between Nelson/Blenheim and Christchurch may well be better provided with a managed service or separate physical networks, rather than traversing the West Coast.
 - Redundancy between Invercargill and Dunedin may be better provided with a managed service or separate physical networks.
 - The Christchurch to Dunedin link would link five potential LFCs.
 - The Dunedin to Invercargill link would require two PoPs for regeneration, this would likely enable Telford Rural Polytechnic and the Gore research/education cluster to take advantage of the network.
 - Redundancy between Nelson and Blenheim can come from two different providers, TheLink and TelstraClear.

North Island

The North Island has 4 separate fibre optic networks providing inter-regional fibre optic connectivity – Telecom New Zealand (TNZ), TelstraClear (TCL), Digital Nation and FX Networks (FX).

In building a KAREN style network the following points should be considered:

- Gisborne and the East Coast region has only recently had fibre optic connectivity delivered to it and has only one route and one provider into the region. Redundancy would need to be provided by wireless solutions.
- FX Networks cannot provide dark fibre on all of its routes. As a rule it can be expected that one side of an FX ring will be Ethernet only.
- Whangarei still sits alone. The current KAREN wavelength does not extend to Whangarei and connectivity to Northland has generally been viewed as less than acceptable.
- The New Plymouth/Hawera LFC may mean an extension to Hawera may service New Plymouth via the LFC.

Possible Routes

For the purposes of this investigation, routes have been schematically represented. Fibre optic network providers may have a physical path between two points that follows a different physical path to another provider. While the physical route may have a bearing on other factors it is not being factored into this report.

Figure 2 – Inter-island Connectivity (potentially incomplete)

