TSLRIC price review determination for the Unbundled Copper Local Loop and Unbundled Bitstream Access services

Model Reference Paper

Commerce Commission

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Summary

0 Introduction

This section provides background information on the project and describes the structure of the document.

0.1 Background

Unbundled Copper Local Loop (UCLL) and Unbundled Bitstream Access (UBA) are services that allow alternative operators' access to the local loop infrastructure of Chorus.

The Telecommunications Act 2001 (the Act) requires the Commerce Commission (the Commission) to determine a price for the UCLL and UBA services. In the first instance the Commission is required to benchmark prices against comparable countries under the 'initial pricing principle' (IPP). If an access seeker or Chorus Limited is not satisfied with the price (either the UCLL or UBA) determined under the IPP, the Act provides that the party can ask the Commission to calculate a price for that service in accordance with the 'final pricing principle' (FPP), which is Total Service Long Run Incremental Cost (TSLRIC) for UCLL and UBA.

The Commission reviewed the benchmarked UCLL price on 3 December 2012 and determined the UBA benchmarked price on 5 November 2013. However, the Commission has received FPP requests both for UCLL and UBA: the UCLL FPP request was received in February 2013, the UBA FPP request was received in December 2013. Therefore, the Commission needs to determine a price for the UCLL and UBA services in accordance with the FPP.

TERA Consultants (TERA) has been mandated by the Commission to calculate a price for the UCLL and UBA services in accordance with the FPP which is TSLRIC.

A consultation paper on conceptual issues of UCLL cost modelling was issued by the Commission in December 2013. A further consultation paper focusing on UBA[1] was also issued in early February 2014. Responses from interested parties were received in February 2014.

The Commission issued a paper which set out its preliminary views on its proposed regulatory framework for the UCLL and UBA TSLRIC cost modelling exercises and its preliminary views on a number of fundamental assumptions for the development of a TSLRIC cost model for the UCLL and UBA services[2]. Having reviewed the Commission

[1] Commerce Commission, Determining a TSLRIC price for Chorus' unbundled bitstream access service under the final pricing principle, (7 February 2014)

[2] Commerce Commission, Consultation paper outlining our proposed view on regulatory framework and modelling approach for UBA and UCLL services, (9 July 2014)

paper, TERA has provided its views on some key methodological choices related to the calculation of TSLRIC in the document "Modern Equivalent Assets and relevant scenarios".

The Commission sought the view of interested parties on all topics and has reviewed the submissions and the cross-submissions sent by all the interested parties.

Based on these consultations, and on the papers previously published, the Commission has made a number of decisions regarding the modelling and the pricing of the different regulated services. These decisions define the criteria for developing the access network cost model, the core network cost model (see §1.1 for the scope of each model) and the OPEX model, which are used to set UCLL and UBA prices. This document is therefore describing the criteria that have been followed.

A draft version of this document was published in December 2014. The Commission sought the view of interested parties on several documents and models including the present document and has reviewed the submissions and the cross-submissions sent by all the interested parties. This draft version has been updated to produce the current version.

The modelling approach is described in the model specification document which refers to this document in order to describe how the different criteria have impacted the modelling. The details of the model are provided in the model documentation.

0.2 Structure of this document

This document details the criteria followed when building the cost models. This Model Reference Paper has the following structure:

- **Section 1** – General considerations on the modelling (see §1): it details general criteria that are common to the access network and to the core network cost models;
- **Section 2** – Access network to be modelled for UCLL (see §2): it details the criteria to be followed for the modelling of the access network cost model;
- **Section 3** – Core network to be modelled for UBA (see §3): it details the criteria to be followed for the modelling of the core network cost model;
- **Section 4** – Types of costs and cost allocation (see §4): it defines the types of costs that should be included in the cost models and how they should be allocated;
- **Section 5** – Regulatory period (see §5): it defines the regulatory period; and
- **Section 6** – Checking the model (see §6): it details the different steps that should be followed to ensure the best overall quality.

1 General considerations on the modelling

1.1 Access and core network cost models

The core network consists mainly of active assets, whereas the access network consists essentially of passive assets.

The costs of the core network are generally variable with the number of active lines or the traffic whereas the costs of the access network are variable with the number of lines.

The costs of the core and access networks, as traditionally defined, would give the costs of the traffic and the line-sensitive parts of the network respectively. As a consequence, core and access networks are modelled separately.

Criterion 1: Access and core networks should be modelled separately.

The access network cost model should therefore include the modelling of the local loop and the different physical links that are part of the core network such as the sub-loop backhaul and the links between the different exchanges. These are included in the access network cost model as they share the same infrastructure. There are thus some economies of scope that should be captured.

Criterion 2: The scope of the access model is the local loop, from the External Termination Point (ETP) (excluded) to the Main Distribution Frame (MDF). The physical links that are part of the core network are modelled in the access network and should feed the core network cost model.

1.2 TSLRIC

TSLRIC is a forward-looking cost-based methodology that is required by the Act to be used by the Commission when conducting pricing review determinations.

Criterion 3: The TSLRIC methodology should be used to price the different regulated services.

1.3 Replacement costs

As network cost models are forward-looking, current costs will be the appropriate cost basis. One way to estimate current costs is to calculate the replacement cost of each asset. The replacement cost can be higher or lower than the historic cost.

General purpose properties such as office buildings are typically valued on an open market valuation basis (either for existing or alternative use).

Criterion 4: Replacement costs in the model should correspond to the costs of buying new equipment in the base year.

For properties in general, the building costs should be valued in accordance with the market price and the public valuation in each geographical area

1.4 International parts

The international parts of the access network and of the core network should be disregarded as they are not included in the scope of the services that are priced.

Criterion 5: International part should be disregarded.

1.5 Red zones in Christchurch area

The Canterbury Earthquake Recovery Authority (CERA) has confirmed that there is no demand for telecommunications services within the Residential Red Zone Area within the regulatory period. Further, they note the extent of the Residential Red Zone Area may change with time.

There are about 8,000 properties within the Residential Red Zone that are either vacant or will shortly be vacated (based on data from Corelogic NZ Limited). Once these properties have been vacated, any remaining buildings will be demolished.

The land is unlikely to have significant building undertaken within the regulatory period. Consequently, the UCLL and UBA demand within the Residential Red Zone Area is deemed to be zero for the purposes of our modelling.

Criterion 6: The red zones in the Christchurch area should be disregarded.

