Benchmarking wholesale fibre access services

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0   Executive summary

The Commerce Commission wishes to understand the wholesale service offerings available in the New Zealand non-residential market – in particular, how these compare with overseas experience and whether there are indications that New Zealand's non-residential market is workably competitive. The focus is on commercial fibre based point to point and point to multi-point services.

To support these objectives, Network Strategies has undertaken a benchmark study of a selection of wholesale fibre access services, comparing New Zealand service offerings with those from wholesale operators in the United Kingdom, Ireland, Sweden and Belgium. Australia was excluded due to the difficulty in deriving appropriate assumptions required for the complex nature of the pricing structure in that country. Singapore was also excluded, as its dense urban characteristics would result in prices that would not be comparable with the geographically averaged prices in New Zealand.

This analysis has highlighted the difficulties of conducting robust benchmarking exercises of non-residential fibre services. As anticipated, pricing for such services is often not publicly available, however we also found that other crucial information relating to service descriptions, pricing definitions or network characteristics was also unavailable, even if prices are published. In addition, the services offered by the operators often have quite different characteristics. In instances where similar services are available they may differ with respect to the speeds offered and/or Quality of Service (QoS) attributes.

Consequently it is not possible to be certain that some services used in the benchmark comparison are directly comparable with those in New Zealand.

We observed that pricing and service structures appear to be very dependent on local factors, including geography, network design, history and regulatory conditions.

Acknowledging the small number of comparisons available and the difficulty in assessing the exactness of the comparison we can conclude that there is no evidence that New Zealand prices are inconsistent with what is available in our sample from other markets. However the

limited number of datapoints is not sufficient to conclude with confidence that the New Zealand market is workably competitive.

1 Introduction

The Commerce Commission ('Commission') seeks a benchmark study of a selection of wholesale fibre access services for non-residential markets in New Zealand against other relevant jurisdictions. The focus is on commercial fibre-based point to point and point to multi-point services.

The objectives are to understand the wholesale service offerings available in the New Zealand non-residential market, how these compare with overseas experience and whether there are indications that New Zealand's non-residential market is workably competitive.

Following the current Introduction this report encompasses:

- a summary of the scope of the study (Section 2)
- an outline of our methodology (Section 3)
- an overview of services in the New Zealand market (Section 4)
- descriptions of the services in our benchmark sample of overseas operators (Section 5)
- results from our comparison (Section 6)
- concluding remarks (Section 7).

A glossary and the exchange rates used in our analysis are provided in the Annexes.

Although this project was commissioned by the Commerce Commission, the views expressed in this report are entirely those of Network Strategies.

2 Scope and method of comparison

The scope of the study is fibre-based wholesale services for non-residential services. For this study that scope has been defined as follows:

Access services greater than or equal to 100Mbps and less than or equal to 10Gbps	The rationale for excluding speeds below 100Mbps is that these speeds are of limited value for most applications and are delivered on technologies like GPON where lower speeds have negligible impact on the cost to serve.

Access services with speeds higher than 10Gbps are delivered using 100Gbps systems that are typically used for network infrastructure which is out of scope. Higher speeds are included when they are clearly part of a specific business offering such as data centre interconnection. |
| *Symmetric vs asymmetric services* | For services delivered via GPON or XG-PON access technologies, our focus is on symmetric, rather than asymmetric, services. Symmetric services were considered to be more favoured by non-residential end-users than residential. |
| *Lowest QoS services* | For pragmatic reasons, our analysis focuses on comparing the lowest QoS services available from each operator. This is due to the huge number of committed information rate (CIR) / excess information rate (EIR) and quality of service (QoS) class options available.

The scope was initially described as Best Efforts however, business services in many markets often include product ranges that are exclusively higher priority traffic. For example, in New Zealand point to point fibre services (also known as Bitstream 4) are implemented as high priority traffic only. |
| *Enhanced operational support not included* | It is assumed that all operators offer relevant levels of support – such as fault response times – for their market as part of their base service offerings. Therefore prices for enhanced operational support have not been included. |
| *Diverse services excluded* | Services described as diverse (or resilient) are delivered by providing duplication of critical parts of the service infrastructure to improve reliability. While pricing may vary between markets it is reasonable |

to expect diverse services to have a simple relationship with non-diverse services – typically, around double the price.

Handovers and other shared services	Shared services such as handover ports and links and co-location space have been excluded as they can be used by non-business services and are more properly considered as network infrastructure.
Interexchange services limited to those directly associated with an in scope access service	Interexchange services are limited to specific extension services associated with the access service (for example, Chorus Tail extension services). Other interexchange services are considered to be shared network infrastructure that may be used by a retail service provider (RSP) network and services.

Comparisons of services from different jurisdictions are challenging as no two operators offer exactly the same set of services. Furthermore, in instances where similar services are available they may differ in the set of speeds offered and QoS attributes. This is one of the reasons for selecting a limited set of speeds for this study – we have chosen speeds that are likely to be more common across operators.

It should also be noted pricing for non-residential services is often not publicly available, as they may be commercially negotiated or commercial in confidence.

Additional challenges include the differing splits of charges between the initial installation and the ongoing rental, together with the availability of long term discounts over differing time periods.

These difficulties have been addressed as follows:

- separate comparisons have been performed on a bandwidth basis and a QoS basis
- the bandwidth comparison is based on the minimum QoS offering available – this is typically best effort with a low CIR, as this most closely reflects the price of the unavoidable infrastructure

- all services are compared on the basis of a 12 month contract, which includes installation and 12 months' rental.

It would be useful to analyse the cost of the enhanced QoS services that are offered on ethernet platforms in each market, however the number of valid comparisons has been small. In addition, the complexity and lack of publicly available information regarding the pricing models has made price comparisons subject to a very high margin of error. As a result we have been unable to draw any conclusions for enhanced QoS services.

3 Methodology

For the purposes of comparing products between operators, we have categorised service offerings by two dimensions: network domain and network layer.

Network domain:
Access

The access domain is defined to be from the end user premise to either the local Central Office (CO) or to a Point of Presence (POP). This is the lowest price for a service.

Examples in the Chorus portfolio are:

- Direct Fibre Access Service (DFAS) which is handed over at the local fibre CO
- bitstream services that are handed over at the POP.

Network domain:
Interexchange

Interexchange is defined as any service that allows an access service to be handed over to an RSP at a location other than the POP or local CO. It identifies the additional cost of centralisation of the RSP's network.

Examples in the Chorus portfolio are:

- Intra candidate area backhaul service (ICABS) which extends a DFAS service to an alternate handover point within a point of interconnect (POI) area

- Tail extension service (TES) which extends a bitstream service to alternative handover point anywhere within the Chorus footprint.

Network layer:
L1 / fibre

L1 / fibre is the passive physical fibre media layer. The access service has a point to point fibre variant and a PON variant: in both cases a connection from the end user to the fibre CO is established, typically using a single fibre strand.

For the PON variant a splitter is included as part of the service.

In all cases, the connection is handed off at the CO to the RSP or connected to an interexchange fibre service. The key distinction with this service is that the RSP has flexibility in deploying technology to meet its needs.

Network layer:
Ethernet transport

Ethernet transport services consist of fixed bandwidth pipes carried over fibre. The underlying technology may include an optical transport network but will not include a switched ethernet network. It is handed over to the RSP either at the local fibre CO, POI, or at a remote location using some form of interexchange or extension service. The service carries the RSP's traffic transparently so that the RSP has full control of QoS and Virtual Local Area Network (VLAN) tagging. These services are always symmetrical. The key distinction here is that the capacity is dedicated to the RSP and not subject to congestion or the influence of other users.

Network layer:
L2 / ethernet

These services are carried over a shared ethernet network. As a result QoS can vary between services and over time. Typically these may be delivered over PON – for example, Chorus Bitstream 3 (BS3) services – or over a point to point fibre to the shared ethernet network – for example, Chorus Bitstream 4 (BS4) services. The services are handed over to the RSP at a POI. The key distinction here is that all capacity is shared and subject to flexible QoS which can be used by the wholesale network operator as a service and pricing differentiator.

4 The New Zealand market

Our analysis includes relevant services from Chorus (Section 4.1) and the Local Fibre Companies (LFCs, Section 4.2).

4.1 Chorus services

Exhibit 1 lists the services offered by Chorus in each network layer and domain. There are several speeds offered in some of these categories, as well as a range of QoS options in the L2/ethernet layer.

	Network domain	
Network layer	*Access*	*Interexchange*
L1/fibre		
PONFAS	PONFAS distribution	ICABS
	PONFAS feeder	
Point to point fibre	DFAS	ICABS
	VDFAS	
Transport	BFA	CRC
	CDCC	CXC
L2/ethernet		
GPON/XGS-PON	BS3/BS3a	TES
Point to point fibre	BS4/P2P bitstream	TES

Exhibit 1:   *List of Chorus services within the project scope [Source: Network Strategies]*

Service summary

PONFAS distribution   Passive optical network fibre access service (PONFAS) distribution is a single dark fibre from a splitter to a termination point in the end user premises.

Pricing comprises an initial installation fee plus an ongoing monthly fee.

