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Report for Chorus

UCLL and UBA FPP draft determination cross-submission – PUBLIC

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1 Introduction

On 2 December 2014, the Commerce Commission published the draft determination for its final pricing principles (FPP)[1] for the unbundled bitstream access (UBA) service and the unbundled copper local loop (UCLL) service.

Analysys Mason has been commissioned by Chorus to review and comment on the draft model and documentation underlying this draft determination. This report provides a summary of our response to key matters raised by other parties on the determination and is set out as follows:

- Section 0 summarises the documents that we have reviewed as part of our investigations
- Section 2 addresses general points
- Section 3 covers UBA issues
- Section 4 is related to opex and non-network costs
- Section 5 covers FWA

Data that is confidential (i.e. can only be read by those who have signed the confidentiality undertakings) has been redacted and is indicated by the scissor symbol '✂'. The nature of the confidential information is indicated by the source abbreviation and CI or RI status, e.g. **[CNZCI: ✂✂]**.

1.1 Reference documents

Figure 1.1 below summarises the list of the documents that we will refer to in this report. All of these documents are available on the Commerce Commission's website. We provide a short name for each document, which we will use to refer to it throughout the report for simplicity.

Figure 1.1: Documents referred to in this report [Source: Analysys Mason, 2015]

Title	Short name	URL
Model Specification (public version)	Model specification	http://www.comcom.govt.nz/dmsdocument/12785
Model Reference Paper (public version)	Reference paper	http://www.comcom.govt.nz/dmsdocument/12777
Model Documentation (public version)	Model documentation	http://www.comcom.govt.nz/dmsdocument/12784
Draft model presentation	Model presentation	http://www.comcom.govt.nz/dmsdocument/12794
Draft FPP briefing presentation	Commission briefing	http://www.comcom.govt.nz/dmsdocument/12787
Draft pricing review determination for Chorus'	UCLL draft	http://www.comcom.govt.nz/dmsdocument/12771

1 http://www.comcom.govt.nz/regulated-industries/telecommunications/regulated-services/standard-terms-determinations/unbundled-copper-local-loop-and-unbundled-bitstream-access-services-final-pricing-principle/

unbundled copper local loop service	determination	
Draft pricing review determination for Chorus' unbundled bitstream access service	UBA draft determination	http://www.comcom.govt.nz/dmsdocument/12786
Beca FPP Corridor Analysis Full Report	Beca report	http://www.comcom.govt.nz/dmsdocument/12783

Figure 1.2 below summarises the list of modelling-related materials referred to in this report. We provided a short name for each of the Excel files as well, which we will use to refer to these files as well. We will be referring to the Excel files with the short names provided in the list below. Analysys Mason also has access to the confidential versions of these Excel files, but we refer to the public versions unless we state otherwise.

Figure 1.2: List of modelling materials referred to in this report [Source: Analysys Mason, 2015]

Title	Short name	URL
PUBLIC_Commission - Access network - v7.0.mdb	(Public) Access database	https://login.filecloud.co.nz/shares/folder/32248963d1ab3a/
PUBLIC_Commission - Access network cost model - v7.3.xlsb	(Public) Access model	As above
PUBLIC_Commission - Inputs for trenches - v5.0.xlsb	(Public) Trench inputs file	As above
PUBLIC_Commission - UBA model v5.1.xlsb	(Public) UBA model	As above
Public_TSO_Cluster_Polygons.zip	(Public) TSO polygons	As above
BECA Corridor Cost Analysis for Trenching Rates.xlsx	(Public) Beca trench cost analysis	http://www.comcom.govt.nz/dmsdocument/12806

All of the Excel files referred to in this report are used in the calculation of the costs of UBA and UCLL services.

Figure 1.3 lists the stakeholder submissions to which we refer to throughout this report.

Figure 1.3: List of modelling materials referred to in this report [Source: Analysys Mason, 2015]

Title	Short name	URL
Final report for Spark New Zealand and Vodafone New Zealand; Commerce Commission Draft Determination for UCLL and UBA; A review of key issues	Network strategies submission	http://www.comcom.govt.nz/dmsdocument/12932
Modelling Fixed Wireless Access UCLL and UBA Final Pricing Principle Network Strategies Report Number 34020. 23 February 2015	Network Strategies Fixed Wireless Submission	www.comcom.govt.nz/dmsdocument/12927
UBA and UCLL FPP pricing review	Spark	http://www.comcom.govt.nz/dmsdocument/129

draft decision: Submission	submission	34
Vodafone New Zealand Limited Submission to the New Zealand Commerce Commission on Process Paper and Draft Pricing Review Determinations for Chorus' Unbundled Copper Local Loop and Unbundled Bitstream Access Services and Comments on Analysys Mason's TSLRIC models: Public version	Vodafone submission	http://www.comcom.govt.nz/dmsdocument/12924
Submission In response to the Commerce Commission's "Draft pricing review determination for Chorus' unbundled bitstream access service" and "Draft pricing review determination for Chorus' unbundled copper local loop service" including the cost model and its reference documents	WIK submission	http://www.comcom.govt.nz/dmsdocument/12935
Submission on the Commerce Commission's Draft determinations for UBA and UCLL services	Call plus submission	www.comcom.govt.nz/dmsdocument/12930
Wigley and company solicitors Submission on draft pricing review determination for UBA and UCLL services 20 February 2015	Wigley submission	www.comcom.govt.nz/dmsdocument/12925
Analysys-Mason-submission-on-behalf-of-Chorus-on-UCLL-FPP-process-and-issues-paper-14-Feb-2014	Analysys Mason UCLL FPP process and issues paper submission	www.comcom.govt.nz/dmsdocument/11493
Response to Commission consultation on regulatory framework and modelling approach for UCLL and UBA 6 August 2014	Analysys Mason UCLL August consultation submission	www.comcom.govt.nz/dmsdocument/12220
Cross Submission In response to the submissions to Commerce Commission's "Consultation paper outlining our proposed view on regulatory framework and modelling approach for UBA and UCLL services (06 August 2014)"	WIK August consultation cross-submission	www.comcom.govt.nz/dmsdocument/12318
Cross-submission for consultation on UCLL and UBA FPP regulatory framework Final report for Spark New Zealand and Vodafone New Zealand, 25 August 2014 Network Strategies Report Number 34018	Network Strategies August consultation cross-submission on aerial deployment	www.comcom.govt.nz/dmsdocument/12324

2 General points

2.1 Commission model

Although we have found errors and proposed certain changes to the way in which the TERA model currently works, we believe that the underlying structure of the calculation is adequate for the task at hand. None of the issues raised by other parties change this view and any changes we have proposed should not be onerous to implement.

2.2 ORC

2.2.1 Conventional approach in BU LRIC is ORC

Bottom up access network LRIC models use ORC. For example, see Sweden, Denmark, Ireland, Norway and Australia.

2.2.2 Reuse would require something reusable in the right position

It is a truism that asset reuse would only be possible if there were an asset of the right type in the right location. In addition, if assets were to be reused they would have the fault rates and operating costs of older assets.

As we show below, WIK have implied that assets will not be reused if they have insufficient future lifetime to support the reuse (e.g. if use would force early cable replacement). This consideration of itself significantly limits the pool of allegedly reusable assets by reducing their effective lifetime (rounding down to the nearest multiple of the lifetime of the supported asset). If there is a wide distribution of asset ages and the supporting assets (duct, pole) have roughly twice the lifetime of the supported asset (cable), then this factor itself rules out approximately half of all potential reuse.

2.2.3 There is no basis offered for the 20% reduction factor in lieu of use of depreciated valuations suggested by WIK

WIK have provided no basis for their estimate of a 20% reduction[2] or indeed to which assets this 20% reduction would apply. They are almost certainly including “double counting” cost savings if they think that this saving is on top of excluding assets needed for non-TSO premises, optimisation, sharing, much greater use of aerial deployment, and FWA. In other words,

- assets that are on routes that are not optimal cannot be reused;

[2] WIK submission, paragraph 4

- existing telecoms poles not capable of carrying EDB loads cannot be used where WIK say shared poles should be used;
- existing ducts cannot in practice be shared with other utilities (except to the extent that those utilities are deployable in ducts, or where the duct and the utility were originally deployed together);
- ducts where WIK say aerial deployment should be used cannot be reused;
- existing duct or poles where WIK say FWA should be used cannot be reused.

2.2.4 Infinite lifetime arguments do not apply

Arguments (such as those quoted by Wigley Submission 12.12) that apply to infinite lifetime assets ("assets that do not deteriorate in service and do not have potential alternative uses") are inapplicable as there are no infinite lifetime assets in the TERA model.

2.3 MEA

Spark state that:

> "The Commission's proposal to identify efficient forward looking prices by reference to the modern technologies and costs a hypothetical efficient operator (HEO) would use in providing a wholesale service capable of supporting voice and broadband services is a robust fibre infrastructure using fibre-based electronics or FWA in areas of non-urban New Zealand."[3]

Spark entirely mischaracterise the core functionality by saying it is "a wholesale service capable of supporting voice and broadband services". UCLL is not a Bitstream service. Layer 2 is not layer 1 – this is a category error.

To draw an analogy, this is similar to equating the use of a toll road (like "layer 1") to a wholesaled bus service (like "layer 2"). If you have access to a road you can run your own buses, or drive a sports car, or transport freight. If you have access to a bus service, you can transport people according to the existing stops and timetable. The fact that "people movement" can be provided over both does not make them the same thing.

The required "Core functionality", based on the Commission's own proposed test, is not provided by FWA. FWA is not capable of providing a non-blocking layer 1 service with sufficient capacity. Not only does this mean that it cannot be used to price UCLL where unbundling occurs, it cannot provide UCLFS either. UCLFS[4] (which is provided using the same infrastructure and which Spark argue must have the same price as UCLL) is used very widely throughput New Zealand. This is yet another reason why FWA cannot be considered as a substitute for wireline service.

[3] Spark submsission, paragraph 2

[4] or the equivalent "baseband" service

2.3.1 Inconsistent views on MEA

We have consistently argued that it is an empirical question as to which technology can meet the required functionality at the lowest unit cost e.g.

> We believe that the appropriate choice for a hypothetical entrant is to seek the lowest (discounted) cost technology meeting the required specification.[5]

Where parties are arguing the MEA should be selected based on the lowest cost technology on an exchange by exchange basis, it is necessary to include the additional costs of multiple technologies; without doing so it is not possible to conclude that such an approach would result in the lowest cost MEA overall.

Parties also seem to be arguing that the MEA must be chosen based on "operator behaviour" – which is a different and inconsistent test. For example, WIK[6] said:

> The technology of choice for the MEA should be the technology a new entrant into the market would deploy today. We are convinced that no investor would today deploy a new network based on twisted copper pairs.

Network Strategies[7] accept that UFB and RBI are not evidence of the behaviour of commercial operators (at least in relation to the extent of the deployment).

> …the UFB and RBI initiatives in fact are not indicative of the extent to which an HEO would deploy these technologies in the absence of Government intervention

However, this is not just a question of degree. If the extent of UFB is not evidence of the behaviour of an unconstrained operator, then the same argument means that it is not evidence for the use of FTTH at any extent (ie any use of FTTH at all).

2.3.2 WIK argument about comparing total costs of fibre and copper

WIK[8] examines how the Commission compare the costs of copper and fibre networks, netting the cost of the SLUBH off the total copper costs rather than comparing the total costs of copper and the total costs of fibre, saying.

[5] Analysys Mason UCLL FPP process and issues paper submission

[6] WIK August Consultation cross-submission, para 10

[7] Network Strategies Submission, 3.1

[8] WIK submission, paragraph 234

> There is no obvious reason for us why the decision on the lowest cost technology is based on two different network configurations of the underlying network technologies.

On the contrary, the reason seems clear: to make the decision about the MEA for UCLL based on the costs that will be recovered from the UCLL service.

2.3.3 Neither cost adjustment nor performance adjustment

Setting the price based on Copper/FTTN is neither a performance adjustment (as characterised by WIK[9]) nor a cost adjustment (as characterised by Spark[10]): it is a choice of MEA.