2 Access network to be modelled for UCLL

2.1 MEA definition

The Commission has consulted the industry on the definition of the Modern Equivalent Asset (MEA) of the UCLL.

The definition of the MEA that has been provided by the Commission is to provide the UCLL service in the most cost-efficient way across the lifetime of the service[3]. This is subject to considerations on the ability to unbundle from the Commission which are given weight.

Criterion 7: The MEA of the UCLL is the cost-efficient way of providing the UCLL service.

The MEA of the UCLL should be based on the most modern technology, i.e. a fibre access network. However, as it would not be cost-efficient to roll-out a wired network in the whole country, the MEA of the UCLL should also be based on a fixed wireless access (FWA) network. This is subject to speed considerations which are given weight. In areas which cannot currently get broadband because the copper lines are too long, FWA enables the provisioning of broadband to unserved customers and reduce the cost of the network compared to a wired network.

Criterion 8: The MEA of the UCLL is based on a mix between a point-to-point fibre network and a FWA network.

The UCLL service is a copper based service. The cost of the MEA should thus be adjusted. As described during the consultation on the MEA, there are three possible adjustments:

1. Speed based adjustment

This adjustment reflects the speed difference between a MEA network and a copper network.

2. Customer willingness based adjustment

This adjustment reflects the customer willingness to pay an extra fee in order to have a fibre connection instead of a copper connection.

3. Cost-based adjustment:

[3] The following factors have been considered when selecting the MEA: Technological performance; Cost; Operator strategy; and Subscriber and retail price.

This adjustment reflects the difference between the cost of the MEA network and the cost of a copper network.

Having consulted the industry, the Commission has retained a cost-based adjustment.

Criterion 9: The cost of the MEA should be adjusted to reflect the cost difference between the MEA network and the copper network.

As a consequence, if the fibre + FWA network is the cheapest network, then the price of UCLL is based on the cost of the fibre + FWA network. If the copper network is the cheapest network, then the cost of the MEA network should be adjusted by the cost difference between the fibre + FWA network and the copper network. The price of the UCLL would therefore be based on the cost of the copper network.

2.2 Network to be modelled

In order to implement this cost-based adjustment, the Commission has identified two scenarios:

- A nationwide copper network; and
- A nationwide coverage achieved by a mix between a fibre network and a FWA network.

The adjusted cost of the MEA network is therefore the cost-efficient network (cheapest) selected between the two roll-out scenarios. The selection should be made at the national level and not per exchange.

Criterion 10: In order to compute the cost-adjustment, a copper access network and a fibre + FWA network should be modelled. The adjusted cost of the MEA network is the cheapest network selected at the national level between the two scenarios identified.

2.2.1 Scope of the access network

The access network should start at the external termination point (ETP) and stop at the distribution frame. The ETP is however not part of the access network as its cost is recovered through a different service.

Criterion 11: The access network starts at the ETP and stops at the distribution frame.

2.2.2 Copper access network

The first roll-out scenario to be modelled is a copper access network. It should be a nationwide network with the restrictions as described in §1.

Assets within the copper access network include:

- The lead-in cable (cable from the copper cable termination to the ETP), the ETP being excluded;
- The distribution cable, including joints;
- The feeder cable, including joints when the line is not cabinetised;
- The trenching including ducts, manholes and poles; and
- The Main Distribution Frame (MDF).

2.2.3 Fibre access network and FWA

The second roll-out scenario should be a mix of a fibre access network and a FWA network. This mix should provide nationwide coverage with the restrictions as described in §1.

2.2.3.1 Fibre access network

Like the copper access network which is a point-to-point (PTP) network, the fibre access network should be a fibre to the home (FTTH) PTP fibre network.

Criterion 12: The fibre network should be a PTP network.

The fibre access network coverage should be complementary to the FWA network, meaning that there is no duplication between the fibre access network and the FWA network in the sense of any end-user being served by both.

The fibre access network should provide a direct connection between the exchange and the customers. As a consequence, unlike the MDF as described in §2.6.1.6, the copper active or passive cabinets should not be used as a constraint for connecting the end-users to the exchanges.

2.2.3.2 FWA network

The general approach to model FWA is that it should only be deployed at the edge of the network where FTTH deployment is very expensive, not economically viable, and where existing copper lines are too long to provide broadband.

The position of the FWA sites can pragmatically be based on the RBI FWA sites as a starting point. It would be reasonable to assume that the best available sites that provide the best possible coverage of low-density area of New Zealand have been used for the RBI.

Criterion 13: RBI sites should be considered as a relevant proxy to assess the cost of FWA.

The FWA sites will be connected to the rest of the network via fibre from the nearest exchange.

Where this fibre cable passes premises on its way to the FWA site, these premises will be assumed to be connected to the FTTH-network and modelled accordingly.

This approach will reduce the number of premises covered by FWA.

Criterion 14: The FWA sites should be connected to the nearest exchange. Customers located on the way from the FWA sites to the exchanges should be connected by the FTTH-network.

The technology used by the FWA network should be based on the most advanced technology as it would offer a higher throughput to end-users and a better coverage for a lower cost. The FWA technology should therefore be based on Long Term Evolution (LTE).

Criterion 15: The FWA should use the LTE technology.

The modelling of the coverage of the FWA network is based on the copper network: premises further than a given distance to the copper active node (active cabinet or MDF) are to be covered with FWA.

As such coverage can be independent from the coverage of Vodafone RBI sites, it is assumed that, provided equivalent coverage and throughputs, the FWA network corresponding to actual coverage has the same cost as the FWA network based on Vodafone's RBI sites.

Criterion 16: The FWA coverage should be inferred from the distance to active nodes in the copper network.

2.3 Non-TSO areas

The areas outside the TSO (Telecommunications Service Obligations) footprint are a proxy for areas where the deployment of a network would be inefficient to invest in without a capital contribution. The TSO-footprint is the TSO-area determined in the TSLRIC model used for TSO. As deploying a network outside the TSO-area is considered uneconomic, Chorus would not have extended its network outside the TSO-area unless it received capital contributions when doing so.

For a hypothetical efficient operator, it is assumed that the boundary between economical and uneconomical network deployment is also the TSO-area.

It is therefore reasonable to assume that a hypothetical efficient operator would only deploy a network where economic, unless required to do otherwise.