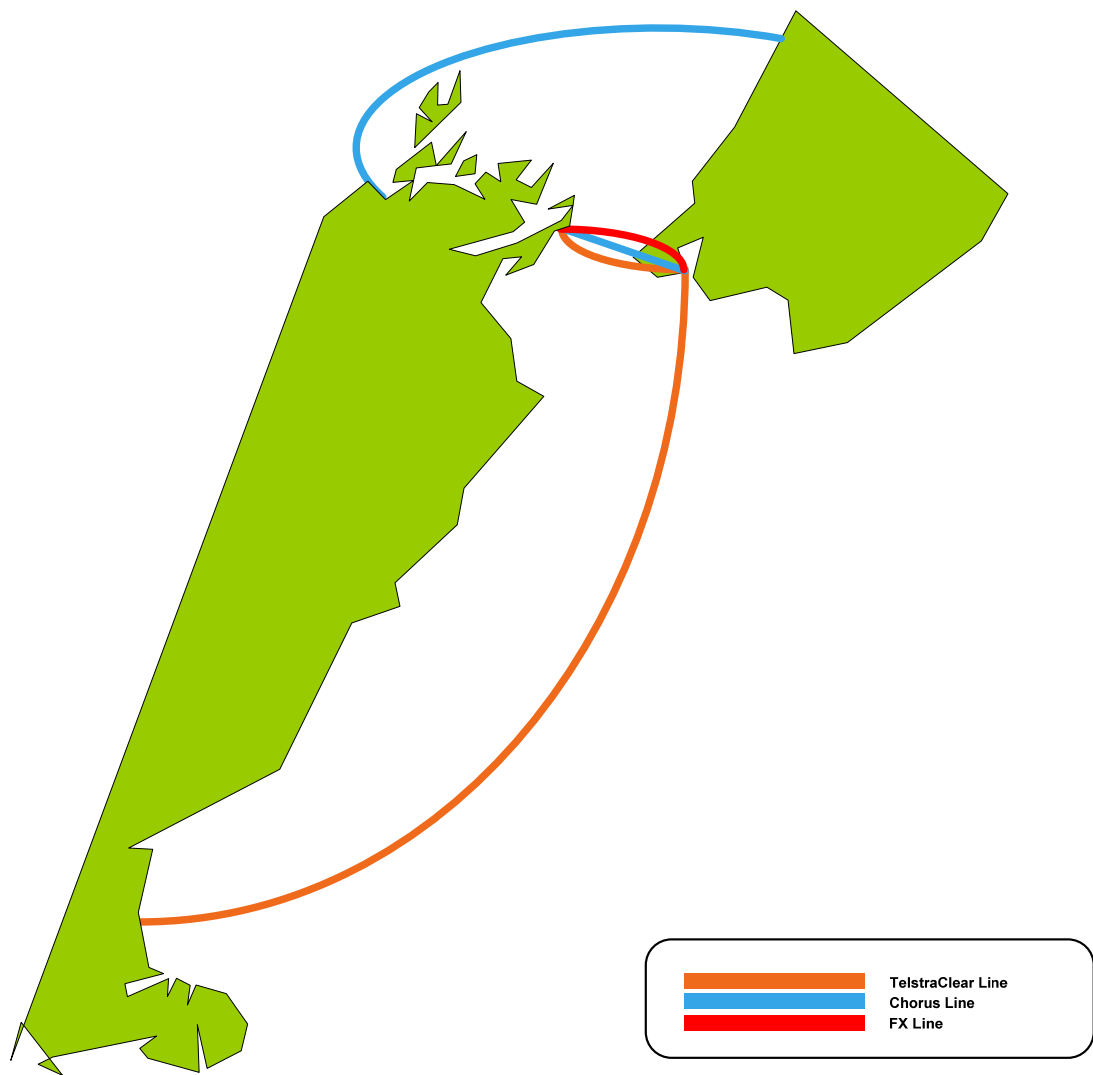


Figure 3 - South