2.3.4 A mix of technologies would incur additional costs

We have already made the point in a previous submission[11] that it is more costly to offer a set of wholesale services based on a mix of underlying technologies such as FTTH and FTTN/Copper (or FTTH and FWA).

Spark argue that RSPs[12] are already capable of buying different wholesale inputs in different locations. This does not however remove the need for the HEO to have a range of multi-technology qualified engineers and technicians to support this variety, or the need for the HEO to provide a set of wholesale interfaces that minimise the differences. Such additional costs are not present in the TERA model.

2.4 Asset counts

2.4.1 Scorched node

We believe a scorched node assumption is appropriate. Not only is a scorched node assumption very commonly used in regulatory cost models, it retains the existing points of interconnection and the current definition of the access network boundary.

For similar reasons, and contrary to Spark's view[13], the FDS locations should be retained. If there are more/ fewer FDS then the service provided by interconnecting at that location covers fewer/more locations respectively at lower/higher cost.

[9] For example WIK submission, paragraphs 115, 173

[10] Spark submission, paragraph 255

[11] Analysys Mason UCLL FPP process and issues paper submission, p25

[12] Spark submission, paragraph 251

[13] Spark submission, para 59c

2.4.2 Resilience

We agree with WIK (Submission para 95) that resilience requirements ought to be borne in mind; we think these requirements are relevant in the access network as well as in the core.

We are advised that for various topographical reasons "rings" are less used in New Zealand than in other countries.

We disagree with WIK's claim that aggregated feeder elements in the access network (SLU backhaul, FWA backhaul) should use aerial deployment. Aggregated links serving many customers would be better protected underground.

2.4.3 Trench and cable optimisation

While WIK does criticise two specific features of the TERA algorithm (related to treating entire street segments as a single entity and routing cables from that segment on the shortest path to the serving node), it is unclear whether the cases they illustrate are material in practice:

- real NZ road networks are not grids with no housing on the "verticals" and extremely sparse distribution of premises served. In reality, when housing is sparse, the network is much more tree-like than grid-like, making the point raised by WIK moot.
- FWA does not serve a large number of contiguous properties in the Commission's model, meaning that the second illustration of WIK is also not likely to lead to a significant saving

WIK are incorrect that the correct algorithm is to minimise trench: the formally correct solution minimises total cost (over time). However, this said, different BU model algorithms (such as those used by WIK, TERA, and Analysys Mason models) all take slightly different approaches to this issue, many of which are not the formal optimum, because full-network-cost-minimisation algorithms are computationally very expensive as the number of served nodes increases. For example, considering the network evolution over time explicitly is often considered to be infeasible. Given these practical constraints, we believe the TERA approach is reasonable.

WIK do not provide any evidence for their assertion that a 5% saving in trench would be possible if using a different network layout algorithm. They have not provided any justification. In any case, using less trench would imply more cable, a factor WIK do not estimate.

2.4.4 Insufficient spares in the network

We agree with the WIK submission (paragraphs 335, 407) that there are insufficient spares.

WIK themselves say (Submission para 471):

> Another typical example of path dependent inefficiency follows from parallel trenching. If a network growths (sic) fast over time often the existing duct – if existing at all - and trench capacity is not sufficient to host additional cables which are needed to meet that demand. In this case parallel trenches have to be deployed.

If there are insufficient spares provisioned in the network design, then is artificially reducing the costs today and at the same time is ensuring that future (allegedly inefficient) costs of parallel trenching will not be recoverable.

2.5 Demand for UCLL

We agree demand will change over time (e.g. Vodafone submission G7 “However the assumption of constant demand over a five year period is incorrect.”). Demand for UCLL will decrease as UFB is taken up. Chorus total demand for UFB and UCLL will decline as customers move onto non-Chorus UFB and onto other networks such as mobile. In this way no NZ operator will have the scale modelled by TERA. This imposes a lack of expected NPV neutrality: no possible real operator can ever reach this level of demand.

Spark[14] argue that the modelled operator ought also to include the current HFC demand. This suffers the same issue: no possible New Zealand operator can reach this level of efficiency. We note that Network Strategies[15] do not agree with Spark.

2.5.1 Constant demand does not imply no further unbundling

Network Strategies (FWA submission p38) says

> In addition we note that the Commission's constant demand assumption effectively precludes the possibility of further unbundling.

This is wholly wrong as the Commission’s assumption is of constant demand for fixed connections to premises, not whether these are bought as UCLL or UCLFS or “baseband” variants.

2.5.2 Inconsistent arguments about use of wireless technologies

According to Vodafone, Spark[16] and their consultants Network Strategies and WIK[17], FWA is a viable access solution meeting wholesale customers’ needs across all rural New Zealand. But they simultaneously hold that the Commission’s implied forecast of 20% mobile only households is by

[14] Spark submission, paragraph 210

[15] Network Strategies Submission, section 2.2

[16] E.g. Spark submission paragraph 40a

[17] E.g. WIK submission paragraph 111

implication an unacceptably high figure for 2020 and that demand for UCLL services will grow as a result[18].

These are inconsistent positions: if FWA can meet these needs then so can mobile for many users (e.g. urban users close to 4G base stations). We believe that FWA or mobile is an inferior solution compared to fixed line access; FWA cannot be unbundled and places strong constraints on end user traffic growth over time.

2.5.3 Impact of UCLL demand changes in dense areas

Network Strategies estimate of the impact on unit costs of expected future demand changes does not assume any increase in costs, which they agree is "obviously not appropriate". But to get to their "decrease in cost per line of around 9%" they mix three factors: increasing demand in areas of existing network coverage (not quantified, but we presume they must be more than the 1.5% as this can only get an 8.5% decrease in unit costs if there is no incremental cost of meeting this demand), partly justified by increasing takeup of fixed line services driven by improved attractiveness of fibre, and some (unquantified) increased cost to cover this growth.

To deliver this growth at the very low levels of incremental cost that are implied by their estimate will require the spare capacity to deliver this growth to be designed in today. If Network Strategies are correct that there will over the next five years be strong densification within the major urban centres (rather than, say, additional zones of new housing at the edges of these cities in which new access network will need to be built), then the TERA network design should be amended to place substantial additional spare capacity within these urban areas.

At the moment, the general lack of spares (none in the FTTH modelling; none in the copper feeder) and lack of spare duct in the TERA model designs means any infill build needed will be significantly more expensive than the average unit cost calculated in the model – because it will need new trenching.

2.6 Unit costs

2.6.1 Benchmarks of unit costs of ducts

In paragraph 358 of their submission, WIK claim that the unit material costs of ducts are not in line with international best practice, citing the cost model developed in Denmark as a single benchmark.

The values quoted from the Danish cost model should be treated with some caution, since they are highlighted in blue. According to documentation accompanying the cost model[19], data highlighted

[18] See for example Network Strategies submission page 11, Spark submission para 83.

[19] See https://erhvervsstyrelsen.dk/sites/default/files/media/lraic-folgebrev-12-2013.pdf

in blue has been redacted i.e. the values present may not reflect the actual values used in by the DBA for pricing.

2.6.2 Benchmarks of unit costs of fibre cabling

We believe that direct evidence of New Zealand costs should carry greater weight than benchmarks. We note that WIK paragraph 342 implies that use of national data is to be preferred to international benchmarks.

Nevertheless, for the specific cases of the underground fibre cabling assets, as a cross-check we have benchmarked the unit capex values assumed in a range of other cost models using publically available information. This benchmark is assumed to be for both material and installation costs of these assets, as the Commission is attempting to capture in its own work.

We have compared the benchmarked values to the values in the public TERA model below, but we note our conclusions still apply if we use the values from the confidential model. We also include the values assumed in the Chorus models.

Figure 2.1 summarises our benchmark of the unit capex for underground fibre cabling assets up to 312 fibres, converted into 2014 NZD. As can be seen, the values assumed by the Commission are considerably lower than the benchmark values for all cable sizes.

Figure 2.1: Benchmark of unit capex for underground fibre cabling [Source: Analysys Mason, 2015]

[CNZCI: ✂✂]

We believe that the Commission's current model does not capture installation and overhead costs.

2.6.3 No evidence of lower costs in large scale deployment

In paragraphs 343/344 of their submission, WIK state

> "Many equipment prices and other cost parameters in the model are based on list prices which Chorus has provided to the Commission… List prices of vendors do not represent the relevant purchase prices of equipment and other services to deploy a new network… The HEO which the Commission is modelling should be in a position to negotiate and use such large discounts. Therefore whenever the Commission/TERA is relying on list prices it should apply a volume discount of 30% which is the midpoint of the relevant range of such discounts."

WIK provides no evidence to support its argument regarding large scale deployment having lower costs. Network Strategies (Section 4.2) also claim that a large volume discount should be applied to the trench costs.

Chorus' UFB build costs are evidence of the trenching costs which a large volume roll-out would face in New Zealand today, and that those costs are included in the Chorus models.

Similarly WIK provides no evidence to support its argument regarding discounts from price lists.

2.6.4 Higher use of aerial in some foreign jurisdictions is not relevant

It is true that in Japan a lot of the FTTH is aerial[20]. There is also a lot of aerial FTTH in Romania, which may explain why it is modelled in this way in that country. This is however irrelevant as to whether the HEO could feasibly deploy in this fashion in New Zealand given planning and other constraints.

We note in passing that Network Strategies have previously misunderstood the level of aerial deployment in the v1.7 access model for NPT, Norway. In their "Cross-submission for consultation on UCLL and UBA FPP regulatory framework on 25 August" they say

> Chorus claims to have compared the percentages of aerial deployment considered in some TSLRIC models used in other countries:
>
> While Chorus is targeting 20% aerial deployment in its UFB areas, we haven't seen anything higher than 16% aerial in a TSLRIC model internationally. Norway used 9% and Portugal 3%.
>
> However Chorus has not provided any references to support its claim. We have not found any publically available data to confirm the stated numbers for Portugal and Norway.

And later they say

> Even for Norway Chorus' quoted value of 9% does not apply to the whole country (and possibly might have been stated in reference to a particular urban area).

They refer to 'Network Design- Access.xlsm' workbook and show the 'percentage of tube metres assumed to be aerial' in Exhibit 2. We are not sure how their figure has been derived. However, if the deployed asset counts in the model are considered, the national average value is 9.3%. This can be found in the sheet B2Deploy of that model. This indicates that in 2013 there was 24,479,123m of aerial copper cable deployed (sum BU60:BU75) and 263,686,152m of copper cable overall (sum BU33:BU50 and sum BU60:BU75) i.e. 9.3%.

[20] It is possible to use Google street view to examine this (and the effect of the pole furniture on the visual landscape) in sample locations.

2.6.5 Sharing of underground assets is not necessarily feasible or economic

Sharing trenches with other utilities is put forward as an efficiency measure by stakeholders. (e.g. WIK para 389).

However, there are significant practical issues of coordination which limit the extent to which such sharing can be achieved to a small number of cases. In essence, the access networks need to be built at the same time: for many utilities it is not possible (as in the case of aerial assets) to come later and share unless there are spare ducts[21].

Sufficient physical separation of the utility assets (e.g. power and telecoms assets) is essential which will lead to a need for wider (and hence more expensive) trenches, which may also restrict the trenching methods used (and the future working practices needed). Even with the greater width this shared approach may still be slightly cheaper than individual construction of two networks in some cases - as for example pavement restitution at full width would only be needed once.

Further, we note that as can be seen in the file “PUBLIC_ComCom - Inputs for trenches - v5.0.xlsx”, the trench costs assumed per metre in the Commission’s model include duct-related labour costs as well as the trenching cost element. In addition to the wider trench required, the duct-related labour costs will not be shareable, which will reduce the percentage impact of sharing on the cost per m.

2.6.6 Slot trenching

WIK (WIK submission paragraph 318) are keen to use Chorus actual UFB practice in using slot trenching as evidence for feasibility; we think that they ought to accept Chorus actual UFB costs as evidence of such costs.