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PONFAS feeder	PONFAS feeder comprises a splitter plus a single feeder fibre to the OFDF (Optical Fibre Distribution Frame) in the local Chorus CO.
	Pricing consists of an initial installation fee plus an ongoing monthly fee.
DFAS	DFAS is a single fibre from the end user premises to the OFDF in the Chorus CO. The service is only offered within Chorus UFB areas.
	Pricing consists of an initial installation fee plus an ongoing monthly fee.
VDFAS	Voluntary DFAS (VDFAS) is a single fibre from the end user premises to the OFDF in the Chorus CO. The service is only available in an area where an LFC other than Chorus has installed a fibre network as part of the UFB initiative.
	Pricing consists of an initial installation fee plus an ongoing monthly fee.
BFA	Bandwidth fibre access (BFA) is a fixed bandwidth ethernet access from an end user premise to the Chorus CO.
	Pricing consists of an initial installation fee plus an ongoing monthly fee based on the bandwidth.
CDCC	Chorus data centre connect (CDCC) is a fixed bandwidth ethernet service between a data centre and a designated Chorus CO – note that the designated CO is not necessarily the closest to the data centre. The list of designated COs is not publicly available. Chorus has extended its optical transport network to nodes in each of the designated data centres, providing transport layer connectivity to its COs.

Pricing consists of an initial installation fee plus an ongoing monthly fee based on both bandwidth and distance steps. Discounts are available for terms of 24 months or more.

BS3/BS3a

Bitstream 3 and 3a[1] (BS3/BS3a) are business-oriented data services over GPON/XGS-PON from the end user premise to the Chorus POP. The services have the following characteristics:

- support for transparent VLANs[2], allowing the end user to build a multi VLAN ethernet network
- symmetrical and asymmetric profiles
- support for a range of QoS profiles.

Pricing consists of an initial installation fee plus an ongoing monthly fee based on the bandwidth and QoS profile.

BS4/P2P bitstream

Bitstream 4 (BS4) and Point to Point (P2P) bitstream[3] are business oriented data services over direct fibre from the end user premise to the Chorus POP, with the following characteristics:

- support for transparent VLANs, allowing the end user to build a multi VLAN ethernet network
- symmetrical profiles only
- support for a range of QoS profiles.

Pricing consists of an initial installation fee plus an ongoing monthly fee based on the bandwidth and QoS profile.

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[1] Bitstream 3 and 3a are service profiles defined by the Telecommunications Carrier Forum (TCF).

[2] A transparent VLAN allows the end user to build a multi-site ethernet network consisting of multiple VLANs. The use of multiple VLANs allows the end user to divide their network into secure zones (for example, a private internal network and an extension of the Internet, or keep surveillance cameras separate from the business network) at layer 2 and to use protocols other than IP.

[3] Bitstream 4 is a service profile defined by the TCF. It describes bitstream services offered over a point to point fibre access.

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ICABS	ICABS is a single fibre point-to-point connection between two Chorus COs within a UFB area.
	Pricing consists of an initial installation fee plus an ongoing monthly fee based on three charging steps which are defined by the location of each end of the fibre. Thus these charging steps are broadly distance based.
CRC	Chorus Relay Connect (CRC) is a fixed bandwidth ethernet service between two Chorus POI within different UFB areas.
	Pricing is only available on request, so CRC has been excluded from our analysis.
CXC	Chorus Exchange Connect (CXC) is a fixed bandwidth ethernet service between two Chorus COs within the same UFB area.
	Pricing is based on charging steps but is only available on request so CXC has been excluded from our analysis
TES	TES is an ancillary service that extends the handover point for any of BS3, BS3a, BS4, and P2P bitstream services from the local Chorus POP to an alternate Chorus POP.
	Pricing consists of an ongoing monthly fee based on speed and QoS parameters of the individual access service. Three distance-based charging steps are also applied. There is no installation charge.
	There is no equivalent to this service in other markets. This market need is typically met through a fixed bandwidth service equivalent to CRC or CXC. Consequently TES has been excluded from further analysis.

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Chorus services – enhanced QoS

QoS variations only exist for switched ethernet services delivered over PON or direct fibre. The QoS profiles being applied are often not defined, or not defined where they are publicly accessible. In other cases complex pricing models are used that can only be interpreted with additional information that does not appear to be publicly available. As a result there are insufficient examples to develop any meaningful comparisons.

4.2   LFC services

The LFCs and Chorus have very similar product portfolios. This is driven in part by the shared origins of their fibre networks through the UFB project, together with industry cooperation through the Telecommunications Carrier Forum (TCF) in developing standards and guidelines for ethernet-based access services.

We identified the wholesale service offerings comparable with those of Chorus, sourced from the three operators:

- Northpower Fibre – serving Whangarei
- Enable Services – serving Christchurch
- Tuatahi First Fibre – serving Hamilton and Tauranga.

The following tables summarise the access (Exhibit 4) and interexchange (Exhibit 5) services from these operators.

	Chorus	Enable	Tuatahi	Northpower
L1/fibre				
PONFAS	PONFAS distribution	PONFAS distribution	PONFAS distribution	PONFAS distribution
	PONFAS feeder	PONFAS feeder	PONFAS feeder	PONFAS feeder
Point to point fibre	DFAS	DFAS	DFAS	DFAS
	VDFAS	n.a.	n.a.	n.a.
Transport				
	BFA	n.a.	n.a.	n.a.
	CDCC	n.a.	n.a.	n.a.
L2/ethernet				
GPON / XGS-PON	BS3/BS3a	GPON / XGS-PON bitstream	GPON / Hyperfibre bitstream	GPON bitstream Hyperfibre small business
Point to point fibre	BS4 / P2P bitstream	P2P bitstream	P2P bitstream	P2P bitstream

Exhibit 2: *Access – comparable services for New Zealand operators [Source: Network Strategies]*

L1/fibre layer   All LFCs offer PONFAS and DFAS services that are essentially identical to the Chorus offering, however the prices charged differ.

Transport layer   None of the LFCs offer transport layer access services.

L2/ethernet layer   All of the LFCs offer L2/ethernet services based on the TCF Bitstream 3 and 4 profiles, as does Chorus, so are comparable.

Bitstream 3 is a collection of profiles for business services delivered over a PON. All of the services provide VLAN transparency, enabling the end user to build a network involving multiple VLANS. They also all include a high priority traffic class. The TCF services make provision for a Best Efforts traffic class suitable for Internet use and a high priority class suitable for voice traffic. Residential bitstream services do not support high priority data – high priority

data is used for voice traffic from the Analogue Terminal Adaptor (ATA) in the end user Optical Network Terminal (ONT).

The main difficulty with comparisons between operators is the combination of QoS attributes that are offered by the operators. This affects both Bitstream 3 and Bitstream 4. We have attempted to base comparisons on the lowest QoS service from each operator in order to minimise this effect. However, the comparisons are still not exact as the minimum QoS can vary – for example, with Bitstream 3 at 1Gbps, Chorus offers a CIR of 2.5Mbps whereas Tuatahi offers 5Mbps.

There are two main variants of Bitstream 3:

- Bitstream 3 is high priority traffic only
- Bitstream 3a and 3b have a mix of Best Efforts and high priority traffic.

Bitstream 4 is a profile for services delivered over a point to point fibre access. Similar to Bitstream 3 it provides VLAN transparency. All traffic is treated as high priority with a CIR equal to the service rate.

	Chorus	Enable	Tuatahi	Northpower
L1/fibre				
Point to point fibre	ICABS	Inter CO fibre service	Inter CO fibre service	Inter CO fibre service
Transport				
	CRC	n.a.	n.a.	n.a.
	CXC	n.a.	n.a.	n.a.
	CDCC	n.a.	n.a.	n.a.
L2/ethernet				
GPON/XGS-PON	TES	n.a.	n.a.	n.a.
Point to point fibre	TES	n.a.	n.a.	n.a.

Exhibit 3: *Interexchange – comparable services for New Zealand operators [Source: Network Strategies]*

L1/fibre layer All operators offer interexchange dark fibre within their coverage areas.

Transport layer None of the LFCs offer transport layer interexchange services. This may reflect the smaller footprint that they serve and hence the reduced need to develop a comprehensive transport layer.

L2/ethernet layer None of the LFCs offer interexchange services similar to Chorus TES at layer 2. This probably reflects the LFCs' lack of national networks.

5   International benchmarks

There are three main challenges for benchmarking the study services:

- ensuring that the service descriptions are sufficiently comparable to those of New Zealand services
- obtaining publicly available cost-based pricing – in many instances, pricing for non-residential services is commercially negotiated or commercial-in-confidence

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- if pricing is publicly available, there may be fundamental differences between the sample countries and New Zealand, in relation to cost drivers, which could encompass geographic, economic, demographic, developmental and/or market factors.

Our selection of benchmark data has therefore been guided by the data available.

We identified a sample of wholesale service offerings comparable with those of Chorus, sourced from the following operators:

- Openreach – wholesale subsidiary of BT, the UK incumbent operator
- Open eir – wholesale subsidiary of the Irish incumbent operator eircom
- Telia Wholesale – subsidiary of the Swedish incumbent operator Telia
- Proximus – the Belgian incumbent operator (previously known as Belgacom).