Island Inter-regional Connectivity

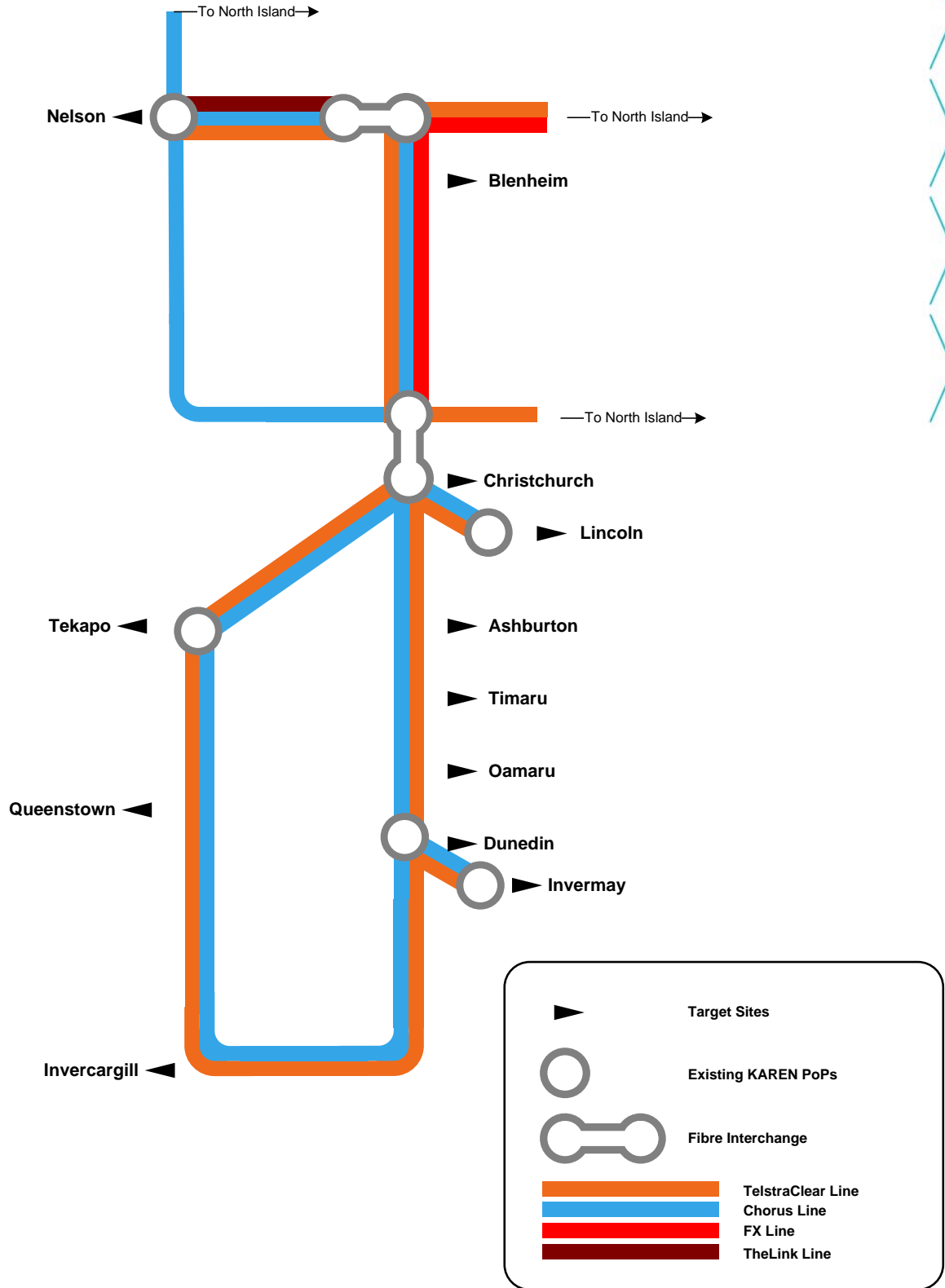