Accordingly, it is recommended to restrict the coverage of the access network to the TSO-area which represents 93.64% of the total number of dwellings in New Zealand.

Criterion 17: The capital cost of the access network should be computed over the TSO-areas, including the cost of connections outside the TSO-area for the part of those connections that is within the TSO-area. It is assumed that the capital contributions cover exactly the cost of the non-TSO areas. The operating costs of the access network should however be computed over a nationwide network.

2.4 Mapping the local loop to services

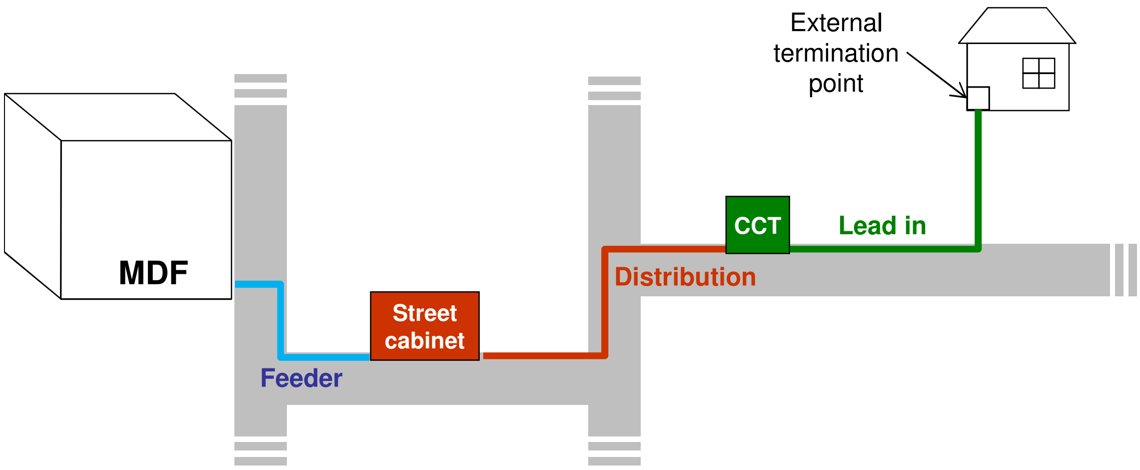
Different services use the local loop either entirely or only part of it.

When the line is not cabinetised, the local loop is made of three parts:

- the lead-in;
- the distribution; and
- the feeder.

The sub-loop is made of the lead-in and the distribution.

Figure 1 - Architecture of the local access copper network



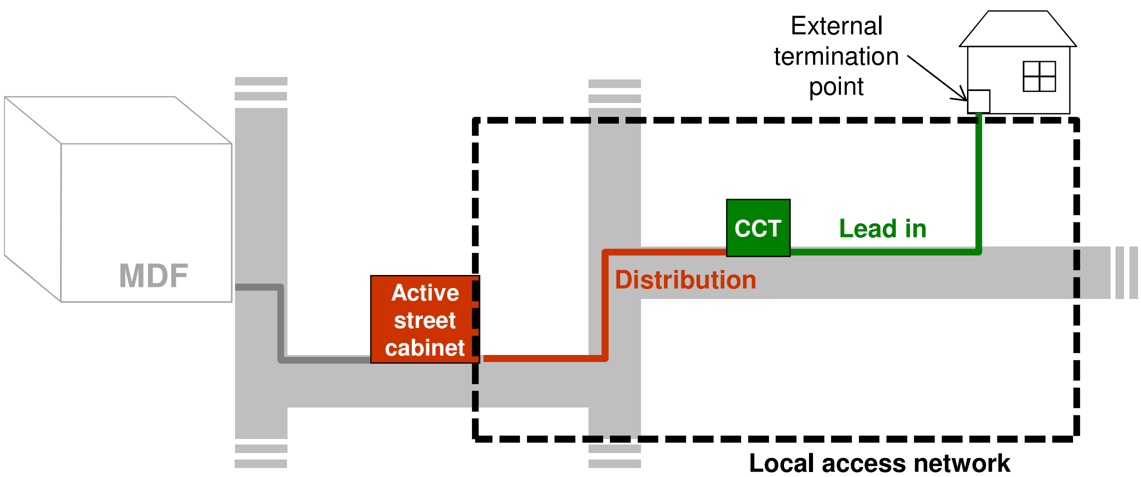
Source: TERA Consultants

When the line is cabinetised, the local loop is made of two parts:

- the lead-in; and
- the distribution.

The "feeder" in this case, i.e. the link between the active cabinet and the exchange, is the assets which would be used to provide the sub-loop backhaul (SLUBH) service if purchased by an access seeker. For convenience therefore the term "sub-loop backhaul" and contraction "(SLUBH)" are used to refer to the feeder assets.

Figure 2 - Architecture of the local access network when the street cabinet is active



Source: TERA Consultants

There are however some relationships between the different services.

The relationship between the unbundling of the local loop (ULL), the sub-loop unbundling (SLU) and the unbundling of the copper local loop (UCLL) is given by the following formula:

$$ULL = SLU * \frac{\#\, active\ lines\ at\ the\ cabinet}{Total\ \#\, active\ lines} + UCLL * \frac{\#\, active\ lines\ at\ the\ exchange}{Total\ \#\, active\ line}$$

The relationship between UCLL, SLU and the sub-loop backhaul (SLUBH) prices is given by the following formula:

$$UCLL = SLU + SLUBH$$

The model should derive the cost of the ULL and the cost of the SLUBH and deduce the cost of the SLU and the cost of the UCLL by verifying the two previous equations simultaneously.

Criterion 18: The access network cost model should derive the cost of the UCLL and SLU based on the cost of the ULL and the cost of the SLUBH.

2.5 Demand

When assessing the demand that should be taken into account in the access network cost model, the key questions that need to be considered are:

- Should the Chorus Ultra-Fast Broadband (UFB) demand be included in the demand assumptions for UCLL?
- Should the Hybrid fibre-coaxial (HFC) demand be included in the demand assumptions for UCLL?
- Should the Local Fibre Company (LFC) demand be included in the assumptions for UCLL?
- Should a constant demand or a projected demand be used for UCLL?

These questions are addressed hereafter:

2.5.1 Should the Chorus UFB demand be included in the demand assumptions for UCLL?

The demand assumption should include both the current Chorus UFB demand and the demand for the service it is replacing (UCLL) because copper customers are expected to migrate to the MEA network given the fact that capabilities of FTTH are greater.