This method can form a part of a mix of trenching strategies for some technologies but is not feasible for all routes, or for large cables[22], or if the Commission were to assume trench sharing. In any case, cost savings will be negligible in some cases (e.g. in those areas where the surface restitution has to be half or full width of walkway.

2.6.7 Delay in revenues (“time to build”)

WIK say[23]:

[21] This naturally also requires that the later arriving entity can deploy into ducts.

[22] Noting that UFB uses PON which can use smaller cables than P2P in some parts of the network.

[23] WIK submission, paragraphs 347-348

> "TERA assumes a construction time (time to build) of the network of six months. We believe that is a reasonable assumption. We, however, do not agree with TERA's assumption that the building time should also reflect the time between the moment the investment is paid and the network is generating revenues. This assumption is too conservative.
>
> (…)Large telecom operators and those with significant market power in particular are able to negotiate vendor contracts which harmonize investment payment and revenue generation. Operators usually do not pay earlier than a system is ready for operation or negotiate "pay as you grow" arrangements. The Commission should assume the HEO to be in such a position. It follows that the annuity formula should not include a prefinancing period of six months but should assume that investment payment occurs when revenue generation starts." (footnotes removed)

WIK provide no evidence that large scale access network deployment can get such financing from vendors.

Such financing would not be cost free (a delay in payments to the vendor is in effect an additional discount from the vendor). In fact such financing is likely to have an increased cost due to higher cost of capital of equipment vendors compared to the regulatory WACC.

We have investigated the assumptions found in other jurisdictions and found that a "time to build" is present in other models such as (for example) Denmark, Croatia, and Bahrain.

Figure 2.2: Examples where a time to build assumption is applied [Source: Analysys Mason, 2015]

Country	Assumption (months)	Citation
Denmark	6	https://erhvervsstyrelsen.dk/sites/default/files/media/endelig-modeldokumentation.pdf, page 102 of 162
Croatia	Not public, but nonzero	http://www.hakom.hr/UserDocsImages/2012/odluke_rjesenja/VL-AT-PC-INTS-Metodologija%20izrade%20tro%C5%A1kovnih%20modela-v1.0.pdf, page 52 of 90
Bahrain	6 (implicitly)	http://www.tra.org.bh/media/document/MCD1011144PositionPaperonBU-LRICcostmodels.pdf, page 113 of 127.

2.7 Different parameters for fibre deployment

WIK argue (WIK submission 5.4.6) that for fibre deployment the changed cable parameters would allow other infrastructure requirements to be relaxed, specifically suggesting higher spacing of poles for fibre networks.

We note that the feasibility of this will depend on whether the poles are shared, as the pole spacing will need to be appropriate to the sharing use (e.g. power cables). It also is affected by the need for poles for CCT/FAT, an issue we commented on in our Submission report.

2.8 Limitations of Microsoft Access

WIK[24] note that regular restarts are necessary in the Commission's Microsoft Access model and suspect that it is working at the limit of its memory capacity.

Whilst we agree that it is not ideal to require these restarts, this is not necessarily an issue as long as the MS Access model is able to run in a repeatable and consistent manner.

2.9 Price trends / lifetimes

2.9.1 Asset lifetimes and price trends in other regulatory models

Asset lifetimes

TERA has based the asset lifetimes in its draft model for the Commission on Chorus data. This data reflects the specific operating conditions that network operators encounter in New Zealand and therefore this is the most appropriate source to use. WIK criticise a number of selected asset lifetimes but do not offer convincing sourced evidence to demonstrate that their suggested values are more appropriate.

- *Copper and fibre cabling*

In paragraph 356 of their submission WIK specifically mention copper and fibre cables, (noting that fibre cables have a 40 year lifetime in the Danish model), but they argued that a 25 year lifetime would be acceptable as this would harmonise with a 50 year lifetime of ducts and trenches (as set in the draft model).

However their own practice elsewhere has been rather different. In the documentation for WIK's model in Austria (2012) all cabling has a lifetime of 20 years and trench/duct lifetime is 35 years[25].

- *Poles, overhead cabling and overhead copper cable terminals*

Poles and overhead copper cable and overhead copper cable terminals lifetimes are criticised by WIK as they are not aligned. WIK say a 20 year lifetime for all would be suitable. They don't offer any further evidence, other than claiming that the lifetimes of all of these assets should be lengthened to align. However, if they must align for the purposes of replacement at the same time it would only make sense for the lifetimes to be shortened to match the asset with the least longevity.

[24] WIK submission paragraph 339

[25] https://www.rtr.at/de/tk/fn_modell/29239_Festnetz_Inputparameterliste.pdf, page 54

► *Street cabinets and underground copper assets*

WIK argue that street cabinets and underground copper asset lifetimes should be harmonised at 20 years based on their experience. No evidence is offered. TERA's selected street cabinet lifetime of 14 years is not out of line with international experience. For instance, street cabinets in the Swedish[26] and Belgian[27] models are 15 years.

► *ODFs*

WIK argue that the lifetime for ODFs should be 50 years. They provide no evidence other than arguing for harmonisation with fibre cables which they argue should be 25 years (WIK, para356a). However, there is evidence to support the 20 year lifetime selected by TERA. For instance, the Norwegian access model[28] use a lifetime of 20 years for ODFs. Furthermore, shorter lifetimes have been used in Sweden[29] (15 years) and in France[30] (8 years).

2.9.2 Asset lifetimes need to include stranding risk

WIK argues that stranding risk due to possible future changes in MEA should not contribute to the assessment of the economic lifetime of the assets used in the modelling.

> "The preferred option of the Commission for an ex ante compensation for the asymmetric risk of asset stranding is to extend and to adopt asset lives that reflect that risk. De facto the Commission used (with a few exemptions) Chorus' asset lives which incorporate in the Commission's view the risk of assets becoming obsolete due to technological change.(…). By accepting them the Commission effectively recognizes allowances for an asymmetric risk. All telecommunications network operators face the same or at least a similar risk of technological change. We do not agree with the Commission's assessment that technological change (including the risk of asset stranding) represents an asymmetric risk for telecommunications operators. Technological change is anticipated by the market and represents a systematic risk in telecommunications. It is properly reflected and measured in the asset beta of the WACC formula."[31]

This is incorrect in principle: the risk of future stranding limits the expected economic lifetime of assets.

26 Model *Final HY Consolidation model 10.1* for 2014 available under the link "Hybridmodell (zip-fil)" at http://www.pts.se/sv/Bransch/Telefoni/SMP---Prisreglering/Kalkylarbete-fasta-natet/Gallande-prisreglering/

27 Model may be downloaded from: http://ibpt.be/FR/operateurs/telecom/marches/controle-des-prix-et-des-couts/modele-de-cout-ngn-nga/module-reseau-d-acces

28 v1.7 Access model available at http://eng.nkom.no/market/market-regulation-smp/cost-model/lric-for-fixed-access-networks

29 Model *Final HY Consolidation model 10.1* for 2014 available under the link "Hybridmodell (zip-fil)" at http://www.pts.se/sv/Bransch/Telefoni/SMP---Prisreglering/Kalkylarbete-fasta-natet/Gallande-prisreglering/

30 Model may be downloaded from http://www.arcep.fr/index.php?id=8080&no_cache=1#c15446

31 WIK submission, paragraph 78

If the best forecast today is that there is a material probability of an alternative infrastructure being found to be the MEA in the future, then the expected asset economic lifetime today is reduced. Given the sustained arguments about which technology is the MEA today (including stakeholders arguing that Copper/FTTN is cheaper in some ESA) it is not possible to argue that this is a settled question for the lifetime of the proposed technologies – and these lifetimes are very long. Accordingly this effect has to be taken into account.

2.9.3 Inconsistent with WIKs own reuse arguments

On the one hand WIK claims assets are reusable (WIK Submission section 1.1.2). On the other in arguing for longer asset lifetimes (in WIK submission paragraph 356a) they imply that operators will not reuse assets whose lifetimes do not support the full lifetime of the supported asset (arguing for pole lifetime to be twice the aerial cable lifetime and similar for ducted trench). This effect places an additional limit on the fraction of existing assets be suitable for reuse.

This also links to our previous comments in relation to the additional costs of sharing in practice. When Chorus wishes to use EDB poles for UFB deployment, it often has to pay for pole refurbishment costs.

2.10 Allocation issues

2.10.1 Allocation to UBA backhaul, leased lines in access

WIK submission, paragraphs 394-396 suggests the use of the required fibre counts to allocate costs to subloop backhaul, FWA backhaul and leased line services. This is a possible approach, but in practice it is dependent on knowing the locations of the leased line and FWA backhaul demand.

Depending on how costs are allocated to copper cables in the same trenches, it can also place somewhat odd incentives on the HEO to serve as much leased line demand as possible using copper (using multiple pairs if necessary) or to aggregate the leased line demand at the cabinet.

2.11 Aggregation approach does not distort the UCLL price of the fibre MEA

WIK state (WIK submission para 171):

> The UCLL price of the fibre MEA is higher than it might be if it is only based on the copper infrastructure elements.

This is untrue, because in the case where fibre is the MEA, the UCLL price is set by the total cost of the fibre network and the total demand.

2.12 Spark suggested “downward adjustment” to account for double counting risk

Spark say (Spark submission para 174):

> The only pragmatic answer may be to apply downward adjustments to one or both prices to account for this risk.

This is just an attempt to re-open the MEA. Given the Commission's MEA decision, there is no double counting in the Commission's approach, and no need to apply any such downward adjustment.

2.13 Validity of Chorus UCLL model

2.13.1 Efficiency adjustments

We accept that the use of a bottom up model leads to a more robust estimate of the required assets for the HEO than an adjusted version of the actual network assets, given that it is very difficult a priori to understand the level of efficiency or otherwise of the existing network assets and their layout. However, and for the same reasons, we do not believe that WIK can estimate in their submission the level of efficiency adjustments required as a "minimum" of 50% (in their table 7.1) with any degree of safety.

Nevertheless, even if the Commission were to choose to disregard the asset counts used, our UCLL model still provides a great deal of information that can be used by the Commission to inform all aspects of their decision.

2.13.2 Network Strategies objections

It is true that our model does not make the same assumptions as the Commission have documented in their Model Reference Paper. Given the date of publication of that paper, this is hardly surprising. However, Network Strategies appear not to have noticed that our models do use constant UCLL demand, scorched node assumptions, and bottom up calculations for power and accommodation (Submission, page 74).

Network Strategies make a specific point[32] that

> the Chorus UCLL model has increasing asset numbers over this period despite service demand remaining constant. These assets include:
>
> • feeder manholes, to active cabinets, fibre (asset IDs 137–144)
>
> • feeder cable route, trench, to active cabinets, fibre (asset IDs 177, 181)
>
> • feeder fibre cables (asset IDs 353–362).

[32] Network Strategies submission, p77

As might be expected from their descriptions, these assets do not affect the cost of UCLL or SLU in our model as they are all allocated to the "Fibre feeder assets" group. Fibre feeder assets are allocated to the "Fibre Feeder pairs (active cabinets)" technical service, which is recovered across the following services only:

- Baseband IP
- BUBA, EUBA 0, EUBA 40, EUBA 90, EUBA 180, -Chorus VDSL, -Multicast, -Clothed Broadband products, and -Sub loop backhaul.

As a result their conclusion that the cost will be overstated is false.

2.13.3 WIK objections

SLU cost relative to NC-UCLL

WIK[33] say

> The results represent some overall inconsistencies which also support our general conclusion and assessment that the Chorus model is not suitable to inform the Commission's UBA and UCLL price determination. As an example, the UCLL model produces an SLU price that is slightly higher than the UCLL price although UCLL includes more network elements. This is implausible. It is also implausible that the costs for UCLFS are about 15% higher than the cost of UCLL although this service uses less network elements than UCLL and supports just low band-width services.

SLU assets in the Chorus model are not a subset of NC-UCLL assets as SLU and NC-UCLL are each provided on a distinct set of lines. Therefore SLU is not necessarily cheaper than NC-UCLL, it is an empirical question that depends on the costs of the assets supporting SLU.