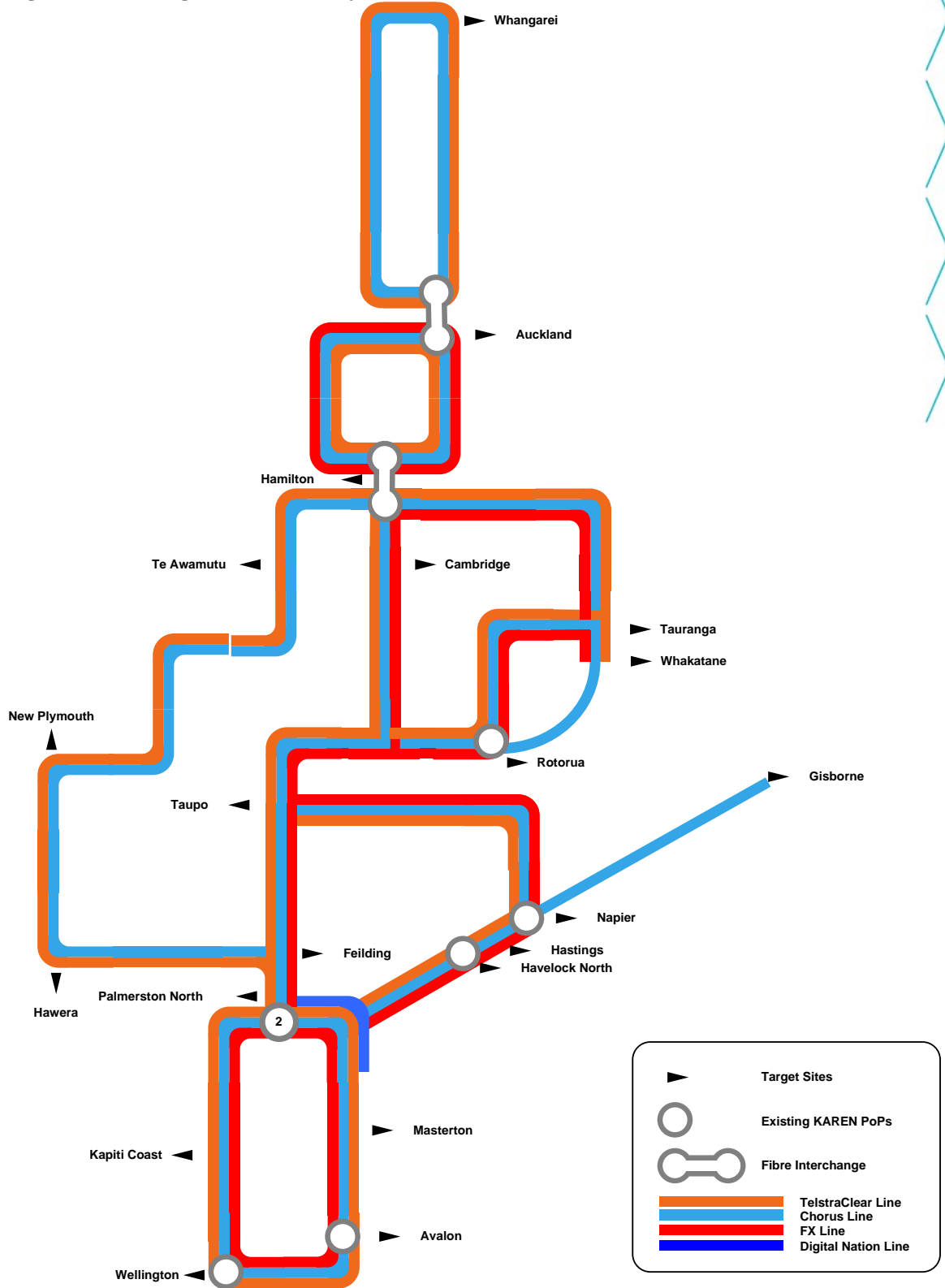