The lack of publicly available pricing for relevant services excluded a number of potential comparators from consideration. This encompassed wholesale operators in Denmark, Finland, Korea, the Netherlands and Norway.

In the case of Australia, the wholesale operator nbn uses a complex pricing structure, which is dependent upon the total end-customer traffic (for the access seeker this represents a mix of residential and non-residential traffic) as well as network design characteristics. Thus various assumptions are necessary in order to undertake a benchmark analysis. Such assumptions would need to be supported by firm evidence to ensure their compatibility with New Zealand services and characteristics, without which any comparison may be misleading. In the absence of such evidence, Australia was therefore excluded from our benchmark sample.

While some wholesale pricing is available for the Singapore market, we expect that the dense urban nature of that country would result in cost-based pricing very different to New Zealand's geographically averaged pricing. For that reason, Singapore was excluded from the analysis.

The following tables summarise the access (Exhibit 4) and interexchange (Exhibit 5) services selected for analysis from the benchmark sample.

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	Chorus	Openreach	Open eir	Telia Wholesale	Proximus
L1/fibre					
PONFAS	PONFAS distribution	n.a.	n.a.	n.a.	n.a.
	PONFAS feeder	n.a.	n.a.	n.a.	n.a.
Point to point fibre	DFAS	DFAL	n.a.	Access fibre	n.a.
	VDFAS	DFAL	n.a.	Access fibre	n.a.
Transport					
	BFA	EAD local access	n.a.	n.a.	n.a.
	CDCC	EAD	n.a.	n.a.	n.a.
L2/ethernet					
GPON/XGS-PON	BS3/BS3a	Generic ethernet access	n.a.	n.a.	Bitstream access: Fiber PON
Point to point fibre	BS4/P2P bitstream	n.a.	WSEA	n.a.	NGLL

Exhibit 4: *Access – comparable services by overseas operator [Source: Network Strategies]*

	Chorus	Openreach	Open eir	Telia Wholesale	Proximus
L1/fibre					
Point to point fibre	ICABS	DFX	n.a.	Wholesale fibre	n.a.
Transport					
	CRC	EAD	n.a.	n.a.	n.a.
	CXC	EAD	n.a.	n.a.	n.a.
	CDCC	EAD	n.a.	n.a.	n.a.
L2/ethernet					
GPON/XGS-PON	TES	n.a.	n.a.	n.a.	n.a.
Point to point fibre	TES	n.a.	n.a.	n.a.	n.a.

Exhibit 5: *Interexchange – comparable services by overseas operator [Source: Network Strategies]*

5.1 Openreach services

Openreach has a large set of wholesale services that has been excluded because either pricing information is unavailable or the services are not sufficiently similar to in-scope New Zealand services – for example nearly all PON-based Openreach services are asymmetric.

Openreach pricing information is generally easily available however, product descriptions require a customer login and so are not accessible. We have used a secondary source[4] to deduce service capabilities however, this does mean there is a margin of error in our comparisons.

Openreach applies some restrictions to how and its services can be used, for example:

- the ethernet transport service incurs a surcharge of over 100% if it is used to backhaul an RSP's FTTH traffic
- some of Openreach's dark fibre services (DFX) are not offered if there are competing network operators within 100 metres of the Openreach exchange.

DFAL	Dark Fibre Access Line (DFAL) is a single fibre between two end user sites, or from an RSP site to an end user site or another RSP site. There are different price points for each configuration. There are some restrictions on the DFAL service:

- maximum fibre length is 86km
- the service cannot be used as network infrastructure
- area-based restrictions exist regarding where the service can be used, which is associated with certain regulatory obligations and may be also be related to where Openreach has infrastructure – without access to product documentation the factors influencing these restrictions are unclear.

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[4]   GOS Consulting (2021), *Openreach EAD pricing*, report for UK Competitive Telecommunications Association, February 2021. Available from http://www.ukcta.org.uk/ukcta-telecoms-policy-papers/.

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Pricing consists of an initial installation fee plus an ongoing monthly fee. The monthly fee includes two components:

- fixed charge
- distance-related charge, representing the straight line distance between Openreach sites if the service spans multiple Openreach sites – note that the distance charge can be zero.

DFX

Dark fibre X (DFX) is a single fibre from one RSP co-location facility at an Openreach site to another. There are two main restrictions on the DFAL service:

- maximum fibre length is 86km
- this service is only available where a service from an alternative operator is not available within 100 metres.

Pricing consists of an initial installation fee plus an ongoing monthly fee. The monthly fee has two components: a fixed charge plus a distance-based charge representing the straight line distance between Openreach sites.

OSA

Optical spectrum access (OSA) has two options: either a dedicated transport link at 10Gbps; or, access to a single wavelength for the RSP's own optical equipment. No pricing is publicly available so OSA has been excluded from the analysis.

GPON / XGS-PON generic fibre access

This is a set of bitstream services over either GPON or XGS-PON. All services provide a transparent SVLAN (service virtual local area network). No information is available on QoS settings.

Pricing consist of a fixed initial installation fee plus an ongoing monthly fee. The monthly fee varies based on bandwidth and QoS options, similar to Chorus BS3/3a services although the number of variations is more limited.

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EAD Local Access Ethernet Access Direct (EAD) Local Access is an ethernet service from an end user site to another end user site or an RSP site co-located at an Openreach POP, or between RSP sites collocated with Openreach POPs.

Pricing consists of an initial installation fee plus an ongoing monthly fee. The monthly fee consists of a fixed charge based on bandwidth plus a distance-related charge ('main link' charge) based on the straight line distance between the Openreach sites.

EBD Ethernet Backhaul Direct (EBD) is an ethernet connection between two RSP sites co-located in Openreach POPs. It appears to be restricted to connectivity from an Access Serving Node (possibly the local fibre CO) to the local POP and can be used to backhaul FTTH services.

Pricing consists of an initial installation fee plus an ongoing monthly fee. The monthly fee consists of a fixed charge based on bandwidth and three charging bands. We have no information on the nature of the bands but they are most likely distance related. Price points are approximately double those for EAD.

Discounts are available for fixed term contracts of 60 and 84 months.

EBD is essentially a network infrastructure service so has been excluded from further consideration.

Openreach is subject to differing regulatory obligations (Exhibit 6)[5], based on the location of the service:

- Area 1 – areas with established competition (as at 2021 no such areas had been identified)

- Area 2 – areas with the potential for material competition (70% of the United Kingdom)
- Area 3 – the remainder of the UK, where Openreach is the only operator providing a large-scale network.

	Area 1	Area 2	Area 3
Dark fibre	✖	✖	Cost based
Ethernet / WDM leased lines	✖	Flat prices in real terms	Flat prices in real terms

Exhibit 6:   *Openreach price controls for selected service types [Source: Ofcom]*

Openreach also has regulatory obligations to offer dark fibre in Area 3, as well as dark fibre for inter-exchange connectivity in exchange areas where there is less than two competing operators (these operators are defined as having network infrastructure, a substantial footprint, and offering a wholesale inter-exchange connectivity service to other telecoms providers).[6]

5.2   Proximus services

Proximus has a large range of wholesale services that have been excluded, either because pricing information is unavailable or the services are not sufficiently similar to in-scope New Zealand services. For example, Proximus offers a range of PON-based services with flexible QoS however the pricing description is incomplete and all of the services are asymmetric.

Fibre PON   Fibre passive optical network (fibre PON) are GPON and XG-PON[7] (in contrast to the use of XGS-PON in other markets) based bitstream services. Handover is from a Proximus POP.

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[6]   Ofcom (2021), *Promoting competition and investment in fibre networks: Wholesale Fixed Telecoms Market Review 2021-26, Volume 3: non-pricing remedies*, 18 March 2021, paragraph 5.5.

[7]   XG-PON is an asymmetric 10G PON technology that delivers 10Gbps downstream and 2.5Gbps upstream. This is in contrast to XGS-PON that delivers 10G both upstream and downstream.

The pricing approach is complex but accommodates all potential residential and business service profiles within a single pricing model. There is a connection fee for individual services. There is also an ongoing rental depending on the upstream/downstream bandwidth and the type of VLAN connectivity chosen.

For comparison purposes we have assumed that a dedicated VLAN with VLAN transparency is the most suitable for business use. In addition there is a QoS-related bandwidth charge based on a progressive charging scale for each traffic priority. For comparison purposes we have chosen guaranteed best efforts services.

Finally, there are no symmetric services. This is probably because XG-PON is inherently asymmetric and unlike XGS-PON cannot efficiently support symmetric services. Consequently our price comparisons are based on the upstream speed, which is the highest speed that symmetric performance can be achieved. While we recognise this is not an ideal comparison, the alternative would be to exclude Proximus from the analysis.

NGLL

Next generation leased line (NGLL) provides a dedicated VLAN from an end user site to a Proximus POP where it is handed over to the RSP. The service provides a transparent VLAN.

The pricing model has the same structure as for Fibre PON with the RSP specifying the required QoS profile.