In summary, Chorus UFB is replacing copper (while HFC is not replacing copper but is competing against copper) and therefore, the aggregated demand of the two should be considered for UCLL.

Criterion 19: The Chorus UFB demand should be included in the UCLL demand.

2.5.2 Should the HFC and LFC demand be included in the assumptions for UCLL?

Not including demand from HFC and LFC would increase unit costs in this area and would encourage inefficient entry. A hypothetic efficient operator would be able to attract demand from competing networks.

Accordingly, it is recommended to include HFC and LFC demand in the TSLRIC model for UCLL.

Criterion 20: The HFC and LFC demand should be included in the UCLL demand

2.5.3 Should a constant demand or a projected demand be used for UCLL?

The starting point for estimating the demand for the regulatory period is the actual demand, i.e. Chorus' current copper demand (broadband, leased lines, telephony) and the demand already migrated to FTTH-network, i.e. the demand on the HFC and LFC networks and demand on Chorus' FTTH-network as explained in §2.5.1.

The reason to project demand is that a constant demand assumption would slightly underestimate the number of fixed lines, as the number of dwellings will increase over time. The forecasts should be based on the number of buildings and population. However, it is expected that this would be a relatively small increase.

The UCLL demand assumption in the model, i.e. 100% demand, is a sufficient efficiency benchmark:

- The existence of several parallel infrastructures in the local loop lowers economies of scale and is not necessarily efficient because of the existence of significant fixed costs. As a consequence, migration to the new platform should be as fast as possible, which means that the 100% demand assumption sends the right economic signal in terms of efficiency;
- Including forecasts is likely to have a relatively minor effect.

Accordingly, it is recommended to use constant demand for UCLL.

Criterion 21: The UCLL demand should be constant

2.6 Optimisation in the TSLRIC model

2.6.1 Optimisation of the nodes of the network

There are generally speaking four degrees of optimisation:

- no optimisation;
- scorched node;
- modified scorched node; and
- scorched earth.

These four degrees of optimisation are presented hereafter.

2.6.1.1 No optimisation

This is the approach where the number, location, topology and function of exchanges and cabinets in Chorus' actual network are retained in the analysis. This approach means that potentially inefficient network designs will be reflected in the model, thus compensating the access provider for investments a hypothetical efficient operator will not make. However, these inefficient designs are often the result of restrictions faced when the network was deployed and reflects the fact that the actual network was deployed and expanded over time. Generally, it is often difficult to argue that the access provider did not deploy an efficient network – all things considered.

In a TSLRIC context however, some degree of optimisation is almost always applied by regulators around the world and no optimisation is therefore not common practice.

2.6.1.2 Scorched node optimisation

In this approach, the number, locations and functions of the network nodes are left as they are, but where the access network is optimised with respect to the efficient routing and dimensioning of the local access network between the nodes and end-users' premises. This method provides a trade-off between efficient and 'real world'/historic investment considerations.

Scorched node optimisation is widely used by regulators.

2.6.1.3 Modified scorched node optimisation

This optimisation is a variant of the scorched node approach.

Under this approach, there is a greater degree of flexibility in the level of network scorching that occurs. The materiality of the difference between scorched node optimisation and modified scorched node optimisation depends on the degree of modifications the regulator applies to the scorched node optimisation, but it tends to be relatively immaterial.

This means modelling an "optimally structured network" which is constrained by the existing number of nodes (exchanges and cabinets) and their existing locations and follows the road network. The boundaries of the exchange can be optimised.

2.6.1.4 Scorched earth optimisation

This is the approach where the network is fully optimised. This approach allows complete redesign of the network, without considering any past investment and existing node locations/numbers. It removes all of the inefficiencies that may have arisen due to the historical development of the network. However, this approach may not reflect a number of 'real world' issues such as the sunk, irreversible nature of some of the investments that the regulated operator has made, such as the number and the location of local exchanges. It may also result in a level of efficiency that Chorus would not be able to achieve, as a number of "real world" issues will in reality constrain the network deployment. Furthermore, it requires the entire network deployment to be re-designed, which can be very complicated and require a great deal of assumptions to be applied and design rules to be developed.

Scorched earth optimisation is generally not used by regulatory authorities in a TSLRIC context.

2.6.1.5 Optimisation for the copper network modelling

The Commission has advised us that the scorched earth approach should in principle be the starting point for the network optimisation, as this is consistent with the Commission's regulatory framework. However the Commission has also acknowledged that scorching the location of MDFs would amount to shifting the boundary between the access and the core networks, which is unlikely to materially affect the total network costs. Also, identifying a right location for a MDF (which street?) and the right size of the MDF (MDF sizes vary a lot from an area to another) is not something that can be modelled since it requires having knowledge of local constraints in each city/village. Trying to model it would generate a high risk of creating a unrealistic network (this is why scorched earth is rarely used by NRAs). Given the constraints of the scorched earth approach, we recommend an optimally structured network taking only the locations of Chorus' exchanges and cabinets as fixed while optimising all other aspects of the network.

Exchange boundaries defined by Chorus should be optimized according to the direct paths from premises to exchanges, i.e. premises will be connected to their closest exchange.

Criterion 22: An optimally structured network based on Chorus' copper network with optimised exchange boundaries should be modelled.

Other minor modifications will apply in the following situations:

- When the different coverage areas provided by the operators are not rigorously contiguous and they create holes in the coverage of the country;

- When needed to ensure the connectivity of the whole road network;
- When needed to ensure the connectivity of the road network within each coverage area;
- When a cabinet is located in the coverage area of a different exchange than the one it is linked to;
- When an exchange is located outside of its coverage area;
- When several exchanges are located in the same coverage area;
- When there is no exchange in some coverage areas; and
- When a coverage area is split in several non-adjacent parts.

2.6.1.6 Modelling of the fibre network

The actual fibre networks deployed are not providing a nationwide coverage.

Furthermore there is no technical argument from a network point of view against using the current copper nodes and their coverage area as the nodes and their coverage area for a nationwide fibre roll-out.

Consequently, it is recommended to use the MDF nodes of the current copper network as the location of the Optical Distribute Frames (ODF) of the fibre network.

ODF boundaries should be optimized according to the direct paths from premises to exchanges, i.e. premises should be connected to their closest exchange.

Criterion 23: The MDF nodes of the current copper network should be used as the location of the ODF nodes. Exchange boundaries should be optimized.