Figure 4 – Inter-regional Connectivity - North Island



Route Distances

The distances between centres can be estimated to give scale to what is required to physically connect all points. The distances are estimates based on road kilometres, and fibre routes will differ in physical route and distance. These distances are useful for planning purposes yet do not define the true route distance of any single network.

Table 3 - Route Distances - South Island

From	To	Length (KM)	Providers		
			TNZ	TCL	FX TFN
Nelson	Blenheim	194	Y	Y	Y
Nelson	Blenheim	93	Y		
Nelson	Christchurch (via West Coast)	531	Y		
Blenheim	Christchurch	308	Y	Y	Y
Christchurch	Lincoln	24	Y	Y	
Christchurch	Ashburton	87	Y	Y	
Ashburton	Timaru	77	Y	Y	
Timaru	Oamaru	85	Y	Y	
Oamaru	Dunedin	113	Y	Y	
Dunedin	Invermay	14	Y	Y	
Dunedin	Invercargill	205	Y	Y	
Invercargill	Queenstown	187	Y	Y	
Queenstown	Tekapo	184	Y	Y	
Tekapo	Christchurch	225	Y	Y	
<i>Total</i>		2,327			

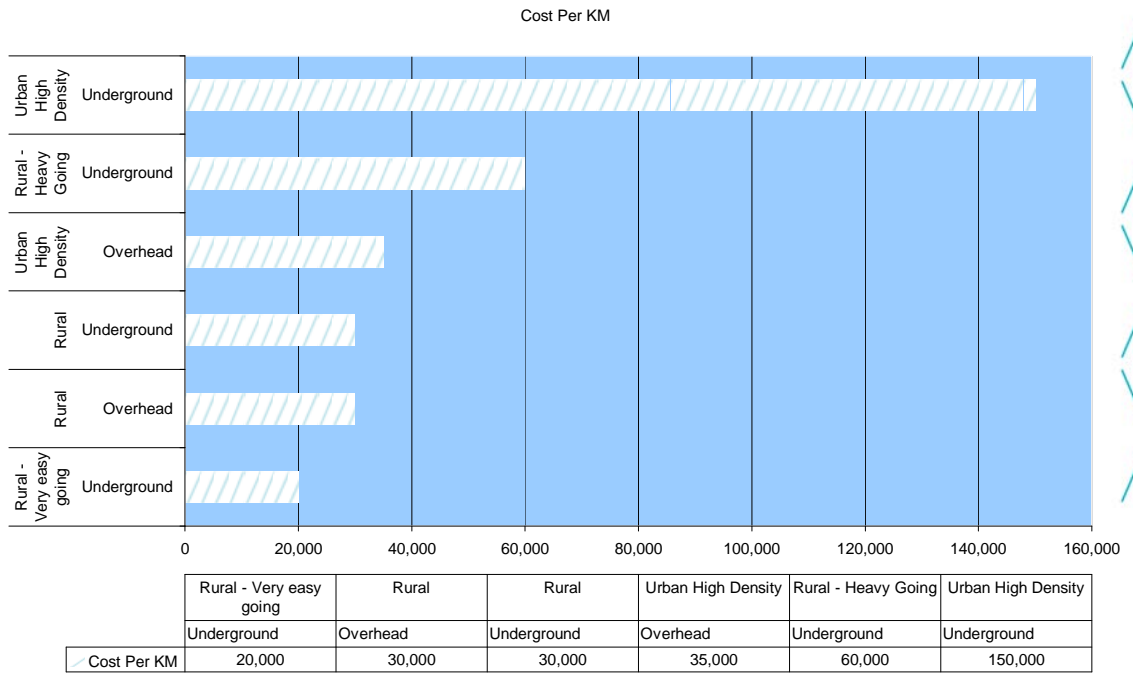
Table 4 - Route Distances - North Island

From	To	Length	Providers			
			TNZ	TCL	FX	DN
Wellington	Avalon	20	Y	Y	Y	
Avalon	Masterton	83	Y	Y	Y	
Masterton	Pahiatua	64	Y	Y	Y	
Pahiatua	Palmerston North	37	Y	Y	Y	Y
Palmerston North	Paraparaumu	100	Y	Y	Y	
Paraparaumu	Wellington	50	Y	Y	Y	
Palmerston North	Wanganui	75	Y	Y		
Wanganui	Hawera	89	Y	Y		
Hawera	New Plymouth	71	Y	Y		
New Plymouth	Te Awamutu	212	Y	Y		
Te Awamutu	Hamilton	30	Y	Y		
Hamilton	Auckland	125	Y	Y	Y	
Hamilton to Auckland 2	Auckland		Y	Y	Y	
Palmerston North	Fielding	20	Y	Y	Y	
Fielding	Taupo	224	Y	Y	Y	
Taupo	Napier	141	Y	Y	Y	
Napier	Pahiatua	167	Y	Y	Y	
Taupo	Rotorua	81	Y	Y	Y	
Rotorua	Tauranga	82	Y	Y	Y	
Tauranga	Whakatane	90	Y	Y	Y	
Tauranga	Tirau	55	Y	Y	Y	
Tirau	Cambridge	32	Y	Y	Y	
Cambridge	Hamilton	24	Y	Y	Y	
Papakura	Whangarei	159	Y	Y		
Auckland to Whangarei 2	Auckland	180	Y	Y		
Total		2,211				

Fibre Deployment Costs

With distances between centres known it is possible to estimate network build costs. These vary depending on the deployment method and terrain. The chart below gives some indicative pricing, yet the potential for variation cannot be underemphasised. By way of example fibre optic deployments in Wellington City are anecdotally costing around \$260 per metre at present for a deep trenched solution (average over urban area).

Figure 5 - Comparison of Fibre Optic Deployment Costs



Breakout points are still required; so should pits and vaults be installed at the same time cost can be significantly higher.