For the purposes of comparison we have priced variants with the low priority QoS class which is the lowest available QoS class and is higher than Best Effort.

Proximus does not appear to have a target QoS for best efforts.

The Belgian regulator requires that the prices for fibre access[8] and high quality business connectivity[9] (SDH, WDM and Ethernet) are 'fair' – defined as a price with a reasonable margin between cost and the wholesale price – set using a bottom-up long run incremental cost (BU-LRIC) model.

5.3 Open eir services

WSEA

Wholesale symmetric ethernet access (WSEA) is an ethernet connection from an end user site to the Open eir POP.

Pricing consists of a one-off installation charge (which includes the cost of an ethernet termination device at the end user site) and an ongoing monthly recurring rental charge.

The rental charge is based on several factors:

- geographic zone
- density
- distance
- line speed
- logical service speed
- QoS class parameters.

The country is divided into two geographic zones: Zone A represents major urban areas, while Zone B is the remainder of the country. In a 2020 decision[10], the Irish regulator ComReg determined that no operator had significant market power (SMP) in Zone A, while Open eir was deemed to have SMP in Zone B and was to be subject

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[8]   European Commission (2018), *Case BE/2018/2073: Wholesale local access provided at a fixed location in Belgium*, 25 May 2018.

[9]   European Commission (2019), *Case BE/2019/2208: Market for wholesale high-quality access provided at a fixed location in Belgium*, 21 November 2019.

[10]   ComReg (2020), *Market Review: Wholesale High Quality Access at a Fixed Location*, ComReg 20/06, 24 January 2020.

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to price control in those locations. Zone B prices are required to be cost-oriented and based on a bottom-up long-run average incremental cost plus (BU-LRAIC+) methodology. No price control obligations were placed on Zone A.

In August 2021 new regulated prices were introduced for the bandwidth component of the WSEA service – Zone A prices by bandwidth remained largely the same as the previous prices, however Zone B prices were reduced by between 17% and 66%.

Given that Zone A is unregulated, we assume that it may be possible for access seekers to negotiate prices to levels below those contained in the Open eir price list. Therefore our comparisons are based on Zone B prices as these are cost-oriented.

There are two density categories, representing the geographical concentration of customers: high and medium. Definitions of these are not publicly available so prices for both are used in our analysis to indicate a range.

There is insufficient information on how the pricing operates when combining multiple service components to reach a final product price. As a result there is some uncertainty with respect to the final prices calculated.

WSEA does not include an explicit interexchange service.

5.4   Telia Wholesale

Telia Wholesale does not offer a PONFAS equivalent but does have DFAS and ICABS equivalents.

Wholesale fibre access

Wholesale fibre access is a single or dual fibre from an end user site to a Telia fibre node.

Pricing consists of a one-off installation charge and an ongoing rental. Telia Wholesale has geographically de-averaged pricing, with 14 separate price categories ('fixed price areas'), however the definitions of these areas are not publicly available.

The installation charge has two components:

- an establishment charge which is a fixed price for all price categories
- a connection charge which is incurred if a new connection point is required (usually when re-connecting a building). There are three options (to which the various price categories have been assigned) and the connection charge also varies by the term of lease (one, three or five years).

The rental is based on a charge that varies by price category and the number of fibres (single or dual). One of the price categories also has a per-km charge. The monthly rental for dual fibre costs a 23% premium although the initial installation costs are the same as for single fibre. Discounts apply for three and five year terms.

Wholesale fibre transport

Wholesale fibre transport is a fibre pair between two fibre area nodes. There is no option for a single transport fibre.

Pricing consists of a one-off installation charge and an ongoing rental. Wholesale fibre transport uses the same 14 pricing categories and the same pricing structure as for wholesale fibre access.

Telia Wholesale's fibre access services are subject to the regulator's economic replicability test (ERT), which ensures that access seekers can economically replicate Telia's retail offers on the basis of the wholesale inputs. Downstream costs are determined using an equally

efficient operator (EEO) standard and calculated with a bottom-up long-run incremental cost plus (BU-LRIC+) methodology.

We believe that the 14 price categories corresponding to fixed price areas may be the result of the geographically fragmented nature of the Swedish wholesale market. There are around 160 city network ('stadsnäten') organisations in Sweden, with city networks located in more than 200 of the 290 municipalities. In many of these municipalities, the largest market share is held by the city network rather than Telia. Thus for competitive reasons, location-based pricing may be a more appropriate strategy for Telia than the use of geographically averaged prices.

In our analysis, we have used the minimum and maximum prices across the price categories. It should be noted that there are another 12 pricing steps between these values.

6   Results

All of the following graphs show the total cost in New Zealand Dollars (NZD) for 12 months of service plus installation. Conversion to New Zealand dollars is based on World Bank purchasing power parity (PPP) rates from 2024 (Annex B). Value added tax is excluded.

6.1   Direct fibre access services

Our comparison of direct fibre access services is for single fibre (Exhibit 7) and dual fibre services (Exhibit 8). We included the latter in our analysis as Telia Wholesale provides a separate dual fibre service which may be significant in some cases. The Chorus prices for both DFAS and VDFAS are compared with the LFCs, Openreach fibre and the maximum and minimum cost for Telia Wholesale fibre – note that the latter has another 12 price steps between these two bounds.
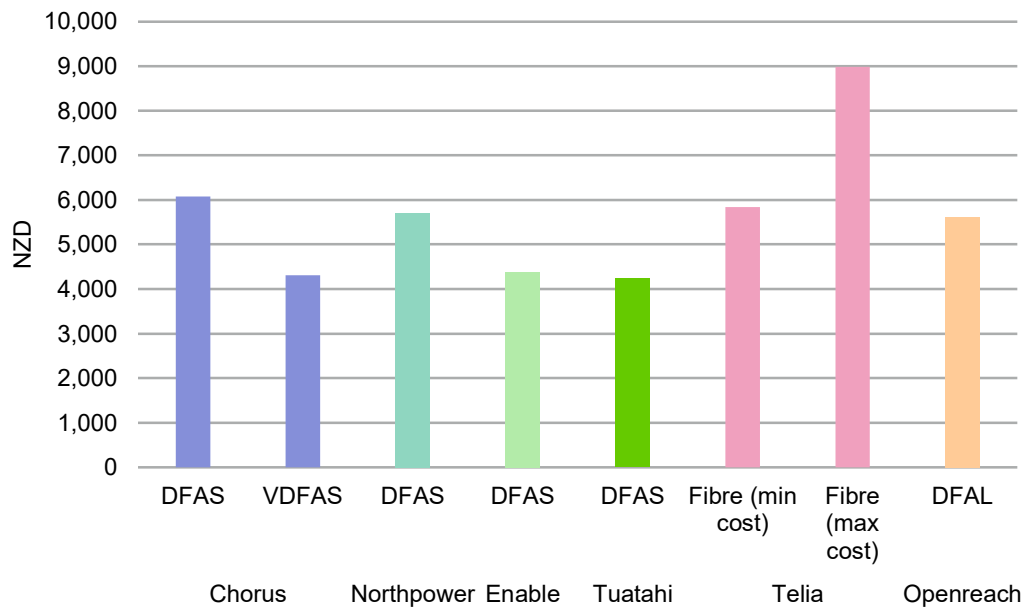
Exhibit 7: *Single fibre access services, installation plus 12 month's rental (NZD) [Source: Network Strategies]*
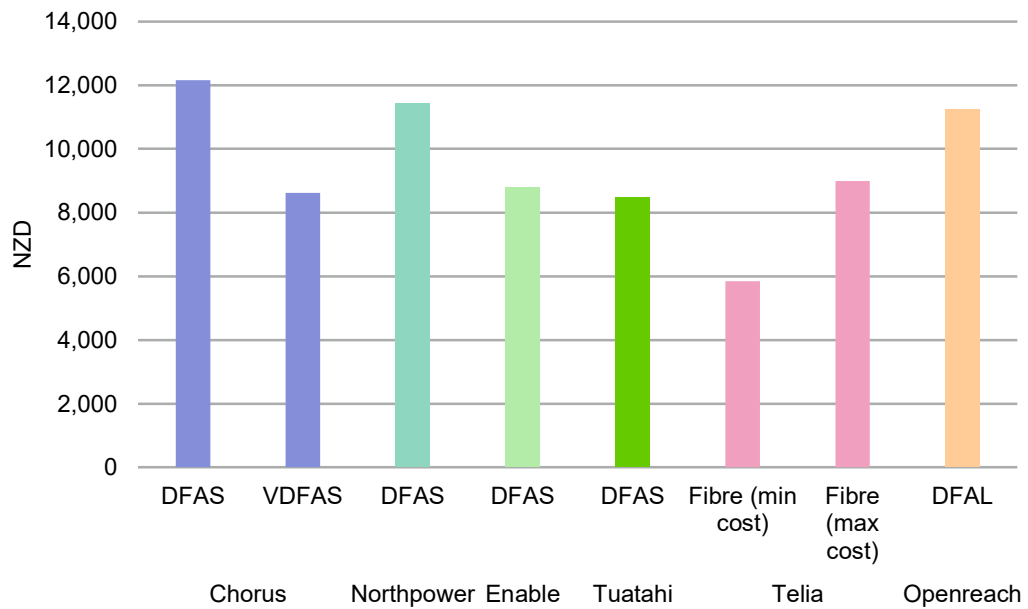
Exhibit 8: *Dual fibre access services, installation plus 12 months' rental (NZD) [Source: Network Strategies]*

The Openreach prices are based on its DFAL service that has some restrictions – it is unclear whether DFAL would be more comparable to a Chorus DFAS or VDFAS.