Depending on location, UCLFS can be provided over the same assets as NC-UCLL, or the same assets as SLU plus (in the Chorus model) the costs of a copper "feeder" cable to the (active) cabinet. Within the Chorus model it is made up of the following technical services, which together overlap with those used to provide NC-UCLL, SLU and copper feeder (SLES) but in different proportions.

- Copper Direct pairs
- Copper Feeder pairs (passive cabinets)
- Copper Distribution pairs (passive cabinets)
- Copper Distribution pairs (active cabinets)
- Copper Feeder pairs (active cabinets)

[33] WIK submission, paragraph 488

As a result UCLFS can cost more or less than NC-UCLL, which only uses the first three of the above technical services. That UCLFS uses only the low frequencies does not change the cost of production.

"Capex has nearly doubled"

WIK (para 487) say:

> CAPEX has nearly doubled during the transformation, which has neither been explained in the model documentation nor in the model. This means, it remains intransparent and unjustified. The level of the resulting monthly unit cost consequently are already inflated by a factor of two just for this reason.

We do not recognise WIK's figures. They could have been clearer as to the exact sources of the numbers they quote, but they appear to be comparing two different things:

- in year capital expenditure based on assets purchased in that year, (as price * quantity) (e.g. Chorus UCLL model Capex sheet cell BQ3070, of order **[CNZRI: ✂**NZD **✂]**)
- the result of the annuity calculation (a charge which is based on the GRC of the entire asset base, which for the whole network is approximately **[CNZRI: ✂**NZD **✂]**, resulting in a figure of order **[CNZRI: ✂**NZD **✂]** per annum e.g. Chorus UCLL model MTAD sheet cell BS9844).

The annuity includes not only an allowance for depreciation but also the return on capital employed. There is no reason why this annuity figure should be the same as the modelled in-year capital spending. There is therefore no "unjustified" doubling.

3 UBA model

3.1 MEA

We support the Commission's choice of MEA for the additional costs of UBA (i.e. DSL based on copper).

We think that the relativity requirement is indeed related to the consideration of the economics of RSPs using UCLL[34]; for this to have meaning, UBA has to be based on DSL.

3.2 Demand for UBA

Demand for UBA (in total, and for specific UBA products) will change over time.

Network Strategies position is unclear (Submission, p17)

> If the model assumed non-constant demand projections for UCLL, it would then be necessary for the Commission to consider how this would affect demand for UBA for the hypothetical operator. In this instance, constant UBA demand may not be appropriate. To achieve the Commission's objective of an efficient outcome, an increasing UBA demand may be required.
>
> However given the difficulties in incorporating non-constant UCLL demand within the model, the Commission may need to continue with the constant demand assumption for both UBA and UCLL.

Here we disagree with the premise: UBA demand can and will vary even if demand for wireline connections is constant.

Having sat on the fence, Network Strategies then criticise[35] the Chorus / Analysys Mason UBA model for having changing demand over time (as this disagrees with the Commission's principles).

WIK Submission para 475 says:

> In contrast to the UCLL model the UBA model assumes a declining demand. This represents a major conceptual difference to the Commission's model which makes the two models unable to be compared without major adjustments, and leads to increased modelled costs.

[34] Spark agrees with this in its submission at para. 233b

[35] Network Strategies submission, p74

This is excessive. We agree our demand forecast is different; but our results can readily be compared with those of the Commission's model.

3.3 Traffic for UBA

We note that WIK agree that traffic per user will grow e.g. WIK Submission footnote 93:

> Moores law of doubling the traffic every 1.5 years would result in 600 Kbps after 1.5 years, 1.200 Kbps after 3 years and 2.500 Kbps after 4.5 years. Even when this rule will not hold for the average peak capacity per end-customer a significant increase can be expected. This increase also will de-pend on the capabilities of the copper access network. One can expect that high usage end-customers will migrate to the UFB fibre network, where available and affordable.

We agree: we expect UBA traffic per user will grow strongly over the modelled period.

Throughput per customer grows in the Chorus model.

3.4 Alleged double counting in Chorus model in relation to operating costs

WIK concerns relating to opex "double counting" (Submission para 485) are not justified. Capitalised costs have been excluded from opex; costs identified as transaction costs have been excluded from the cost base of monthly rentals; certain other costs such as IT have been allocated between monthly rentals and transaction costs (e.g. based on revenue).

3.5 Criticism of Chorus UBA model

Network Strategies criticism of the UBA model

Network Strategies list of the ways in which our UBA model is not according to the Commission's principles. Several of their objections are not correct:

- Lack of modified scorched node approach (our model does use a scorched node approach based on the existing cabinet locations, like that of the Commission)
- The price control period being 2015-2019 (our model does calculate a flat nominal 5 year unit cost)

They also note and criticise that we model declining demand for UBA even though such a decline is a natural consequence of competition from other services and other networks including unbundlers and UFB (as noted by WIK in their footnote 93 as quoted above).

WIK criticisms of UBA model

In addition to points already considered in this section, WIK identify a couple of additional points related to the UBA model:

- Lack of common cost optimisation
- High WACC (not considered in this document, but easily modified in the model)

Summary in relation to UBA model

In our view none of these objections raised by Network Strategies or WIK justifies rejection of the Chorus UBA model outright; the effects of each of these points of difference could be taken into consideration if needed.

Our UBA model does use the Commission's MEA; we do use a completely BU approach for electronics, and we use a backhaul approach sharing assets with the access network. Points where we differ from the Commission's approach are transparent and can be understood.

We note that other parties have not provided their own UBA models.

3.6 Out of date data ?

WIK (para 340) states:

> The equipment used in the model is to the utmost extent based on information provided by Chorus. This covers DSLAMs, FDS Ethernet switches, duct and cable cost etc. These data are typically historic data, describing equipment being bought some eight years ago. Neither system performance nor system components have been actualized to state of the art systems Therefore the model is not using relevant prices.

We disagree: the prices are today's prices (see Annex A below for the trenching cost analysis).

3.7 Subscriber and traffic demand should be considered for dimensioning assets in TERA's UBA model

WIK say (para 99):

> The UBA model has to be efficiently dimensioned according to traffic demand and quality of service of all services and not just by the number of customers. That is what operators do and what a proper modelling approach should replicate.

and (para 206):

> … Both, DSLAMs and FDS, are dimensioned on the basis of the number of ports fitting into the chassis (called subracks in the model), not taking customer traffic demand into account. Thus, the model does not allow for dimensioning sufficient capacity.

We agree.

3.8 Utilisation rates for DSLAMs

WIK say (Submission para 333.):

> Typically a DSLAM or switch cannot be fully loaded with ports, but requires some spare ports to be taken into account. Thus, not all ports of a port card will be used for end-customer connections and traffic.
>
> …Such not optimal but efficient filling of port cards may be reflected in cost modelling by a utilisation factor which will be different for the aggregation switches and the customer DSLAMs.

We agree.

3.9 FDS dimensioning issue

We agree with WIK (WIK submission para 243) that there is an error in the TERA FDS dimensioning calculation.

3.10 Allocation to UBA backhaul, leased lines in core

WIK submission paragraph 398 criticises the arbitrary allocation of 1/3 of the core network costs between exchange and FDS to voice as

> One may doubt if a voice service can be simply allocated to a fibre use between local exchange and FDS, since the voice traffic is at least in parts a small bandwidth share in the UBA, and the PSTN voice traffic behind the local exchange is out of scope for the Chorus network. Thus the service allocation chosen (equal parts for voice, bitstream and leased lines) does not hold, because voice just has a minor share in the bitstream part of services and is integrated into the bitstream. Voice therefore cannot carry link cost in addition.

We agree.

Also in paragraph 398 WIK instead suggests using a fibre count as the cost allocation mechanism in the core, suggesting 2 fibres per cabinet for leased lines and one for UBA based on “resource consumption”. Although this is conceivable, we think that in the core network either traffic or revenue are more natural cost allocation mechanisms.

We note that at paragraph 273 WIK oppose the Commission's rejection of traffic-based allocation.

> 273. The Commission is justifying its approach of not allocating backhaul costs on the basis of bitstream service traffic for the reason that this would lead to distortionary effects between services. We do not subscribe to this argument. If the allocation of costs according to its real cost drivers would lead to distortions then something would be fundamentally wrong with the modelling approach. (footnote deleted)

3.11 Gradient based allocation for EUBA variants

We disagree with WIK[36]; a gradient based method is not a departure from TSLRIC. Such a method has been successfully and appropriately used in LRIC models in Denmark and Sweden. It can be seen as a kind of simplified Ramsey markup of inter-service-speed common costs.

We agree that changes in service mix during the price control period will create changes in cost recovery. To use a gradient based method, the Commission therefore needs to forecast takeup of the mix of services for the entire modelled period.

3.12 Not necessary to calculate rural and urban UBA prices

We do not share the opinion of WIK (WIK submission para 90) that the Commission should calculate separate urban and rural unit costs for UBA.

[36] WIK submission para 86

4 Opex and non-network costs

4.1 Overall OPEX approach[37]

Starting from the operating costs of an actual operator in New Zealand operating a local access network of the correct scale is a good way to ensure that the actual costs of operating in New Zealand are fully taken into account. Chorus' accounts are therefore an appropriate starting point.

WIK disagrees with using Chorus opex data as a starting point with efficiency adjustments and instead recommends using a mark-up on CAPEX based on international benchmarks. Part of the argument is that the modelled network is different from the Chorus one and therefore the opex would be/should be different.

WIK do not provide any evidence of why their approach would work better. In fact, their recommended approach (an international benchmark) would have the same flaw as the one they argue against (i.e. the networks used for the benchmarking would be different from the one modelled for the UCLL/UBA HEO). In addition the suggestion of using a mark-up based on CAPEX for opex represents a way to model OPEX which may have cost allocation issues if implemented crudely e.g. an expensive asset may not consume large amount of power but with WIK's approach it would be allocated the cost of power consumed by cheaper but more power-hungry assets. Many jurisdictions have moved beyond the use of capex mark-ups to calculate network opex. See for example Belgium[38], Italy[39], Spain[40] and Denmark[41].

The Commission's approach is an appropriate choice in our view.

4.2 LFI and fibre efficiency adjustments[42]

WIK criticises the LFI adjustment for being subjective and single source and the fibre adjustment for being "extremely rough and questionable".

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37 WIK submission, paragraphs 137-145

38 Model may be downloaded from: http://ibpt.be/FR/operateurs/telecom/marches/controle-des-prix-et-des-couts/modele-de-cout-ngn-nga/module-reseau-d-acces

39 Model available at http://www.agcom.it/default.aspx?message=viewdocument&DocID=4178

40 Available from http://www.cmt.es/consultas-publicas?p_p_id=101_INSTANCE_lF6E&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-2&p_p_col_count=1&_101_INSTANCE_lF6E_struts_action=%2fasset_publisher%2fview_content&_101_INSTANCE_lF6E_urlTitle=20121221_web_analysys_mason&_101_INSTANCE_lF6E_type=content&redirect=%2fconsultas-publicas%3fp_p_id%3d101_INSTANCE_lF6E%26p_p_lifecycle%3d1%26p_p_state%3dnormal%26p_p_mode%3dview%26p_p_col_id%3dcolumn-2%26p_p_col_count%3d1%26_101_INSTANCE_lF6E_struts_action%3d%252fasset_publisher%252fbusqueda&pag_anio=2012&

41 Model *2012-55-DB-DBA-Fixed LRAIC-Access Cost Model - v4.07 DBA – Public* for 2015 available under the link "LRAIC-modeller" at http://erhvervsstyrelsen.dk/gaeldende-prisafgoerelse-for-2015

42 WIK submission, paragraphs 137-145

We agree with WIK that the adjustments are arbitrary and not supported by strong evidence.

The assumption that opex adjustment is constant over the regulatory period would not be correct as the adjusted modelled network will age over time.

4.3 Overhead on Chorus maintenance contracts[43]

WIK criticises the treatment of maintenance overheads (i.e. GL codes **[CNZRI: ✂ ✂]**) WIK expresses doubt that those represent efficient costs.