2.6.2 Optimisation of the network

Having defined the nodes of the network to be modelled, the network itself should be optimised.

There are generally speaking three degrees of network optimisation:

- no optimisation;
- a cost-based optimisation; and
- a cable-length-based optimisation.

These three degrees of optimisation and presented hereafter:

2.6.2.1 No optimisation

This is the approach where the inventory of the network modelled is Chorus' actual inventory. Similarly as in §2.6.1.1, this approach means that potentially inefficient network designs will be reflected in the model, thus compensating the access provider for investments a hypothetical efficient operator will not make. However, these inefficient designs are often the result of restrictions faced when the network was deployed and reflect the fact that the actual network was deployed and expanded over time. Generally, it is often difficult to argue that the access provider did not deploy an efficient network – all things considered.

In a TSLRIC context however, some degree of optimisation is almost always applied by regulators around the world and no optimisation is therefore not common practice.

2.6.2.2 Cost-based optimisation

This is the approach where the cost of the network is optimised. This approach means the cost of the network is computed for each possible set of engineering rules identified. The set of engineering rules that gives the lowest cost is the one that is kept. This approach is in line with the MEA definition. However, it has several drawbacks:

- this approach would lead to a level of efficiency not achievable by even the most efficient operator, especially as it may not be able to take into account quality constraints;
- this approach is not in line with how an actual operator is rolling out a network; and
- finally, a practical consideration is that it is not possible to model all possible network configurations.

Cost-based optimisation is generally not used by regulatory authorities in a TSLRIC context.

2.6.2.3 Length-based optimisation

This is the approach where the length of the cables is optimised. This approach means that for each line, the length is following the shortest path between the customers' premises and the nodes of the network.

This approach has many advantages:

- it approach ensures the best quality of service possible to the customers as the length of the lines has been minimised, all other things being equal;
- it also approach optimises, to a certain degree, the costs as the cost of the network is driven by the length of cables and trenches;
- it approach is in line with how an operator is traditionally planning its network.

Length-based optimisation is widely used by regulators.

Cable length-based optimisation was tested in New Zealand against infrastructure (pole/trench) length-based optimisation and proved to be more efficient from a cost point of view.

2.6.2.4 *Optimisation of the copper network modelling*

A length-based optimisation is recommended for the modelled copper network.

Criterion 24: For the copper network, the cable length-based optimisation approach should be followed for the modelling of the copper network.

The optimisation of the length of each line should be done in two steps:

- Optimisation of the length of the line between:
  - The customers' premises and the active cabinet for lines connected to an active cabinet;
  - The customers' premises and the passive cabinet for lines connected to a passive cabinet; and
  - The customers' premises and the exchange for lines connected directly to an exchange.
- Optimisation of the length of the line between the cabinet (active or passive) and the exchange

2.6.2.5 *Optimisation of the fibre network modelling*

For the same reasons, a length-based optimisation is also recommended for the modelled fibre network.

Criterion 25: For the fibre network, the length-based optimisation approach should be followed for the modelling of the fibre network.

The optimisation of the length of each line is done by directly optimising the path from the customers' premises to the exchange, i.e. without considering the copper cabinets.

2.7 Access modelling approach

2.7.1 Demand assessment

The access increments include all services that use the access network. The relevant measure of demand for these services, defined as end user demand (internal and external), is the current level of demand, as explained in §2.5.

Criterion 26: The starting point when building the bottom-up model is the level of demand in New Zealand for all the services.

2.7.2 Network design

Engineering principles will inform the dimensioning process for direct network cost categories. These engineering rules should be provided by Chorus as a starting point e.g. the number of pairs per dwelling is derived from the engineering rules provided by Chorus.

When no engineering rule is available (e.g. the MEA is a point-to-point fibre network with FWA), data provided by industry best practices should be used (data from either alternative operators in New Zealand or data from other countries).

Other cost categories will be required to provide functionality to direct network cost categories. These are referred to as indirect network cost categories.

Criterion 27: The engineering rules as provided by Chorus are the starting point of the modelling, except if very different from standard practice elsewhere.

2.7.3 Network costing

In the access network cost model, both unit costs of equipment and the operating and indirect costs associated with the different types of equipment are included. Using this information, the total investment costs for the network can be estimated. However, the model also needs to calculate annual costs, so the investment costs will need to be annualised to generate an annual figure for the capital expenditure involved with using each asset.

Operating costs and corporate overheads should be calculated in accordance with §4.3 and §1.

Criterion 28: The access network cost model should derive a total investment and an annualised cost.

Criterion 29: Operating costs, corporate overheads and indirect costs should be included when relevant.

2.7.4 Services costing

The final step in the process will be to calculate the costs for various products under scrutiny. Based on the hypothetical network that has been built, the model needs to calculate the costs attributable to each of the various services.

This means that all of the different cost categories (direct network costs, indirect network costs, operating costs and overheads) will be aggregated when calculating the costs of the products.

3 Core network to be modelled for UBA

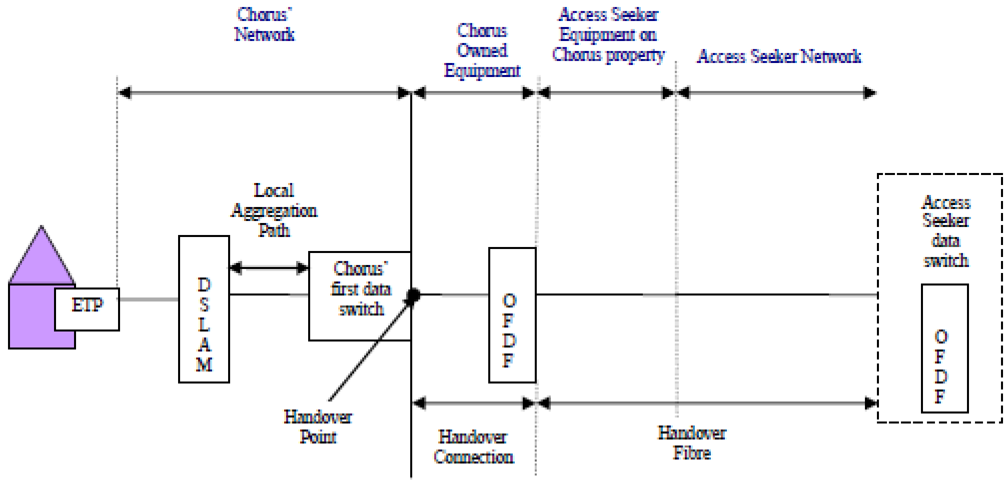
3.1 Scope of core model

The aim of the core network cost model is to derive a price for the different variants of the UBA service.