In the single fibre case Chorus is broadly similar to Openreach with Telia Wholesale prices spanning a higher range. However, the Telia Wholesale dual fibre prices over 12 months (including installation) are only about 10% higher than its single fibre equivalents, in contrast to those of both Chorus and Openreach where the prices are double that of the single fibre.

6.2 PONFAS

PONFAS or equivalent unbundled PON are not available from the four overseas operators in our benchmark sample. The following analysis compares the offerings from Chorus and two LFCs – Enable and Tuatahi.

Northpower has been excluded as its installation charges are based on time and materials rather than a fixed fee. We also note that installation charges for Chorus and the other LFCs are either zero or one month's rental so are unlikely to be cost based. Thus these installation charges would not be comparable with the time and materials based charges used by Northpower. Furthermore, we do not have sufficient information to derive reasonable assumptions for the average time and materials charges that Northpower would incur during an installation.

Ranking of the network operators by price differs between distribution costs and feeder cost (Exhibit 9), suggesting that the number of distribution tails deployed on each feeder will affect the price rankings of the total PONFAS cost for the network operators. A single PON would consist of one feeder and a number of distribution fibres – the maximum number of distribution fibres depends on design choices by the RSP but is typically 16 or more. As a result the total cost to serve a number of customers depends on the cost of the feeder plus the cost of the distribution fibres (illustrated in Exhibit 10).
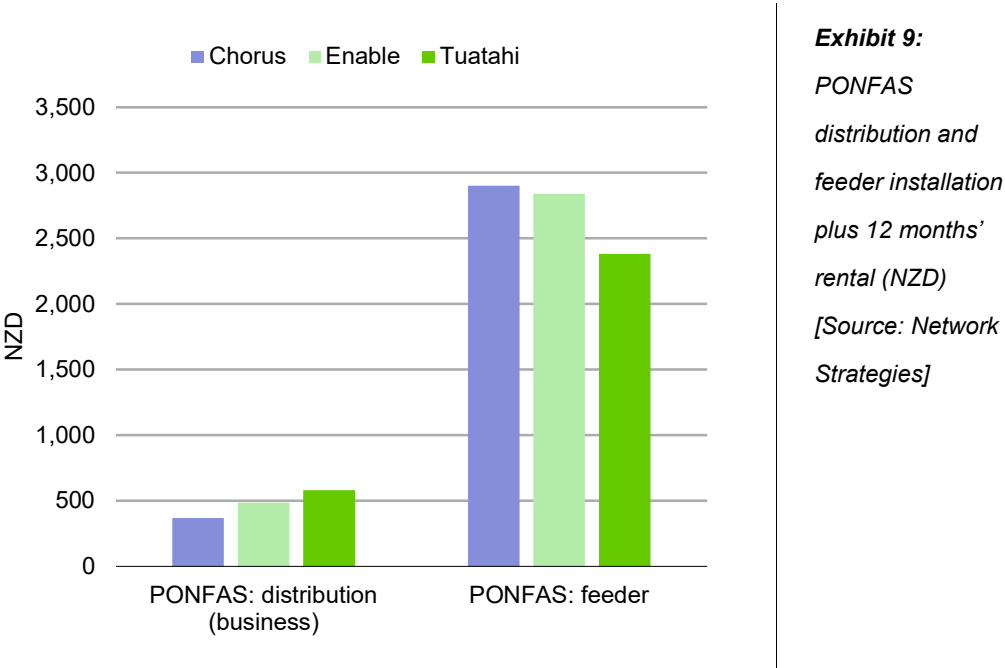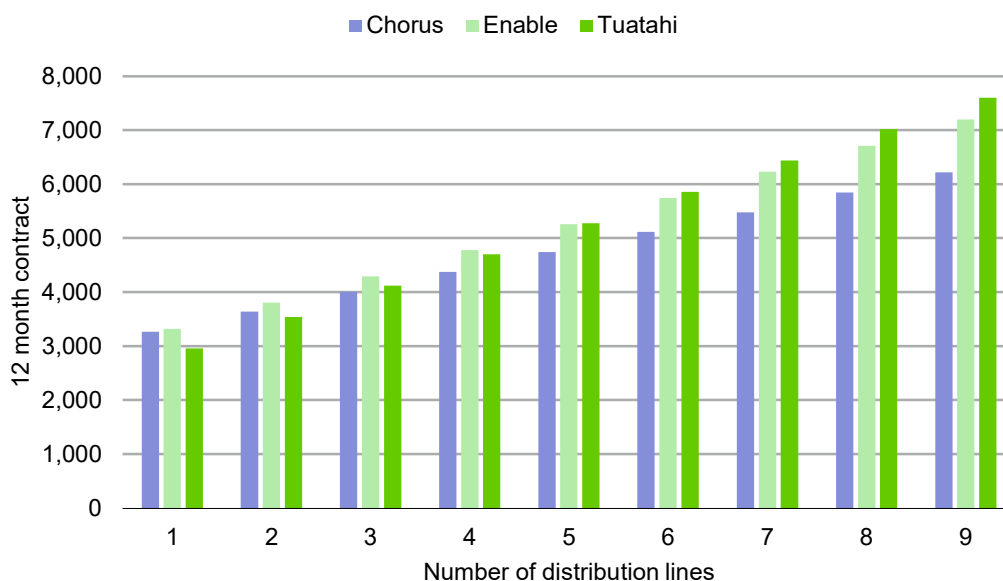
Exhibit 10 compares the costs over 12 months for a single PON consisting of a feeder plus a given number of distribution fibres. Enable has the highest cost for one to five distribution fibres but Tuatahi is most expensive for six or more. Tuatahi has the lowest cost for one to three distribution fibres but Chorus has the lowest costs for four or more.

Exhibit 10: *PONFAS cost as a function of distributions per PON, installation plus 12 months' rental (NZD) [Source: Network Strategies]*

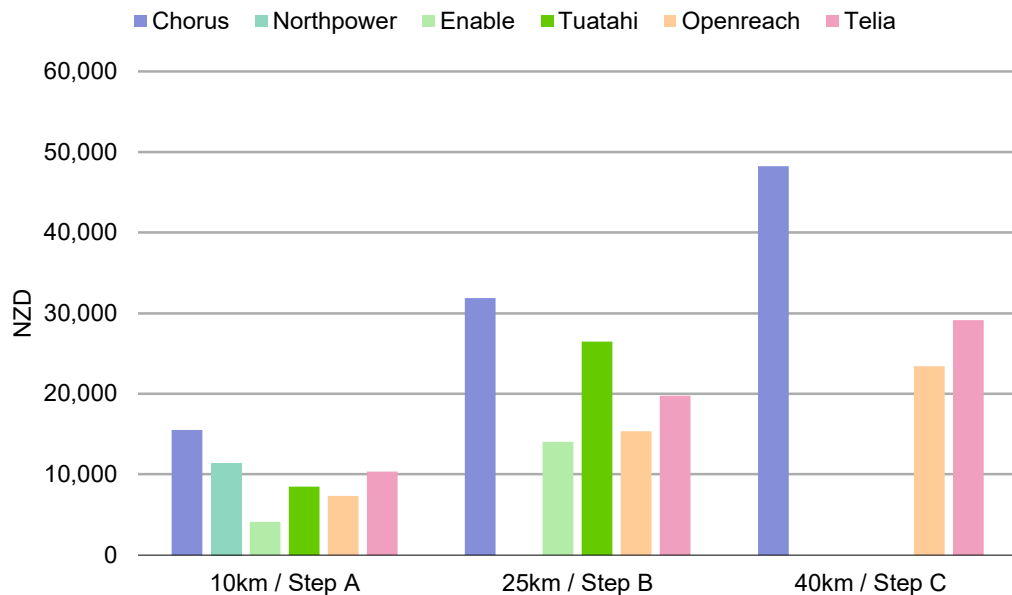## 6.3 Fibre interexchange services

In the case of fibre interexchange, Telia Wholesale does not have a single fibre product, only offering a fibre pair. Despite not being strictly comparable with the New Zealand operators and Openreach, we have compared the price of Telia Wholesale's fibre pair against the single fibres of New Zealand operators and Openreach (Exhibit 11), as well as dual fibres for these operators (Exhibit 12).