First, it seems that TERA's wording makes WIK believe that the overhead represents "Chorus costs of dealing with contractors"[44] which leads WIK to speculate that there may be double counting and that maintenance outsourcing might not be efficient. This is erroneous as GL codes **[CNZRI: ✂ ✂]** relate to external payments to service companies to cover their overheads rather than internal Chorus costs.

Second, WIK expresses concerns about the allocating of the maintenance overhead costs and whether some costs should be allocated to transaction charges or unregulated services.

We do not believe that there is double counting as our understanding is that the GL codes **[CNZRI: ✂ ✂]** are pure maintenance codes and not relevant to transaction charges.

Some other payment to service companies (**[CNZRI: ✂✂**) are shared across network maintenance, customer maintenance and provisioning activities and have been split between the 3 types of activities in the Chorus opex model. In the TERA model, those have been allocated between maintenance and provisioning.

4.4 5% annual opex efficiency improvement[45]

WIK agrees with the use of the LCI but argues that efficiency/productivity improvements should be taken into account. WIK argues for efficiency/productivity improvements no lower than 5% (presumably year on year though that is not clear) based on the practice of Ofcom.

WIK's assertion that 5% improvement is the minimum is not supported by Denmark using 2%

Many models use 0% real price trends for opex so WIK's opinion that 5% efficiency/productivity improvements should be used is aggressive. This is the case for the models built for the regulators in Norway[46], Netherlands[47], Mexico[48] and Portugal[49].

43 WIK submission, paragraphs 146-148

44 WIK submission, paragraphs 146

45 WIK submission, paragraphs 149-152 and paragraphs 153-154

46 v1.7 Access model available at http://eng.nkom.no/market/market-regulation-smp/cost-model/lric-for-fixed-access-networks

4.5 "Discrepancies between the various models"[50]

WIK identified that the opex and non-network costs are different in the OPEX and CORE modules without any explanations.

We agree with that assessment.

4.6 Alleged risk of double-recovery (e.g. transaction services)

WIK[51] argues there could be double recovery of labour (as opex and capitalised labour). However, they provide no evidence.

The GL codes from Chorus clearly identify capitalised labour.

In the Chorus model, the 59 cost categories are based on opex with any capitalised part netted off. This is for instance the case for the various 'Net Personnel Costs' categories whose opex values come from the GL 'Net Personnel Costs' row. This row is calculated in the GL as all pay related costs minus capitalised labour. The same netting off happens for other cost categories such as capitalised service companies provisioning charges, capitalised service companies maintenance charges, capitalised purchase of fixed assets, etc. so that the only expenses remaining in the Chorus model are the expenses net of any capitalisation.

In the same way the TERA model uses 'Net Personnel Costs' rather than 'Gross Personnel Costs' as seen for instance in sheet 'Pay cost allocation' that links to column D rather than to column B in sheet 'Detailed staff'.

WIK[52] argues there could be double recovery of opex between rental and transaction costs. Again, no evidence is provided.

4.7 Power and accommodation costs in the TERA opex model

We provide more detail on power and accommodation costs in annex B.

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47 Model last updated in 2013, available at the following link: https://www.acm.nl/nl/publicaties/publicatie/11321/Ontwerpbesluit-marktanalyse-vaste-en-mobiele-gespreksafgifte-2013-2015/

48 Model available here: http://www.cft.gob.mx:8080/portal/industria-2/unidad-de-prospectiva-y-regulacion/modelo-de-costos-utilizado-por-el-pleno-de-la-comision-federal-de-telecomunicaciones-para-determinar-las-tarifas-de-interconexion-en-redes-fijas-para-2012/

49 Available from http://www.anacom.pt/render.jsp?contentId=1278256

50 WIK submission, paragraph 239

51 WIK submission, paragraph 256

52 WIK submission, paragraphs 257-264

4.8 Non-network efficiency

WIK criticises[53] the lack of efficiency adjustment to non-network costs such as IT as well as the lack of justification for the location keys. They give a few examples e.g. Sales and Marketing costs to be allocated to products, IT costs to be allocated to network elements. Finally they recommend a mark-up based on benchmarks.

We agree that Sales and Marketing can be allocated directly. This is what we did in the Chorus model.

We disagree with the WIK opinion that “Generally IT staff is responsible for certain network elements and therefore does not represent common costs”. In fact many IT staff will work on multiple projects and/or systems. A detailed allocation would therefore require a complex analysis of timesheets and usage of systems by different services. This is the reason why IT costs, unless unambiguously related to a service, are usually treated as common costs.

4.9 Non-network exclusions

WIK[54] makes general statements on lack of transparency in treatment of non-network cost centres and then identifies a single example (“regulatory levies”) which they seem to interpret as levies only on regulated services and therefore not to be split **[TERACI: ✂✂]** in the modified EPMU approach)

The example given is incorrect (TDL and Commission levies are based on total qualifying revenues).

4.10 Opex use for allocation rather than total cost[55]

WIK identified a lack of consistency in the way non network costs are allocated in the model on the basis of OPEX rather than on the basis of total attributable costs as explained in the model documentation.

We agree that the EPMU implementation should be based on total costs rather than opex.

4.11 Inconsistent non-network cost allocations

The TERA model also uses a **[TERACI: ✂✂]** allocation between UCLL and UBA for non-network building costs rather than allocating based on revenue as it does for non-network costs between regulated and non-regulated services.

53 WIK submission, paragraphs 320-326

54 WIK submission, paragraph 383

55 WIK submission, paragraphs 400-403

In the UBA model, the opex allocated to UCLL or UBA services is then allocated to assets types (copper local loop and SLUBH for UCLL; xDSL and SHDSL for UBA) based on annual capex rather than total costs.

4.12 Overhead markups

WIK say

> "As we have shown in para. 326 the implicit mark-up of overheads looks a bit too high for UCLL. Regarding UBA, however, the mark-up of [...] CNZRI % exceeds relevant international benchmarks by a factor of two to three. Therefore it would be totally unacceptable only to apply the EPMU allocation rule properly. This would just lead to a zero sum re-allocation game of non-network common cost from the UCLL to the UBA service. Besides getting the allocation right the major request to the Commission would be to bring down the level of non-network common cost to an acceptable level according to the efficiency standard of international best practice and then apply the allocation rule in an appropriate way." [56]

The reference to the use of benchmarks has been discussed in previous points. In addition it is worth noting that there are economies of scale in overheads, so comparison to larger countries will not be a good comparison. In addition to this purely national effect, Chorus, being structurally separated, does not have the same economies of scale in overhead costs relative to e.g. retail telcos.

4.13 Allocation of "other maintenance"

WIK say

> "The allocation of other maintenance cost to "DSLAM & Active Equipment" and "Passive Equipment" has not been provided by Chorus and now are allocated by TERA on a pro-rata basis on the number of active and passive cabinets in case of passive cabinets (Passive Equipment) and by 100% to active cabinets (DSLAM & Active Equipment) (…)We wonder, why the cost for the passive equipment is not fully allocated to the UCLL cost and by that also recovered by the BUBA service, which includes the UCLL cost. This we would have expected under this approach. If there are reasons against this view we are wondering why there has not been taken the same cost allocation key as for the Chorus maintenance already differentiated into active and passive. Thus, the decision described in the Model Documentation, Section 3.3.11.1.3 appears to be very arbitrary, not consistent and is not really argued for." [57]

56 WIK submission, paragraph 404

57 WIK submission, paragraphs 405-406

This comment from WIK is a direct response to section 3.3.11.1.3 of the Model Documentation.

Looking into the TERA model in more detail we believe that the TERA model documentation could have been clearer.

In the rest of this section we review the way the TERA model allocates the different types of maintenance costs and whether the allocation criticised by WIK applies to those different types.

The first and largest category, "Chorus maintenance costs", **[TERACI: ✂✂],** is allocated based on Chorus' response to question 6.19.3 i.e. based on fault data. This is what is explained in Section 3.3.1 of the Model documentation. The criticism does not therefore apply to them.

Similarly, the second and third category, "Engineering services costs", **[TERACI: ✂✂],** and "Alcatel Lucent specific costs" , **[TERACI: ✂✂],** have their own allocation and the criticism does not therefore apply to them.

The allocation criticised by WIK could theoretically apply to some part of the fourth category "project opex" , **[TERACI: ✂✂]** though as the entire project opex category is excluded in the TERA model, this point is currently not material.

Most of the final category 'other maintenance costs', **[TERACI: ✂✂]** correspond to customer maintenance **[TERACI: ✂✂]** and are classified as out of scope of the model. This is what is explained in Section 3.3.1.5 of the Model documentation. The only part remaining is GL code **[CNZRI: ✂ ✂]**, **[TERACI: ✂✂]**. However, contrary to the implication of section 3.3.11.1.3 of the TERA model documentation, that cost category is not allocated between passive and active cabinets based on the allocation criticised by WIK but based on the proportion of "Chorus maintenance costs" allocated to active and passive cabinets.

Finally the allocation criticised by WIK is applied to a non-maintenance cost category despite section 3.3.11.1.3 of the TERA model documentation referring to "other maintenance costs". The cabinet part of rents (**[CNZRI: ✂ ✂]**) is split between active and passive cabinets based on the number of active and passive cabinets - which is reasonable.

Our conclusion is that having investigated this point in detail, TERA's approach appears reasonable.

4.14 Non-network IT costs

WIK say[58]:

58 WIK submission, paragraphs 408-410

> "Parts of the IT costs are treated in the model as non-network cost. These costs are allocated directly to services by using an allocation key of [...] CNZRI % for UBA, [...] CNZRI % for UCLL and [...] CNZRI % for other services.
>
> These allocation keys are not supported by or justified in the documentation. For us these allocation keys are highly implausible for two reasons: Why should "other services" which generate [...] CNZRI % of Chorus' revenues not bear a certain part of these costs? Furthermore, which service characteristic would justify that UBA bears four times more IT cost compared to UCLL while it represents only [...] CNZRI % of the UCLL revenues?
>
> The Excel map "CI_ComCom-OPEX model v1.10.xlsm", sheet "Alloc key" includes nine different network IT allocation keys, which are not explained in detail on this sheet. One of them is the IT allocation key mentioned under para. 408, which is presented with not rounded numbers. The source is just stated as "TERA Consultants assumption" (see cell L65) and the allocation key itself is named with "Benchmark" (see cell F65), so that this allocation keys cannot assessed by us due to this unspecified information. Following the links of this allocation factors to the sheet "Costs summary", these allocation factors do not seem to be used, be-cause they are multiplied with "0" cost values (see cells I 212 to 213 and cell I189). Surprisingly the multiplication factor, the cost value, stands for "IT network costs", although they should be multiplied with non-network IT costs (See TERA, Model Documentation, Table 26 – Non-network cost allocated to UCLL and UBA). Finally the cell above (I188) contains the "IT non-network costs". These are summed up with other positions to "Non-network costs except IT costs " (see cell I183 and I199) without using the allocation key for IT costs shown in the Table 26, TERA, Model Documentation." (footnotes removed)

WIK criticizes the allocation rules for IT costs, and more specifically the amount allocated to 'other services' and the reason why the allocation key allocates "four times" more IT costs to UBA than UCLL.

Contrary to the labelling in Table 26, non-network IT costs are treated in the same way as other non-network costs and therefore allocated to UCLL, UBA and Other services based on revenues.

The allocation key which allocates UBA "four times more IT cost compared to UCLL" about which WIK is complaining is therefore not in fact applied to any network IT cost, so is irrelevant. Indeed, in paragraph 410, WIK acknowledges this fact.

5 FWA

5.1 FWA does not meet the required functionality

The modelled FWA service is not a suitable MEA as it is incapable of providing the non-blocking physical layer interface functionality required for UCLL (or indeed UCLFS).

An RSP currently offering DSL over UCLL would not be able use FWA as an input to operate their own layer 2 electronics and compete with UBA or other retail service providers.