The UBA service is defined as follows by the STD[4]:

"The UBA service is a DSL enabled service (and its associated functions, including the associated functions of Chorus' operational support systems) that enables access to, and interconnection with, that part of Chorus fixed PDN that connects the End User's building (or, where relevant, the building distribution frames) to Chorus first data switch (or equivalent facility) other than a DSLAM."

Figure 3: Different types of costs in an operator's costs



Source: STD for Chorus' unbundled bitstream access service

3.1.1 Assets to be modelled

The UBA service is therefore a combination of:

- Chorus' copper local loop which connects the end user to an exchange or an active cabinet (to a point where a DSLAM is located); and
- Chorus' core network restricted to the part located between the DSLAM and the first data switch, the handover point being excluded from the UBA service as this part of the handover connection, which is paid separately. It is noted that handover points were designated when UBA was first regulated and that these

[4] Commerce Commission, Standard Terms Determination For Chorus' Unbundled Bitstream Access Service, 30 November 2011

corresponded to the switches in the network at a point in time (2007). Since 2007, subsequent switches have been deployed and have become new first data switches, but the UBA handover points have remained the same. However, given the fact that the TSLRIC model reflects a new network built bottom-up, such legacy specificities are not considered.

The access network cost model contains the dimensioning of all passive links as explained in §1.1. The core network cost model should therefore contain the dimensioning of all active assets. The assets to be included in the core network cost model are:

- DSLAM;
- Switches; and
- Site assets, including power equipment, air-conditioning equipment and other assets such as security, furniture etc.

Criterion 30: The core network should start at the DSLAM (located either at the exchange or in the active cabinet) and stop at the first data switch (FDS).

3.1.2 Economies of scope

As the aim of the core network is to derive a price for UBA variants, the modelling of Chorus' core network beyond the first data switch is not required. However:

- The handover points should be included in the modelling. The handover points are the point of interconnection with access seekers. As ports on the first data switch are dedicated for this type of interconnection, these ports plus a share of the cost of the first data switch should be allocated to interconnection; and
- The inter-exchange links not included in the local aggregation path (e.g. inter-FDS links) should be modelled to capture the economies of scope as they share the same trench as the access network.

Criterion 31: The handover points and the inter-exchange links should be modelled.

3.1.3 RBI program

Chorus has received some subsidies as part of the RBI program in order to roll-out DSLAM in rural areas. A hypothetical efficient operator building a network in these rural areas, and so building these DSLAMs, would also receive a government subsidy that would cover the cost of the RBI DSLAMs. Otherwise, it would not deploy any network.

The cost of the DSLAMs included in the RBI program should therefore not be recovered through UBA.

Criterion 32: The cost of the DSLAM included in the RBI program should not be recovered by Chorus through UBA.

3.2 MEA definition

The Commission has consulted the industry on the definition of the MEA for UBA. The definition of the MEA for the UBA that has been retained by Commission is a service provided over the copper/FTTN access network architecture with a Next Generation Network (NGN) Ethernet core network to support broadband.

Criterion 33: The MEA for UBA is the copper/FTTN access network architecture with an NGN Ethernet core network to support broadband.

3.3 Demand

When assessing the demand that should be taken into account in the core network cost model, the key questions that need to be considered are:

- Should the LFC demand be included in the demand assumptions for UBA?
- Should the RBI FWA demand be included in the demand assumptions for UBA?
- Should the HFC demand be included in the demand assumptions for UBA?
- Should unbundled lines be included in the demand assumption for UBA?
- Should a constant demand or a projected demand be used for UBA?

These questions are addressed hereafter:

3.3.1 Should the LFC demand be included in the demand assumptions for UBA?

LFC demand is not usually considered in UBA modelling. This is because the LFC platform is different than the platform used for UBA and therefore its demand cannot be reasonably included in the core network for the UBA service.

It is therefore recommended that, consistent with common international practice, LFC demand should be excluded from the demand for UBA.

Criterion 34: The LFC demand should not be taken into account in the demand assumption for UBA.

3.3.1 Should the FWA RBI demand be included in the demand assumptions for UBA?

For the same reason as for LFC, it is therefore recommended that FWA RBI demand should be excluded from the demand for UBA.

Criterion 35: The FWA RBI demand should not be taken into account in the demand assumption for UBA.

3.3.2 Should the HFC demand be included in the demand assumptions for UBA?

HFC demand is not usually considered in UBA modelling. This is because HFC is a competing platform and therefore its demand cannot be reasonably included in the core network for the UBA service.

It is therefore recommended that, consistent with common international practice, HFC demand should be excluded from the demand for UBA.

Criterion 36: The HFC demand should not be taken into account in the demand assumption for UBA.

3.3.3 Should the unbundled lines demand be included in the demand assumptions for UBA?

Demand for unbundled lines is not usually considered in UBA modelling. This is because unbundled lines use a competing platform (the core network of access seekers) and therefore its demand cannot be reasonably included in the core network for the UBA service.

It is therefore recommended that, consistent with common international practice, unbundled lines demand should be excluded from the demand for UBA.

Criterion 37: The unbundled lines demand should not be taken into account in the demand assumption for UBA.

3.3.4 Should a constant demand or a projected demand be used for UCLL?

For pricing the UBA service, a FTTN network is being modelled.

The approach followed by regulatory authorities is generally to use the actual and forecasted demand of the incumbent in its core network.

As a consequence, the demand for UBA set by regulatory authorities is the actual and forecasted demand.

Chorus' actual demand for UBA may decrease over the regulatory period. So, assuming constant demand may be inappropriate if a new operator deploys copper today for UBA and has to compete with FTTH, HFC and unbundling.

The implication is that the actual demand for UBA is decreasing as FTTH is being developed, which may lead to UBA costs increases.

Assuming a declining demand profile is likely to lead to cost increases because of the smaller quantity base over which the fixed costs would have to be spread. Therefore, if prices are smoothed, the prices based on a declining demand profile are likely to be higher compared to prices based on costs with a constant demand profile.