Chorus' three ICABS charging steps (A, B and C) have been compared against 10km, 25km and 40km distance steps, respectively, for the other operators. Note that this is not an exact comparison. In addition, the Openreach price is based on the straight line distance between COs instead of the fibre distance. It is unclear how Telia Wholesale measures distance but it is most likely related to fibre distance. Enable and Tuatahi have two charging zones that map approximately to 10km and 25km. Northpower's price does not vary by distance, however it only provides service within Whangarei where distances are up to 10km.
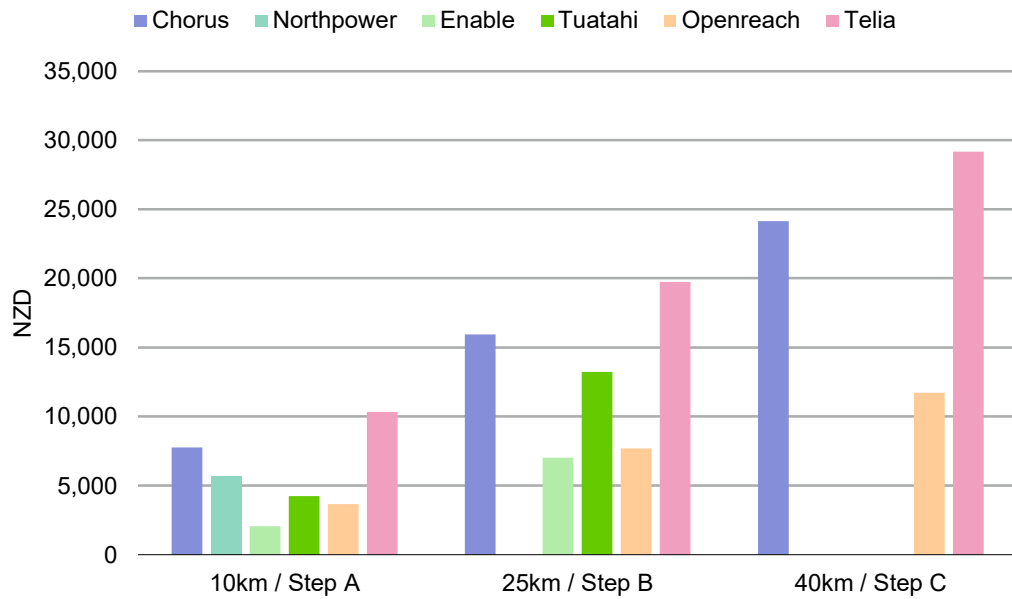
Note: Telia Wholesale price is for a fibre pair as it does not offer a single fibre.

Exhibit 11: *Single fibre interexchange services, installation plus 12 months' rental (NZD)*
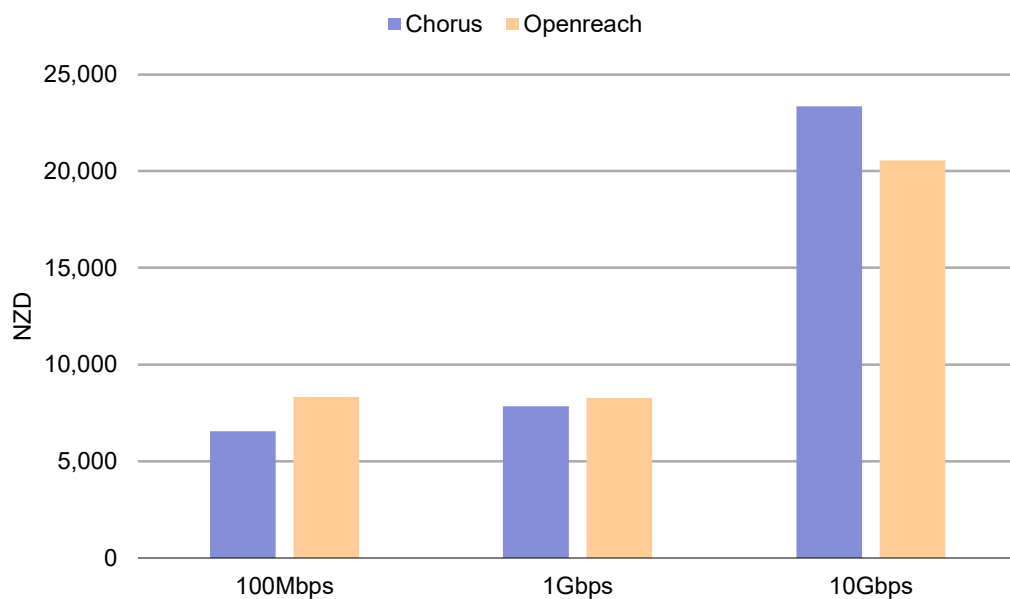*[Source: Network Strategies]*

Exhibit 12: *Dual fibre interexchange services, installation plus 12 months' rental (NZD)*
[Source: Network Strategies]

Telia Wholesale offers one, three and five year contract terms with discounts and a 50% discount on the monthly rental for additional fibre connections.

The price of a Chorus single fibre is higher than the LFCs in all charging steps. The Chorus price is comparable to Telia Wholesale's fibre pair but is higher than Openreach's single fibre. However Chorus' dual fibre is significantly higher than dual fibre from either Telia Wholesale or Openreach. Overall, Chorus appears to be more expensive than all other operators although the difficulty associated with comparing charging steps should be noted.

6.4   Access transport services

In our comparison of Chorus BFA and Openreach EAD Local Access we found that the prices were relatively similar for the three speeds considered – 100Mbps, 1Gbps and 10Gbps (Exhibit 13). Note that Openreach offers rental discounts for five year and seven year contracts.


Exhibit 13:   *Access transport services, installation plus 12 months' rental (NZD) [Source: Network Strategies]*

6.5 Chorus Data Centre Connect service

Chorus CDCC service is unique in providing a service targeted to data centres. In this application CDCC includes the possibility of connections that transit a Chorus CO which adds a complexity to price comparisons. Openreach EAD Local Access hands over at either the POI or the local CO. CDCC hands over at designated exchanges that may not be the local CO or the POI and the distances involved are unknown. This makes comparison with a service like Openreach EAD difficult.

The Openreach EAD service includes a charge for the distance between COs. For this reason Exhibit 14 includes variations with distances of zero, 10 and 20km. A zero distance equates to a case where the service accesses the local CO.
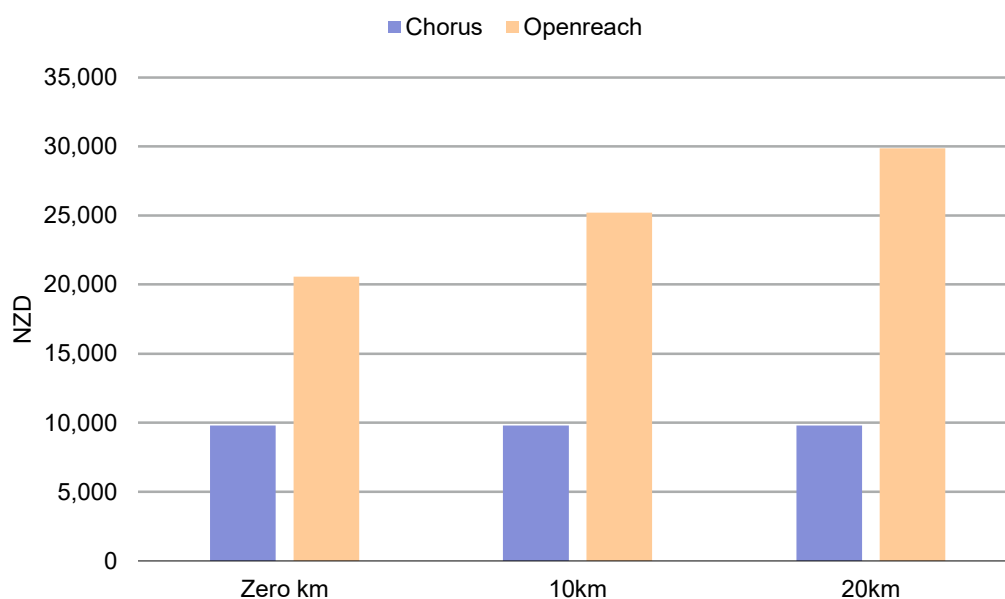
Exhibit 14: *Chorus Data Centre Connect (10Gbps) compared with Openreach EAD, installation plus 12 months' rental (NZD) [Source: Network Strategies]*

Chorus prices are low compared with Openreach. This may be expected given the highly specific niche market and the targeted solution based on the optical transport network built by Chorus.

Openreach does offer rental discounts for five year and seven year contracts of about 15%, but even with these discounts the service is still more expensive than Chorus CDCC.

6.6 PON-based ethernet access services

PON-based ethernet access covers the Chorus and LFCs BS3/3a based services. Restricting comparisons to symmetrical services limits the available comparators, as most overseas operators focus on asymmetric services over PON. This is a possibly a consequence of the asymmetric nature of GPON and XG-PON and a strategy to make full use of the available capacity in both directions. Newer technologies such as XGS-PON are symmetric and are more suited for delivering symmetric services. XGS-PON is widely deployed for this reason in New Zealand but not by all of the overseas operators in our benchmark sample. Business services are differentiated by offering transparent VLANs that support logical separation within the network, and by offering a range of higher QoS options, that support higher performance for applications. These features are not available with residential services.