5.2 The geographic extent of FWA needs to be restricted to where the lower functionality is realistic

Other regulators such as the Swedish regulator PTS have considered the use of FWA, but in effect have restricted this consideration to areas where this is either actually present in the real world today (e.g. NZ customers served using “country sets”) or will be so in the immediate future. For example, in Sweden we understand that TeliaSonera has a public plan to de-install wireline and use wireless means to deliver services for the relevant 50,000 premises. We have already commented on this in previous submissions[59].

5.3 Insufficient detail has been provided on critical technical parameters

Network Strategies do not include sufficient detail regarding the modelling of the radio network and in particular the link budget, radio propagation prediction model and associated assumptions. While some parameters have been presented in the confidential report, we would expect to see considerably more detail including such critical matters as the uplink and downlink service specifications (including modulation scheme (e.g. QPSK) and error correction coding used), full uplink and downlink link budgets (with equipment parameters which need to be consistent with the assumed equipment costing) and a specified propagation loss model, so that we can check it is appropriate to the antenna heights, frequency of interest, propagation environment and fading effects.

5.4 The modelled sites will not serve 100% of premises

Network Strategies state[60]:

[59] Analysys Mason FPP Process and Issues paper submission, p13

[60] Network Strategies Network Strategies Fixed Wireless Submission, section 4.1

> Radio planning was performed to ensure that the two criteria – coverage and capacity – were satisfied. Coverage sites were planned to cover 100% of customers using co-location on existing Vodafone sites if possible and adding new multi-access sites (to allow for colocation in the future) where required. In addition repeaters were added where there were only a few customers to cover and it was more economical to do so (rather than adding a new site).

We do not believe that the modelled coverage sites will actually cover 100% of the customers. Even if the planning tool says they are theoretically covered, they would not all be covered in practice. The process as described cannot provide this level of certainty.

Despite the lack of transparency we know this because the information supplied does include a "lognormal fade margin" (although the method of estimating the path loss relative to this fade margin is not specified). The nature of such models of fading is that the propagation prediction is statistical, and that according to the amount of margin and a parameter relating to the standard deviation of the lognormal distribution in the relevant terrain type (e.g. rural) we can calculate the probability of coverage based on fraction of the lognormal probability distribution covered.

We note that such propagation models often have a maximum percentage coverage level beyond which they are no longer considered to be accurate (e.g. 99% probability of coverage).

In addition, in practice there can be localised obstructions that are not possible to include within the clutter and terrain databases used in the propagation loss calculations and the existence of which are not likely to have been taken into account in the calibration of the lognormal distribution[61]. For example, many rural buildings in New Zealand are provided with linear shelter belts of trees. These can (unfortunately in this context) provide effective screening from radio coverage but are too small in their spatial extent to feature in typical clutter databases used in propagation models, so they must be considered in addition.

Therefore, a fraction of the premises notionally served in the Network Strategies model will in fact remain unserved due to the probabilistic nature of the planning model and localised effects not included within the propagation model such as shelter belts. There is no provision to remedy these issues within the Network Strategies model: the costs of the additional facilities needed to serve these premises have not been included. The additional resources required can be such as: using wireline connectivity; placing remote antennas above / beyond the local obstruction and laying cabling to bring back the signal to the CPE; removal of parts of the shelter belt; and adding additional repeaters. All of these would have substantial additional costs.

If we assume that 10% of sites require remedial measures costing NZD3000 with a lifetime of 10 years, then this effect alone would contribute an additional NZD 2.9 per premise per month on average (averaged over all premises).

61 i.e. because the environment of different premises is likely to be quite different

We note that commercial mobile networks do not attempt to guarantee to serve each and every site. If they did, they would be much more costly to build.

5.5 Capacity is insufficient

Network Strategies' model provides 250kbit/s capacity per premise in each year of the model. This is below the throughput that needs to be supported by UCLL today, let alone in 2019.

Network Strategies do not attempt to model the impact of a higher required throughput. The impact of such a change to the unit costs would be very significant: very large numbers of additional "capacity" sites would have to be added.

If the throughput per user were to rise to (say) 1.5Mbit/s, then the required number of base stations would substantially increase, by a factor of approximately 6 (1.5Mbit/s / 250kbit/s in areas where the network dimensioning was capacity driven. Our estimate is that the network may be capacity driven even at 250kbit/s in most of the areas considered by Network Strategies, given the use of a significant number of base stations for additional capacity (reported in exhibit 4.1 in the Network Strategies FWA submission), and the homogeneity of the unit cost results in the modelled areas. If we assume the number of base stations required to meet the 1.5Mbit/s per subscriber is 5 times the previous number, then this results in a unit cost of NZD167/month, a unit cost 4.8 times the unit cost without this traffic increase[62]. In other words, the unit cost will increase very dramatically as the required throughput increases. In this estimate we have also not taken into account the fact that more of the additional sites would need to be new sites rather than the less expensive co-location option used for a fraction of sites in the Network Strategies model.

5.6 Capacity and coverage are not transparently linked as they should be

Network Strategies' do not state the maximum throughput per base station in their radio planning even though they criticise that used by the Commission. The basis of the Network Strategies calculation (e.g. link budget, cell capacity, modulation scheme) is not sufficiently transparent.

The Network Strategies model provides an average of up to approximately 260 premises served per LTE base station. This includes sites that are present for coverage reasons.

The WIK view on potential capacity per LTE site (paragraph 191) is not matched to the number of base stations required to deliver to the desired service boundary using that quantity of spectrum. In other words, it is not safe for WIK to assert that 150Mbit/s cell capacity can be obtained with the current cell coverage using 2*20MHz: the signal to noise ratio needed to deliver such high spectral efficiency and hence throughput cannot be provided over long distances within the type of terrain being considered.

[62] The detailed figures are affected by the fixes to the backhaul issue and opex; we have also set mobile to off and FWA to recover all the costs. However the qualitative conclusion is not affected by these changes: the cost would dramatically increase in line with the number of base stations required to carry the traffic.

5.7 Spectrum costs must be the full opportunity costs.

Network Strategies (FWA report p31) say:

> If 700MHz spectrum was purchased by the HEO at the price achieved at the digital dividend auction then it would only have been under the expectation of a revenue stream commensurate with that of a national mobile operator in order for the business case to assign that particular value to the spectrum. Such revenues would not be achieved by FWA subscribers in RBI areas, hence the HEO will need to offer mobile services as well in order to have a valid business case to support the spectrum fee achieved in the auction.
>
> If the HEO was not to offer mobile services then the valuation of the spectrum must be based only on the revenues that would be achieved by RBI FWA subscribers (that is, the FWA business case). In other words, the HEO would pay less than $22 million for spectrum to be used only within the RBI areas and to deliver only FWA and no other services.

All of these arguments are incorrect. The correct cost to use for the spectrum is the opportunity cost. In this case the user denied the use of the spectrum would be a mobile operator, and we already know the value placed on the spectrum by mobile operators: the price paid at auction.

The revenues from FWA customers are not relevant, because the HEO is under an obligation to serve them. The question is therefore whether this technology is or is not (in combination) the lowest total cost method of providing the required functionality, not whether these users revenues cover these costs.

5.8 Exclusively rural use of spectrum does not merit access to the spectrum at a lower cost

Any attempt to allow extensive use of the spectrum in rural areas but at a lower cost justified by the lower value of spectrum to mobile operators in such areas would be fraught with coordination difficulties. Many of the areas that Network Strategies say are economically served with FWA are adjacent to urban areas; indeed, they point out that many of the base stations located in urban (UFB-served) areas also provide rural coverage. It would be extremely difficult to coordinate the effective rural use of the spectrum in an efficient way without placing strong constraints on either the urban or the rural network.

5.9 Assuming a 13% share of the mobile market is unrealistic

Network Strategies in effect assume that the HEO is 2degrees:

> Mobile subscribers reported by Vodafone and Spark as at June 2013 indicates that both account for around 87% of the total mobile connections − a total of 4.77 million as note by the Commerce Commission. Following a conservative approach, it is assumed that the HEO will capture the remaining 13% of the market. (footnote removed)

This is not a conservative approach. A conservative approach would assume that the HEO has 0% of the mobile market.

Not only is assuming an unachievable day-one scale in a different market is incorrect; it would unnecessarily complicate the already challenging task of the Commission by bringing into scope the rest of the NZ telecoms market; and it would also instantly require a variety of decisions regarding the technology, services, spectrum holdings, WACC etc. of this entirely different hypothetical operator.

5.10 Homogeneity of results is surprising

The model produces 8 unit cost results, one for each of areas A1..D2.

We are surprised that in the allegedly "difficult" geotype D there is not a greater difference from the mean result in terms of the number of base stations required per served premise. Once the network design is coverage limited (the number of premises served is limited by the area that can be reached by the base station, rather than its capacity), we would expect the number of premises per base station to fall sharply. Rural New Zealand does have some extremely sparsely populated areas with high mountains. We would expect some base stations in such areas to serve as few as 1-5 premises, which would materially reduce the average subscribers per base station.

5.11 Use of FWA for buildings outside the TSO polygons

As the TERA model decides on TSO status of buildings at the segment level, and decides about the segments based on whether they are 50% or more inside the TSO polygons, their modelling will include some buildings outside the polygons (the issue identified by Network Strategies) and also fail to include some buildings inside the polygons (not identified by Network Strategies). Whilst we think that this is not the best approach and have offered other comments about the failings of the approach to the TSO premises in our submission, Network Strategies have not offered evidence that the result is biased by including or excluding premises at the section level.

5.12 If on shared sites, FWA antennas would be at a lower height

The radio planning assumes that on shared sites antenna positions at the top of the site can be obtained. This is unrealistic as these positions are considered superior and will therefore most likely already be taken by MNOs.

5.13 The Network Strategies model does not include backhaul for colocation upgrade sites

Due to an error, there is no cost included in the model for backhaul for so-called "colocation upgrade" sites. This error in itself leads to a material underestimate of unit cost of approximately $2/premise/month.

5.14 Use of microwave backhaul may need multiple hops

The TERA modelling uses fibre based backhaul from the RBI FWA sites. The Network Strategies model uses a mix of fibre backhaul and microwave point to point links. Fibre backhaul is a superior solution due to its higher capacity, and we understand fibre backhaul is realistic to assume for the RBI locations as fibre backhaul is often used by Vodafone RBI sites - although we understand that microwave backhaul is also used on occasion.

Even if it were considered appropriate to be used for high capacity sites, microwave backhaul will not always be a single "hop", leading to additional costs which are not included in the Network Strategies model.

5.15 Insufficient opex is included

The Network Solutions model does not include any operating cost for the base station or repeater electronics.

Benchmarks of public mobile network models in UK, France, Sweden, and Spain indicate an average of NZD6711/base station per annum in operating costs in 2015. Adding these costs adds approximately NZD 3/premise per month to the unit cost.

5.16 The Network Strategies model does not include CPE/antenna costs

Network Strategies have modelled only half of the network. RSPs would have to provide substantial additional or entirely replacement equipment at the end user premises including an antenna (which will need a new site visit to install as the modelling has assumed a high wall or roof mounted and directional type) and support structure, coaxial cabling, and customer premise electronics of a type closely coordinated with the capabilities of the network (e.g. compatible frequency, technology/release, transmit power, SIM).

Similarly, at the network side, there is no cost included in the model for core electronics to which RSPs could interface, as there is no serving gateway.

Not including these costs means that the network as modelled is not shown to be efficient in terms of total costs. The incentive is for Network Strategies to model a network that pushes as much cost as possible onto the RSP (e.g. requires new CPE; requires roof mounted directional antenna, support, and cabling with professional installation; requires costly remediation of lack of coverage for a fraction of sites such as remote antennas above or beyond local obstructions or additional repeaters; requires additional core network electronics).

To draw an analogy: if modelling a geosynchronous satellite service, it would not be cost efficient to require each end user to have a 5m diameter dish with automatic tracking even though such terminals would reduce the cost to a wholesale satellite provider who was just providing network ground station and satellite capacity. A commercial provider making an end-to-end retail service offering would consider the total cost of the system and would minimise the total costs (even if so doing involved spending more on the central network elements).

If we assume that all sites require an antenna costing NZD200 and a CPE costing NZD300 (installed) with a lifetime of 10 years and 5 years respectively, then these would contribute an additional NZD1.9 and NZD1.4 per premise per month respectively.