An approach to include declining demand as a result of greater competition, will lead to an increase in prices – which is counter-intuitive. It is expected that as competition increases, prices will decline.

In this regard, Professor Vogelsang also advised that:

"TSLRIC is conceptually based on an expanding market, where additional capacity is being installed. Since a large portion of the copper-related costs are sunk and some overcapacities develop, true forward-looking costs will therefore be much lower than TSLRIC as traditionally calculated by regulators. Also in this stage of the market an operator in a competitive environment would wish to take advantage of wholesale demand to defend its position against competing technologies. But if TSLRIC were still measured based on the old technology this would lead to price increases because of the smaller quantity base over which then fixed costs would have to be spread. Summing up, in the face of long-term declining demand relying on the TSLRIC standard for the old technology would induce unnecessary over-capacities and allocative inefficiencies in copper networks"[5]

In the July consultation, the Commission stated that if migration away from Chorus' actual network to alternative networks is included within the model, this again will not reflect an efficient outcome.

- Declining utilisation of the network would imply a higher cost to end-users and could attract build decisions where that is not efficient; and
- It is noted that the declining utilisation could lead to a cost spiral – increasing costs would likely accelerate migration away from the network, leading to further cost increases to end-users that remain on the network.

Accordingly, it is recommended to use constant demand for UBA.

[5] Ingo Vogelsang "The effects of the UCLL contribution to the UBA aggregate on competition for the long-term benefit of end-users in New Zealand telecommunications markets" 2 July 2014, paragraph [10].

Criterion 38: The UBA demand should be constant.

3.4 Services to be modelled

Given the limited scope of the core network being modelled (see §3.1) as it is fit to derive the price of the UBA services, the model should include solely the services that share assets with the UBA services.

3.4.1 Broadband services

3.4.1.1 Regulated broadband services

The model should include all the regulated broadband services provided using either ADSL or VDSL.

Criterion 39: The model should include all the regulated broadband services.

3.4.1.2 Non-regulated broadband services

DSLAMs are dimensioned according to the number of active customers. With a single DSLAM, ADSL, VDSL and SHDSL customers can be served. All these services should therefore be included in the network cost model.

Criterion 40: The model should include all the non-regulated broadband services.

3.4.2 Remaining services

3.4.2.1 SLUBH

This link is shared between the bitstream services and other services such as leased line services or legacy services.

The model should therefore capture the relevant economies of scope of the SLUBH.

Criterion 41: The model should capture the economies of scope of the SLUBH.

3.4.2.2 First data switch

The first data switch is dimensioned based on the number of DSLAMs that should be connected to it and based on the number of handover points it should offer. The handover connection service should therefore be included in the core network cost model.

Criterion 42: The core network model should include the handover connection service to dimension the FDS and capture the relevant economies of scope.

3.5 Technologies to be modelled

3.5.1 Switching technology

The core network that should be modelled is an Ethernet network as it is the most cost-efficient way to deliver the UBA service.

Criterion 43: The core network model should be an Ethernet network.

3.5.2 Transmission technology

3.5.2.1 No SDH

The Synchronous Digital Hierarchy (SDH) transmission technology is a legacy technology that does not reflect the MEA choice. Any existing SDH links in Chorus' network will therefore be disregarded and replaced by Ethernet links.

3.5.2.2 Use of microwaves for remote sites

On remote sites with no easy access, microwave links can be used. However, microwave links are less future proof than fibre. Also, programs to replace microwaves by fibre links have been observed. As a consequence, it is proposed to exclude microwave links.

Criterion BU 44: The model should not include Chorus' existing microwaves links.

3.5.2.3 Use of submarine cables

Where microwaves cannot be used, submarine cables should be used to connect islands to the main land. The existing links should be used.

Criterion BU 45: The model should include Chorus' existing submarine links.

3.5.2.4 Use of DWDM

Improvements in laser technology have increased the capacity of optical fibre. Dense wavelength division multiplexing (DWDM) allows the combination of a number of wavelengths on a fibre so the capacity of a single fibre is increased even more.

From a top-down perspective, an all-IP network might well incorporate a considerable amount of DWDM equipment. However, it is most likely that this has occurred due to historical reasons of limited fibre availability within existing trenches and ducts. Choosing between digging up the streets to install additional fibre optic cables or installing DWDM equipment at relevant node locations, the latter option will probably prove to be more cost effective in most circumstances.

Nevertheless, from a bottom-up/replacement cost perspective, the number of fibres in each cable/duct/trench becomes a variable and thus no longer acts as a constraint for the network design. Furthermore, the cost of rolling out more fibre cables (or cables with more fibres) is more cost-efficient than installing DWDM.

There is however one case where the use of DWDM could be necessary in the cost model, which is for long distances. In this case, even a new operator building a new network would require DWDM.

Criterion BU 46: The models should include only DWDM links for long distance links.

3.6 Optimisation in the TSLRIC model

An optimally structured network taking only the locations of Chorus' exchanges as fixed while optimising all other aspects of the network is recommended.

- Under this approach, there is a great degree of flexibility in the level of network optimisation that occurs. The materiality of the difference between this approach and the scorched node optimisation depends on the degree of optimisation the regulator applies, but it tends to be relatively immaterial.
- This means modelling an "optimally structured network" which is constrained by the existing number of nodes (exchanges and cabinets) and their existing locations and follows the road network.

The choice of this approach also facilitates the potential issue of double recovery between UCLL and UBA as node locations is more likely to the same if the same optimisation is chosen.

Criterion 47: An optimally structured network based on Chorus' copper network with optimised exchange boundaries should be modelled.

However the optimisations that should be made are different than those made in the access network cost model.

This approach means making optimisations in the following situations:

- Number of assets should be assessed based on the demand;
- Space required should reflect the number of assets modelled and not the actual surface of Chorus' buildings;
- Power usage should reflect the assets modelled, i.e. the power consumption of the modern assets given the number of assets modelled;
- The air-conditioning requirement should also reflect the assets being modelled.

3.7 Core modelling approach

3.7.1 Demand assessment

The core increments include all services that use the core network. The relevant measure of demand for these services, defined as end-user demand (internal and external), is the current level of demand.

Criterion 48: The starting point when building the TSLRIC model is the level of demand in New Zealand for all the services using the core network of the incumbent in accordance with §3.3.

3.7.2 Network design

Engineering principles will inform the dimensioning process for direct network cost categories. E.g. the number of ports per line card is derived from the engineering rules provided by Chorus.