This comparison is based on the lowest business QoS class available partly to focus the comparison on the cost of the base service rather than the value add of additional performance, and partly to limit the high complexity of pricing for QoS variants.

The Chorus services considered are:

- GPON Bitstream 100Mbps with 2.5Mbps symmetrical High Priority CIR
- Hyperfibre Small Business –1Gbps and 2Gbps access with 2.5Mbps High Priority CIR.

These services are compared with the Northpower, Enable and Tuatahi implementations of the same services, however with minor differences:

- Northpower services include 2.5Mbps Best Efforts CIR
- Enable provides 10Mbps of High priority CIR with the 2Gbps service
- Tuatahi provides 5Mbps of High priority CIR with the 100Mbps and 1Gbps services.

The services are compared with those of two of the overseas operators:

- Openreach Ultrafast fibre access 1000/1000 – Openreach's only symmetric option. No information is available on the Openreach QoS parameters but the price point is an outlier when compared with Openreach's other ultrafast services, suggesting it may offer a higher QoS profile.
- Proximus fibre PON 500/100 and 2500/1000 services – asymmetric services however are included to expand the number of overseas comparators. The analysis is based on the speed of an equivalent symmetric service that could operate on the access provided so they are compared based on the upstream speed. These Proximus services are Best Efforts.

Among the New Zealand operators the prices are very similar (Exhibit 15) with an anomaly being a high price for the Northpower 100Mbps service, for which we have not identified an obvious reason. Note also that the price of 100Mbps services is higher than the price of 1Gbps and 2Gbps services – this may be explained by the use of XGS-PON instead of the older GPON technology.

Chorus has a lower price than either Openreach or Proximus. However, the QoS uncertainties make these comparisons subject to caution.
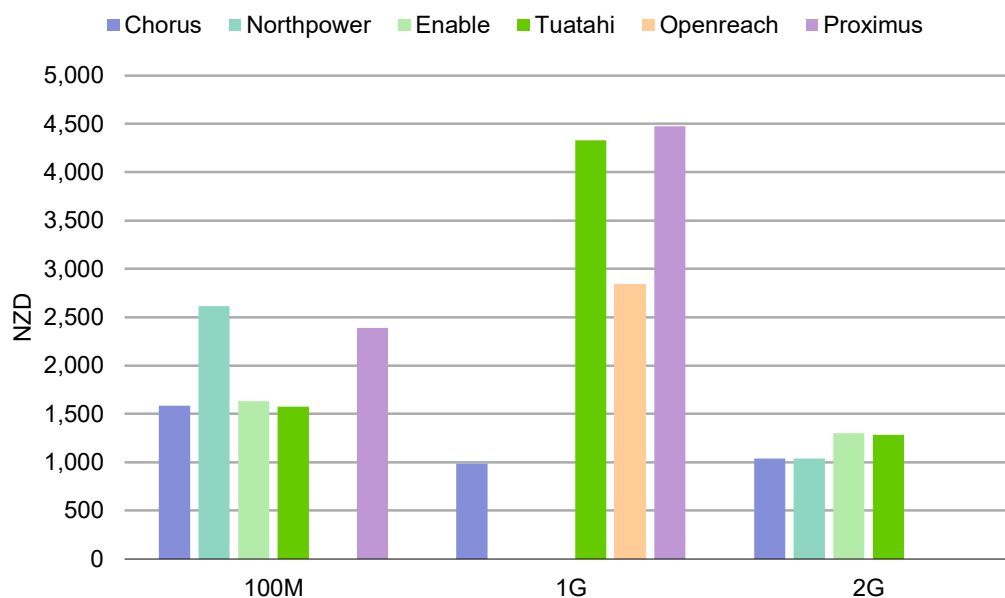
Exhibit 15: *PON based ethernet access services, installation plus 12 months' rental (NZD) [Source: Network Strategies]*

In future it may be worth considering asymmetric services in order to increase the pool of comparators. However, this would also considerably increase the complexity of the analysis due to the additional service attribute variations. Our analysis has included asymmetric services from Proximus, based on an equivalent symmetric service that could be offered on that access. This limits the service options to those based on the downstream speed.

6.7 Direct ethernet access services

The Chorus services considered are:

- Chorus Enhanced Bitstream 4 1G with High priority CIR (1Gbps)
- Chorus Enhanced Bitstream 4 10G with High priority CIR (10Gbps).

These are compared with Northpower, Enable and Tuatahi implementations of the same services, with minor differences:

- Enable offers the service at 100Mbps, 1Gbps and 10Gbps – in all cases high priority CIR is the same as the line rate.
- Northpower offers the service at 100Mbps, 1Gbps and 10Gbps but with zero CIR. High priority CIR is offered as an add-on feature at a price of $12.17 per 10Mbps. The comparison with Chorus and Enable is based on a service with the same CIR. However, the 10Gbps service has been excluded from consideration as the Northpower price is exceptionally high at $167,000 per annum. Inclusion of this value in the graph obscures the relationships between the other price points.
- Tuatahi, similar to Northpower, offers the service at 100Mbps, 1Gbps and 10Gbps but with zero CIR. High priority CIR is offered as an add-on feature at a price of $3.02 per 10Mbps. The comparison with Chorus and Enable is based on a service with the same CIR.

The Chorus Enhanced Bitstream 4 has also been compared with Open eir WSEA and Proximus NGLL (Exhibit 16).

Among the New Zealand operators we observe:

- Chorus and Enable prices are similar

- Tuatahi is relatively inexpensive at 1Gbps but high at 10Gbps, as a result of having a linear bandwidth charge

- Northpower is comparable to Chorus and Enable at 100Mbps and 1Gbps but is more expensive at 10Gbps. We have not included the 10Gbps result in Exhibit 16. As with Tuatahi, this is a result of having a linear bandwidth charge, however this effect is more marked with Northpower because its bandwidth charge is four times higher.

Chorus prices are relatively low in comparison with those of Proximus and Open eir.
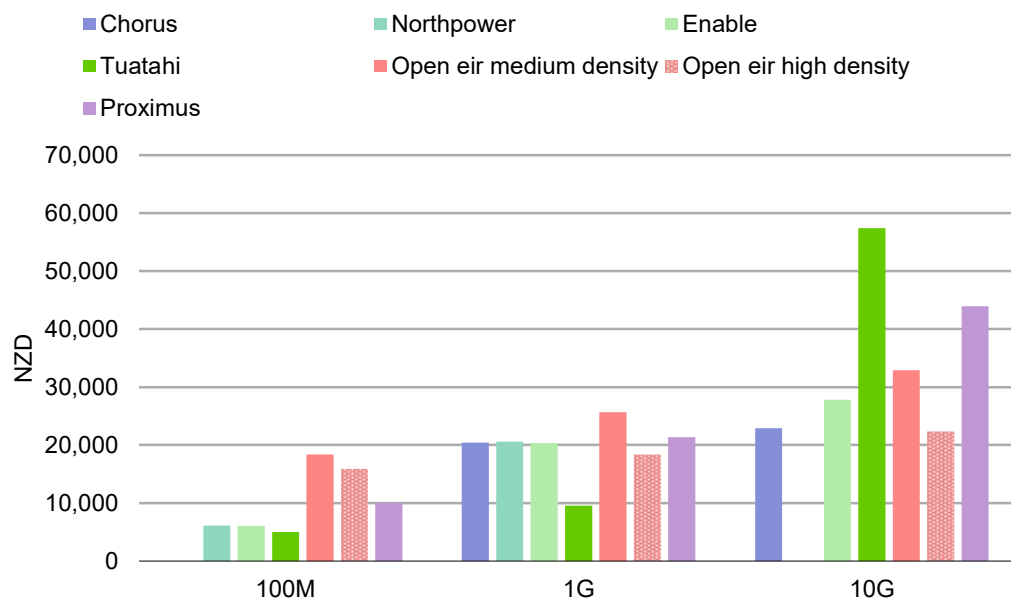
Exhibit 16:   *Direct ethernet access services, installation plus 12 months' rental (NZD) [Source: Network Strategies]*

The following assumptions have been used for the Open eir prices:

- prices for both high and medium density are included

- a nominal distance of 3km for access

- there are six options for the QoS charge, however the option definitions are not publicly available. We have chosen to use the lowest priced option – note that the highest priced option is approximately three times that of the lowest.

Proximus has a two part monthly rental based on the headline rate of the service and the QoS option chosen. QoS options offer a trade-off between business and voice QoS classes. The performance of the individual QoS classes is not stated. For comparison we have used the QoS option for 100% data traffic class. We note that the QoS charge constitutes less than 10% of the monthly rental.

6.8 Observations

In our examination of the pricing structures of the operators in our benchmark analysis, we noted several observations in relation to:

- installation charges
- pricing zones
- term discounts
- best effort
- QoS comparisons.

Installation charges

Installation charges are typically a price per transaction and often decomposed into two or more components that are related to cost elements of the installation process.

Chorus and the LFCs are unusual in that the installation charges for many of the products we examined – including PONFAS distribution, DFAS, VDFAS, BFA, BS3/BS3a, BS4/P2P bitstream and ICABS – are a multiple of the monthly rental charge, typically corresponding to either one or two months' rental. This suggests the charges are not cost-based but are a tool for front loading the lease costs.