5.17 The statistics used are not shown to be appropriate

We note that the statistical sampling estimates provided by Network Strategies appear to tacitly assume Gaussian distributed results.

In practice, Network Strategies is adopting an approach of sampling large "chunks" of coverage (so there are not 550 areas in the population but perhaps 60 of which they have sampled 8). This means that the 95% confidence limit will be considerably wider than is implied by their analysis (even if the population is Gaussian).

It is unsurprising that with 4 geotype (A,B,C,D) average unit costs, each of which has been estimated from a sample of 2 areas, Network Strategies cannot show statistically significant evidence (at the 5% level) for differences between the geotypes (footnote 41, page 42). However, absence of evidence is not evidence of absence: they have not proved a lack of difference between the geotypes.

Indeed, such differences in unit costs are to be expected a priori: the most rural geotypes are likely to have more of the base stations provided for coverage reasons and hence lower average numbers of subscribers per base station, which will have a direct impact on unit costs.

We are therefore concerned that the 8 areas selected by the radio planning may not be truly representative of the full range of the most difficult and costly combinations of terrain and geo-demographics (mountains, widely spaced properties).

Annex A Statistical estimation of trenching costs based on Chorus recent UFB and RBI trenching experience

A.1 Introduction

The hybrid UCLL and bottom-up UBA models that Analysys Mason built for Chorus needed estimates of trenching costs that could vary in different geographic areas.

In order to undertake such a calculation, we analysed datasets that capture the different geographical and network features found in New Zealand. We identified candidate drivers for different types of trenching costs (including digging/drilling, reinstatement and traffic management) based on the mix of clutter types, underlying rock types and road types present in each exchange service area (ESA).

Our calculations used recent actual trenching costs for Chorus's recent deployments for its ultrafast broadband (UFB) network and as part of the Rural Broadband Initiative (RBI).

In this document, section A.2 describes the datasets we have used and how we have processed them, whilst section A.3 describes the analysis we have undertaken and the results we have found.

A.2 Datasets used

Chorus has provided us with several datasets and identified others in the public domain that we have used, namely:

- a database of clutter type for New Zealand ("Clutter database")
- coverage areas for their ultrafast broadband network ("UFB coverage areas")
- associated cost data for the UFB coverage areas ("UFB cost data")
- coverage areas for cabinet areas in their network ("cabinet areas")
- network routes for projects in their Rural Broadband Initiative ("RBI routes")
- associated costs data for their RBI projects ("RBI cost data")
- road network
- rock types.

These datasets are described in turn below.

A.2.1 Clutter database

Chorus has provided us with a national database of twelve clutter types, ranging from heavily urbanised to rural areas. The database has been supplied on a 25 metre resolution. The full list of clutter types, with their descriptions, is shown in Figure A.1.

Figure A.1: Clutter types [Source: Chorus, 2014] ***[CNZRI: ✂***

Clutter type	Name	Description

✂]

For the purposes of our analysis, we have focused on clutter types 8–12 on an individual basis and grouped the remaining clutter types together as "other" clutter. We believe this is reasonable since:

- a significant proportion of the route network will be contained within clutter types 8–12 due to a greater density of customer premises in these areas
- there is a greater differential in costs within clutter types 8–12 e.g. clutter type 11 **[CNZRI: ✂✂]** which is likely to incur far higher digging costs than clutter type 8 **[CNZRI: ✂✂]** .

As would be expected, the land area of clutter types 8–12 is much smaller than clutter types 0–7. Clutter types 8–12 are mainly centred on the larger urban settlements, such as Auckland, Christchurch and Wellington.

Within these cities, it is clutter type 9 that dominates in area terms.

A.2.2 UFB coverage areas

We have been provided with the coverage area boundaries for approximately 6000 UFB areas. These are particularly clustered around the cities of Auckland and Wellington.

A.2.3 UFB cost data

Chorus has also provided us with the available associated project costs for 1311 UFB projects (where one project represents the deployment of one FFP to its coverage area). For the purposes of our analysis, to ensure that the most accurate data is used, we have only used the FFP cost data available for the third and fourth years in the roll-out and also then only where the number of metres of trench dug/drilled is available (1162 FFP areas in total).

The cost data received allows us, for each project, to split out the costs associated with:

- trenching
- reinstatement for trenching
- drilling/thrusting
- traffic management
- arborists (e.g. where trees need to be protected during deployment)
- laterals.

We also have the number of metres of trenching, split by digging and drilling/thrusting. Using this data, for each project we derive a blended per-metre cost of trenching, and include overheads (assumed to be a mark-up of **[CNZCI: ✂ %✂]**). A cost of **[CNZCI: ✂**NZD**✂]** per metre for other project costs and a design cost of **[CNZCI: ✂NZD✂]** per metre are also included for the UFB projects (based on information received from Chorus).

A.2.4 Cabinet areas

Chorus has provided us with coverage areas for almost 9500 cabinets in its copper network – noting that this dataset is not complete on a national level. Cabinets are identified by a code of the form ABC/XY, where ABC is the 3-letter ESA code and XY is the 1/2-letter code for the cabinet.

This data is useful for the analysis of RBI project data, since some of these projects are to upgrade a cabinet in Chorus's network. By mapping RBI cabinet codes to these datasets, we have identified a cabinet area for 255 RBI projects where we also have the available cost data.

We have also received the coverage areas for all 778 ESAs in Chorus's network.

5.17.1 RBI routes

In addition to cabinet area-based RBI projects, there are projects to provide broadband-capable network to specific buildings (such as schools or hospitals). Chorus has been able to supply RBI fibre routes which are related to such projects, extracted from its NetMap database.

The mapping between the routes extracted from NetMap and the RBI projects is not evident. However, based on our own manual mapping, we believe that we can associate the routes to 443 RBI projects.

A.2.5 RBI cost data

Chorus has provided us with the cost data for 2788 projects. As is the case with UFB cost data, we are unable to use all of the projects and have focused on those projects where the data is of the highest quality and most recent. Furthermore, not all RBI projects currently have complete cost information, which is only provided when the work is complete, all stage payments have been made and the project has been properly documented.

We have only included trenching costs in our calculations and in particular have excluded costs associated with manholes, aerial, cable splicing, cable hauling and costs for connection to the exchange. Overheads have been included assuming a **[CNZCI: ✂ ✂]** mark-up (based on information received from Chorus). The internal project cost of **[CNZCI: ✂ ✂]** has been included in our analysis, by calculating the average project cost per trench metre across all RBI projects that are statistically analysed. This amounts to **[CNZCI: ✂ ✂]** per metre.

A.2.6 Road network

We have taken the street network centrelines available from Land Information New Zealand.[63] We have then specified each road segment as either:

- highway ("H") – those with a highway number
- level 2 roads ("2") – those with multiple lanes or one-way streets
- other roads ("O").

Most roads in this classification are either Level 2 road or other road, with highways generally featuring between urban settlements.

We understand from Chorus that higher traffic management costs are incurred on Level 2 roads and even higher costs on highways.

A.2.7 Rock types

We have used the rock database of New Zealand from the Land Resource Information System (LRIS)[64] to classify the top rock and base rock for the country. We have classified the rock types in this database into four main types: "urban", "soft", "hard" and "lava". New Zealand is predominantly a mixture of hard and soft rock, with some lava found on both islands. The database is not able to distinguish the rock types in heavily urbanised areas.

Rock data is not available for Chatham Island and therefore we are unable to calculate the rock distribution for the Waitangi ESA (WTG).

A.3 Analysis of data

In order to analyse all of this data, we have undertaken several steps as listed below and then described in more detail in this section:

- Section A.3.1 describes how we have calculated key measures for use in our analysis
- Section A.3.2 describes the statistical analysis we have defined and the results we obtained.

A.3.1 Calculation of measures

As shown in Section A.2, the properties that we believe are relevant to our analysis are the clutter type of an area, the road type in an area and the rock type of an area.

In particular, we have estimated these distributions for the road network in areas, given that the properties of the road are more relevant to network routes than the properties of the area as a

63 https://data.linz.govt.nz/layer/329-nz-mainland-road-centrelines-topo-150k/.

64 https://lris.scinfo.org.nz/layer/65-nzlri-rock/.

whole. Therefore, we have calculated the distribution of clutter type, road type and rock type for the road network in:

- all UFB FFP coverage areas available
- all RBI cabinet-based project coverage areas available
- all ESAs.

We have also calculated the distribution of clutter type, road type and rock type for the NetMap routes provided for the RBI projects (since we do not have a coverage area as such for these projects). We calculate the road type for each route by buffering the routes with a 20m buffer (in case the NetMap routes are slightly misaligned with the road network).

We have also derived a blended trenching cost per trenching metre for each project that we include in our analysis (1162 UFB FFPs, 255 RBI cabinet areas and 443 other RBI projects – 1862 in total).

Having calculated the blended unit cost for each project, we then remove projects where less than 50 metres of trench is being dug/drilled on the basis that these could distort the results (e.g. if they are road crossings, they might be very specific high-cost trenching exercises). This leaves 1589 projects.

In the next step, we aggregate the data for these projects to be on an ESA basis. Therefore, we calculated the blended-average distributions for all the projects within each of the ESAs for which data exists.

It was also proposed that the trenching costs in the Auckland/Wellington central business districts (CBD) were unusually high and could introduce distortion to the analysis. The ESAs in the Wellington City and Auckland CBD clusters were therefore excluded from the statistical analysis.[65] For these ESAs, we instead propose to directly use the average per-metre trenching costs derived from the projects we have been able to identify.

This left cost and route metre data for 1483 projects in 376 ESAs.

A.3.2 Statistical analysis

The next step was to define a model function to estimate the trenching cost for an ESA based on the geographic characteristics of the ESA (i.e. mix of clutter types, mix of road types and mix of rock types). We have defined a function for the total unit trenching costs per metre in each of the 376 ESAs as:

$$\text{Estimated unit trenching cost} = \mathbf{A} \times P_{other} + \mathbf{B} \times P_{8\text{-}9} + \mathbf{C} \times P_{10} + \mathbf{D} \times P_{11} + \mathbf{E} \times P_{12} + \mathbf{F} \times Q_{O} + \mathbf{G} \times Q_{2} + \mathbf{H} \times Q_{H} + \mathbf{I} \times R_{Urban} + \mathbf{J} \times R_{Soft} + \mathbf{K} \times R_{Hard} + \mathbf{L} \times R_{Lava}$$

65 We excluded AT, CPC, WN, MAB, RUE, MOD and POY.

where:

- P_X is the proportion of road in the ESA project areas in clutter X
- Q_X is the proportion of road in the ESA project areas of road type X
- R_X is the proportion of road in the ESA project areas of rock type X
- **A** to **L** are constant coefficients.

For the purposes of our analysis, we have assumed that A, F and J must be zero (i.e. their corresponding variables P_{other}, Q_O and R_{Soft} are excluded). We note that this is reasonable since they are all complementary to the remaining variables (e.g. $Q_O = 1 - Q_2 - Q_H$) and therefore will be negatively correlated to them.

We used R[66] to undertake a weighted multiple regression analysis to examine the relationship between clutter, road and rock characteristics of the ESAs and their associated trench cost. We weighted our inputs with the total road metre length in each ESA.

Figure A.2 below summarises the descriptive statistics and results of this analysis. These results indicate that the statistical function using the values for A–L shown below is indicated as being statistically significant for all the nine variables used (since the P-values below are all less than 0.05). All the values derived for A–L are non-negative as well.

Figure A.2: Summary of regression statistics from R [Source: Analysys Mason, 2014 ***[CNZCI: ✂***

✂]

In order to use these outputs of our analysis to derive trenching costs per metre for each ESA, then we would therefore propose the following:

- The 7 ESAs in the CBD excluded from the statistical analysis should use the per-metre trenching costs derived from the available projects

- For the 376 ESAs statistically analysed, the actual per-metre trenching costs from the available projects should be used unless it was calculated with two or fewer projects – 125 ESAs satisfy these criteria.

- The remaining 646 ESAs should use the function with the coefficients derived above, based on the distributions of clutter type, road type and rock type derived for the road in the ESA.

This allows the unit costs of trench per metre derived from the actual UFB/RBI projects to be used in the ESAs where there are sufficient projects to generate reasonable averages (i.e. those with three or more projects). Our fitted function can then be used for the remaining cases.

66 http://www.r-project.org.

Annex B Power and accommodation costs

B.1 Electricity

In the TERA model, the 'Electricity opex cost' of [**TERACI:** ✂NZD ✂**]** is calculated as total 'Network Electricity Expenditure' of [**TERACI:** ✂ NZD ✂**]**divided by total consumption of [**TERACI:** ✂ ✂**]**. We note however that the value calculated in the TERA opex model is slightly different from the value used in the UBA model (**[TERACI:** ✂ ✂**]**).

B.1.1 Unit costs in the TERA model should include the costs of space used by power equipment and related engineering services

In the TERA model, the inputs ('Power Variable Investment' of **[TERACI:** NZD ✂ /kW ✂**]**, 'Cooling Variable Investment' **[TERACI:** NZD ✂ /kW ✂**]** and 'Fixed investments for power at exchange' of **[TERACI:** NZD ✂ ✂**]** per exchange) are direct inputs in the sheet 'Inputs – Forecasts'. Those numbers are calculated in 'CI_ComCom-UBA Inputs v1.0' which calculates value using a regression using data from 'Q 6.15.3 Power' a sample of only 4 sites which is insufficient for this type of analysis, as WIK also point out[67]). TERA should instead calculate total power and cooling investments based on the number of exchanges of each geotype and the MEA investment value provided for each of the 6 building geotypes in S98 response to Q3.14. This is the approach followed in the Chorus model.

In the Chorus model, the cost per kWh includes the cost of electricity and the following areas of expenditure which TERA omits but should include:

- annualised capex and opex costs for the property space used by power equipment
- annualised capex and opex costs for the engineering services dedicated to power equipment including
  - For power in Chorus exchanges, annualised investment in power equipment (**[CNZCI:** ✂NZD✂**]** based on Q3.14) and opex (**[CNZCI:** ✂NZD✂**]** built as the sum of the engineering services part of maintenance opex from Q6.19.3 9 and the share of labour opex for staff looking after 'Property infrastructure (engineering services)' and 'Chorus Network Maintenance (Inside Plant - Power)')
  - For power in Spark's exchanges, **[CNZCI:** ✂NZD✂**]** calculated based on the difference in prices between Chorus renting "passive" (i.e. excluding power and cooling) and "active" (i.e. including power and cooling) floorspace from Spark. The difference represents the annualised cost of the investment and operational costs incurred by Spark to provide power and cooling to the active floorspace it rents to Chorus.

[67] WIK submission, paragraphs 376 and Annex 1

B.1.2 Power consumption in the TERA model is way too low

The TERA public model consumes 19,9 GW-h in total while the data used to calculate the cost per kWh uses a total consumption of [**TERACI:** ✂ kWh✂**]**. By contrast, the Chorus model consumes [**CNZCI:** ✂kWh✂**]** ([**CNZCI:** ✂kWh✂**]** for access and [**CNZCI:** ✂kWh✂**]** for core).

The low consumption of electricity in the TERA model is partly as a result of the following factors:

- There is no allowance for power conversion losses or other power overheads such as lighting, cable losses, etc. TERA should apply an uplift of 10% for each of these factors as in the Chorus UCLL and UBA models (equivalent to a 23%[68] uplift on electricity consumption overall as the factors are multiplicative)
- Cooling is only an investment in the TERA model, it does not consume electricity. This is incorrect as cooling equipment itself requires power. TERA should multiplies the bottom-up electricity consumption by 1.4 to account for the power consumed by the cooling systems (as in the Chorus UCLL and UBA models)
- The TERA model assigns no power cost whatsoever to UCLL services which is incorrect as both metallic line testing and wireless assets such as "country sets" (for UCLFS) require power. TERA should ensure that their modelling accounts for the power consumption of UCLL services.

B.1.3 Fixed investments in the TERA model are erroneously underestimated by the application of a mean to max ratio for power consumption

The mean to max ratio for power consumption is potentially reasonable for power consumption (if justified by evidence of usage consumption patterns in New Zealand) but should not be applied to fixed investments as TERA do in the 'Network costing' sheet of the UBA model for DSLAMs and FDSs. Fixed investments need to be dimensioned based on peak rather than mean consumption.

B.1.4 TERA should improve the labelling in its opex model

Power and Cooling variable investment are reported as using kWh as a dimensioning driver (in sheet 'Assets' of the UBA model) but use kW in reality (in sheet 'Inventory' of the UBA model). TERA should check the consistency of units used in the model to ensure that the correct values are being used.

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68 As noted in the publically available Analysys Mason model user guides "we apply an uplift of 23% (based on 1/(90%*90%)) to account for a 10% reduction in the usable energy supplied due to DC power plant losses and the reduction in usable energy due to other site operational requirements such as lighting, cable losses etc."

B.2 Rents and rates

This section focuses on *network rents and rates* though it also includes data on non-network rents and taxes due to the way the TERA model allocates the costs of rents and taxes.

B.2.1 The allocation of rates to services would be better done by including those costs in property costs

The TERA model allocates rates costs directly to services based on the response to Q6.19.3 (as shown below in Figure B.1). It would be more robust to include the cost of rates in the cost per square meter (for exchange related rates) or in the cost per meter of route (for non-exchange related rates). This is the approach followed in the Chorus model.

*Figure B.1: Allocation of rents and rates to services [Source: TERA, 2014] [**CNZRI / TERACI:** ✂*

[CNZRI: GL codes	[TERACI: Value used by TERA (NZD)	UCLL	UBA	Other
	[69]			
	[70]			
		[71]		
[72]				

✂]

B.2.2 The TERA model substantially underestimates the amount paid for space in Spark exchanges

T2 property charges are significantly underestimated as they ignore the part that is considered as leased. [**CNZRI: ✂ ✂]** charges are used in calculating the cost of building floorspace which is in turn used as part of the bottom up calculations. However, this is only [**CNZCI: ✂**%**✂]** of the total cost to Chorus of the use of Spark exchanges. The [**CNZCI ✂✂]** file used as an input to the Chorus opex model calculates the full cost to be [**CNZCI:** NZD✂**✂]**.The difference is due to the remainder of the costs being captured elsewhere in Chorus' accounts.

B.2.3 The TERA applies an arbitrary efficiency adjustment to the rents paid in non-Spark sites

TERA excludes a number of sites from the GL code[**CNZRI: ✂✂]** (which captures the rents paid for non-Spark sites)]. Some sites are excluded with no stated reason. Other sites are excluded

[69] [**TERACI:** ✂✂]is used in the bottom up calculation of floorspace cost and not directly allocated to services

[70] [**TERACI:** ✂✂]is used in the bottom up calculation of floorspace cost and not directly allocated to services. The remaining cost is allocated on the basis of the usage of each site. Costs associated with sites with a purpose that is deemed out of scope are not allocated

[71] [**TERACI:** ✂ ✂]

[72] [**TERACI:** ✂✂]

as ‘Out of scope: old network’. It is unclear on what basis these sites have been identified as ‘old network’. In addition, TERA already makes a number of adjustments for efficiency and technology elsewhere in its modelling – arbitrarily excluding these sites therefore creates a risk of ‘double counting’ efficiency gains unless justified by proper. The costs excluded as a result of this arbitrary efficiency adjustment amount to [**TERACI:** ✂NZD per annum✂**]**.

B.3 Buildings

We note that the per square metre value calculated in the TERA opex model ([**TERACI:** ✂ NZD/m²/year✂**]**) is significantly higher than value used in the UBA models ([**TERACI:** ✂ ✂**]**/147.95[73] NZD/m²/year).

B.3.1 Unit costs in the TERA model should use the correct building size, include an allowance for spare space and modelling mistakes should be corrected

The building size used in the TERA model is calculated in a complex way. The initial building sizes used by TERA are derived from [**CNZCI:** ✂ ✂**]** which has a total floorspace of [**TERACI:** ✂m^2✂**]**. As TERA only uses a list of 729 exchanges, the total size of the sample is only [**TERACI** ✂ ✂m^2**]**. For exchanges with no size in [**CNZCI:** ✂ ✂**]**, the typical MEA size from Q3.1.2 is used

The conclusion is that TERA is taking the MEA valuation from the analysis carried out at the time of structural separation (i.e. optimised costs) and dividing them by the historical building size (i.e. non-optimised floor space) to calculate the unit cost. This means that the calculation is not consistent: TERA should instead use an MEA building size based on the number of exchanges of each geotype and the MEA building size value provided for each of the 6 building geotypes in S98 response to Q3.1.2. This is the approach followed in the Chorus model.

TERA does not use an utilisation factor for accommodation. This omission should be rectified since all operators require additional space for instance in order to perform essential maintenance or changeover equipment without service interruption. This is the approach followed in the Chorus model with a [**CNZRI** ✂✂] utilisation factor.

The TERA model includes several modelling mistakes in the calculation of the ‘average building cost’, one of the three components of the total cost per square meter.

- First, for the [**TERACI:** ✂✂**]** Chorus sites ‘with a land valuation’ (whose cost include depreciation of property fit outs[74], buildings[75] and land[76]), there is mistake in the

[73] Public model

[74] Using the same values as the Chorus model (i.e. the MEA values) with a 10 year lifetime, a 0% price trend and an adjustment to pretax annuity

[75] Using the same values as the Chorus model (i.e. the MEA values) with a 33 year lifetime, a 0% price trend and an adjustment to pretax annuity

calculation as the floorspace denominator includes all Chorus sites rather than only Chorus sites ‘with a land valuation’.

- Second, for the [**TERACI:** ✂✂] Chorus sites ‘without a land valuation’ (whose cost include depreciation of property fit outs, buildings and either assumes the same per land valuation per m^2 as the other Chorus sites or include the cost of rents), there is the same mistake in the calculation as the floorspace denominator includes all Chorus sites rather than only Chorus sites ‘without a land valuation’.
- Third, for the [**TERACI:** ✂ ✂] Spark sites, the TERA model cost is the [**TERACI:** NZD✂ ✂] of Spark payment expenses (and therefore not the total [**CNZCI:** NZD✂ ✂] true cost discussed above) and is divided by a size so large ([**TERACI:** NZD✂m^2 ✂]) that it must be the total size of the Spark sites rather than the amount used by Chorus (calculated in the Chorus model as [**CNZCI:** NZD✂m^2 ✂])

B.4 Space consumption in the TERA model is significantly too low

The TERA model consumes **[TERACI:** ✂ ✂**]**m^2 of floorspace in total (**[TERACI:** ✂ ✂**]**m^2 for DSLAM services and **[TERACI:** ✂✂**]**m^2 for non-DSLAM services) while the data used to calculate the cost per m^2 is the total consumption of **[TERACI:** ✂ m^2✂**]**. By contrast, the Chorus model consumes [**CNZCI:** ✂m^2✂] ([**CNZCI:** ✂ ✂]) while the data used to calculate the cost per m^2 is that the total consumption is [**CNZCI:** ✂m^2 ✂].

So the TERA model provides too little space, at a unit cost that is substantially too low.

The difference in space consumption between the TERA model and the Chorus model is partly explained by the following factors:

- The TERA model does not include any space occupied by power equipment while the Chorus model calculates that [**CNZCI:** ✂m^2 ✂] is required
- The TERA model dimensions less space for MDFs, ODFs and exchange based electronics.
- The TERA model does not use a mark-up for common floorspace (like the 10% used in the Chorus UCLL model)
- The TERA model has a rack surface of [**TERACI:** ✂m^2 ✂] per rack while the Chorus UBA model has a rack surface of 3.85m^2 per rack (including common space) based on Chorus’ real world experience

76 Using the same values as the Chorus model (i.e. the MEA values) with a 1000 year lifetime, a 0% price trend and an adjustment to pretax annuity