This differs from the installation charges from most non New Zealand operators in our sample, which were generally presented as a numeric value rather than a multiple of the monthly rental.

Pricing zones

Geographically averaged prices are used in New Zealand. This contrasts with overseas operators (Openreach, Telia Wholesale, and Open eir) which often set certain service prices based on location, population density or demand density. Where possible we have reported high and low density results to provide a range with which to compare New Zealand prices.

Term discounts

The New Zealand operators do not make a practice of offering term discounts. The only term discount offered by Chorus or the LFCs is for Chorus' CDCC where the installation charge is waived and monthly rental reduced for a 24 month contract.

In contrast, the overseas operators offer a range of term discounts, but the terms vary between the operators. Discounts would typically be of the order of 15% over the term of the contract but can be higher. For example, Telia Wholesale offers three and five year terms for fibre that provide a 14% discount over the minimum term contract price, and Openreach offers a 15% for a five year term and 35% for a seven year term for its EAD 10G service.

Best Effort

The lowest traffic class available is the Best Efforts class. Other traffic classes have higher priority and as a result exhibit lower packet loss[11], latency[12] and jitter[13]. The performance of the Best Effort traffic class is dictated by the level of congestion in the network which is subject to the operator's design and operations policies. The performance of best efforts can

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[11]   Packet loss is the fraction of packets of data that are lost by the network, usually due to congestion. Packet loss requires packets to be retransmitted or the loss to be covered by the applications. It can cause data transfers to slow down or become unreliable.

[12]   Latency is the average time for a packet to traverse the network. For best efforts traffic it can increase as congestion increases. For interactive services like video calls, high latency can affect useability. High priority traffic typically has a better managed latency close to the minimum time for a packet to traverse the physical network path.

[13]   Jitter is the variation in time taken for packets to traverse the network. Best efforts traffic can exhibit high jitter as the level of traffic in the network varies. High jitter requires streaming media to operate larger buffers to prevent media playback. Higher priority traffic typically has low jitter.

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vary depending on how much traffic is on the network, which can be related to time of day or week. Business applications typically need higher certainty of low packet loss, latency and jitter and so would opt to consume higher priority traffic services, however, if the best efforts service is good enough during business hours then this level of service may be acceptable.

The performance of the Best Effort traffic class is not publicly available in the markets we have analysed. This means that the trade-off made by RSPs and end users between business and residential offerings or business services with minimum or higher QoS may differ between operators. In other words a best efforts service in one market may have similar performance to a service with High Priority or Assured Forwarding in another market.

QoS comparisons

New Zealand operators have a small number of QoS variations within their service portfolios, mostly comprising variations in CIR for a fixed priority class. The pricing models are straightforward with each variation having a single price point for each speed.

Other operators have more complex models where the RSP is able to specify profiles with CIR and EIR for each traffic class. However, the associated pricing models are complex and rely on information that can only be interpreted with additional information that does not appear to be publicly available. In some cases published QoS profiles are available with fixed prices but the actual profile definitions do not appear to be publicly available.

7   Concluding remarks

This analysis has highlighted the difficulties of conducting robust benchmarking exercises of non-residential fibre services. As anticipated, pricing for such services is often not publicly available, however we also found that other crucial information relating to service descriptions, pricing definitions or network characteristics was also unavailable, even if prices were published.

Consequently there is inevitably some uncertainty that some services used in the benchmark comparison are directly comparable with those in New Zealand.

Pricing and service structures appear to be very dependent on local factors, including geography, network design, history and regulatory conditions, for example:

- end to end services are available in some markets that would not be permitted in New Zealand
- Openreach has specific restrictions on the use of its services (for example, interexchange fibre is only available if there is no alternative within 100m) and can charge a premium based on usage (EBA incurs a premium price if it is used for FTTH backhaul)
- geographically deaveraged pricing is common
- pricing based on competitive intensity is also common.

Is the New Zealand market workably competitive?

As Chorus and the LFCs have geographically discrete footprints, direct competition is limited. Our analysis identifies that the service portfolios are similar with some relatively small differences in pricing. This is not sufficient to demonstrate that the market is workably competitive – pricing is publicly available and it would certainly be possible for Chorus and the LFCs to price match or reduce prices, however without direct competition there may be little incentive to do so.

Assessing New Zealand prices against those from other jurisdictions is therefore an important tool to assist the Commission in determining whether those prices are out of step with those in other markets.

Acknowledging the small number of comparisons available and the difficulty in assessing the exactness of the comparison we can conclude that there is no evidence that New Zealand prices are inconsistent with what is available in our sample from other markets. However the limited number of datapoints is not sufficient to conclude with confidence that the New Zealand market is workably competitive.

Annex A: Glossary of terms and abbreviations

ATA: Analogue Terminal Adaptor; a function or device for connecting traditional analogue telephones, fax machines and similar devices to a voice over IP telephone network

BFA: Bandwidth fibre access; a wholesale Chorus service

BS3/BS3a: Bitstream 3 and Bitstream 3a; Telecommunications Carrier Forum template for business broadband access over PON used for wholesale services offered by Chorus and the LFCs

BS4: Bitstream 4; Telecommunications Carrier Forum template for business broadband access over point to point fibre used for wholesale services offered by Chorus and the LFCs

BU-LRAIC+: Bottom-up long-run average incremental cost plus; a costing methodology used for regulated pricing

BU-LRIC: Bottom-up long-run incremental cost; a costing methodology used for regulated pricing

BU-LRIC+: Bottom-up long-run incremental cost plus; a costing methodology used for regulated pricing

CDCC: Chorus data centre connect; a wholesale Chorus service

CIR: Committed information rate

CO: Central Office

CRC: Chorus relay connect; a wholesale Chorus service

CVLAN: Customer VLAN; the inner tag on a double tagged ethernet frame

CXC: Chorus exchange connect service; a wholesale Chorus service

DFAL: Dark fibre access link; an access fibre service offered by Openreach

DFAS: Direct fibre access service; a wholesale service offered by Chorus and the LFCs

DFX: Dark fibre X; an interexchange fibre service offered by Openreach

DSL: Digital Subscriber Line

EAD: Ethernet access direct; an ethernet access service offered by Openreach

EBD: Ethernet backhaul direct; an interexchange ethernet service offered by Openreach

EEO: Equally efficient operator

EIR: Excess information rate

ERT: Economic replicability test

FTTH: Fibre to the home

FTTP: Fibre to the premise

FTTC: Fibre to the cabinet; a solution that relies on a data over copper solution for the last 100m or so

Gbps: Gigabits per second

GEA: Generic Ethernet Access

GPON: Gigabit passive optical network; PON technology that delivers 2.5Gbps downstream and 1.2Gbps upstream

Hyperfibre: Access services offered over XGS-PON; term is used by Chorus and the LFCs

ICABS: Intra candidate area backhaul service; a wholesale Chorus service

IP: Internet Protocol

Jitter: Variation in time taken for data packets to traverse the network

Latency: Average time for a data packet to traverse the network

LFC: Local fibre company

Mbps: Megabits per second

MPLS: Multi-Protocol Label Switching

NGLL: Next generation leased line; service offered by Proximus

NZD: New Zealand dollar

OFDF: Optical Fibre Distribution Frame

ONT: Optical Network Terminal

OSA: Optical spectrum access; an optical transport service offered by Openreach

OTN: Optical transport network

P2P: Point-to-point; in this report it refers to P2P connection from an end user site to a CO.

Packet loss: Proportion of packets of data travelling across a network that fail to reach their destination

PIR: Peak information rate

POI: Point of interconnect

PON: Passive optical network

PONFAS: PON fibre access service; a wholesale service offered by Chorus and the LFCs

POP: Point of Presence

PPP: Purchasing power parity

QoS: Quality of Service

RSP: Retail service provider

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SDH: Synchronous Digital Hierarchy

SVLAN: Service VLAN; the outer tag on a
double tagged ethernet frame.

TCF: Telecommunications Carrier Forum

TES: Tail extension service; a wholesale
Chorus service

UFB: Ultra fast broadband

VDFAS: Voluntary direct fibre access
service; a wholesale Chorus service
offered in areas where an LFC other than
Chorus has installed a fibre network as
part of the UFB initiative

VLAN: Virtual Local Area Network; a
method of dividing an ethernet network
into separate virtual networks for
security or other reasons

WDM: Wavelength division multiplex

WSEA: Wholesale symmetric ethernet
access; service offered by Proximus

XG-PON: Asymmetric 10G PON
technology that delivers 10Gbps
downstream and 2.5Gbps upstream

XGS-PON: 10G symmetric PON; PON
technology that delivers 10Gbps both
downstream and upstream

Annex B: Exchange rates

Our analysis uses the following purchasing power parity rates for currency conversion (Exhibit B.1).

Country	Local currency	Local currency: USD
Ireland	EUR	0.779
New Zealand	NZD	1.488
Sweden	SEK	8.819
United Kingdom	GBP	0.694
United States	USD	1.000

Exhibit B.1:

Purchasing power parity rates, 2024 [Source: World Bank]