Other cost categories will be required to provide functionality for direct network cost categories. These are referred to as indirect network cost categories.

Criterion 49: The engineering rules as provided by Chorus are the starting point of the modelling**.**

3.7.3 Network costing

In the core network cost model, both unit costs of equipment and the operating and indirect costs associated with the different types of equipment are included. Using this information, the total investment costs for the network can be estimated. However, the model also needs to calculate annual costs, so the investment costs will need to be annualised to generate an annual figure for the capital expenditure involved with using each asset.

Operating costs and corporate overheads should be calculated in accordance with §0 and §1.

Operating costs, corporate overheads and indirect costs will however be carried out in the core network cost model.

Criterion 50: The core network cost model should derive a total investment and an annualised cost.

Criterion 51: Operating costs, corporate overheads and indirect costs should be included when relevant.

3.7.4 Services costing

The final step in the process will be to calculate the costs for various products under scrutiny. Based on the hypothetical network that has been built, the model needs to calculate the costs attributable to each of the various services.

This means that all of the different cost categories (direct network costs, indirect network costs, operating costs and overheads) will be aggregated when calculating the costs of the products.

The costing of the different services will be carried out in the core network cost model.

Criterion 52: The different services under scrutiny will include all the different cost categories.

4 Types of costs and cost allocation

There are two dimensions in categorising costs when considering fixed telecommunications networks:

- The first dimension categorises costs depending on how assets contribute in producing certain services (e.g. directly or indirectly).
- The second dimension deals with whether costs refer to investments to acquire physical assets (Capital expenditure, or CAPEX) or are the result of normal business operations (Operational expenditure, or OPEX). This raises the question of how to identify CAPEX and OPEX costs.

Figure 4: Different types of costs for a telecom network and examples

	CAPEX	OPEX
Direct costs	DSLAM…	Electricity consumption of the DSLAMs…
Indirect costs	Trenches…	Staff managing the trenches…
Overheads	IT…	CEO wage…

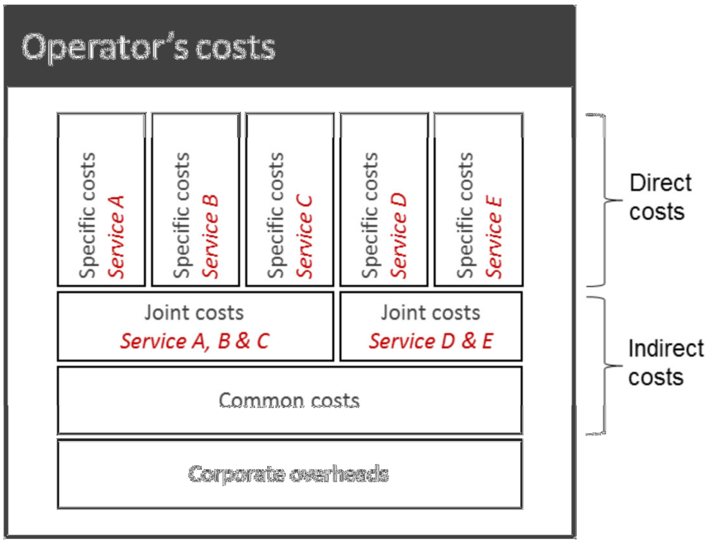
Source: TERA Consultants

4.1 Direct, Indirect costs and Corporate Overheads

In a telecommunications network, assets are usually not used exclusively for one set of services but are instead shared between a group of services or even among an entire portfolio of services produced by an operator (e.g. trenches in the fixed network).

Costs can thus be categorised into four main groups: direct costs, joint costs, network common costs and corporate overheads.

Figure 5: Different types of costs in an operator's costs



Source: TERA Consultants

The definition of each group of cost is given below.

- **Direct costs**: these costs are directly related to the production of a given service. They would cease to exist if the service was to be terminated. They are therefore directly attributable costs that have an unambiguous causal relationship with the *considered service*.
- **Joint costs**: these costs cannot be specifically allocated to one service; they are incurred when producing a given set of services. They are indirectly attributable costs that have an unambiguous cause-effect relationship with the *considered group of services*.
- **Network common costs**: these costs are incurred when producing all services. As in joint costs above, network common costs are indirectly attributable. They have an unambiguous causal relationship with *all services*.
- **Corporate overheads (also known as "non-network common costs")**: Overhead costs are costs that are incurred to operate a telecommunications company but that are not directly incurred to provide a core and access network. Examples include human resources, legal, and planning departments. These costs cannot be allocated in a non-arbitrary way. They are shared by the entire portfolio of services.

As a general rule, it can be considered that when an operator produces several services, it is less expensive to jointly produce these services than to produce them separately: the total cost of producing several services is lower than the sum of the stand-alone costs. Joint and common costs, therefore, consist of economies of scope achieved by an operator.

When trying to assess the cost of a service, its joint and common network costs raise the question of how to allocate them among the different services produced by the operator. Joint and common costs are prevalent in telecommunications networks. Several network elements are not specific to a given service but are required to provide a set of services. The allocation of network costs between different services is a key issue for network costing because telecommunications networks support and share many services (voice services, broadband, IPTV, leased lines, etc.).

Joint and common cost allocation is a complex and critical task as different methods can lead to different unit costs for a given service. The following sections will present various cost allocation approaches for indirect costs and the special case of corporate overheads.

4.1.1 Allocation of joint and network common costs allocation

Different allocation keys can be envisaged for the allocation of indirect costs. The choice of the allocation can lead to very different unit costs for a given service.

In cost modelling, two types of cost allocation families are generally considered: proportional rules cost allocation families (technical allocation) or game-theory rules cost allocation families (economical allocation):

- **Proportional rules** (technical allocation): capacity based allocation, Moriarty, and residual benefit.
- **Game-theory rules** (economic allocation): Shapley-Shubik, nucleolus.

Each allocation rule has its advantages and drawbacks. The capacity based allocation rule and the Shapley-Shubik rule are the rules that are generally considered and used by regulatory authorities for allocating joint and common network costs. These two approaches have the advantage of being more easily implementable in a bottom-up model. They are presented hereafter:

- **The capacity based allocation rule** allocates common and joint costs to the services based on the network capacity required by each service. This rule is the one traditionally used by regulatory authorities as it follows the cost drivers (networks are dimensioned to support a given capacity such as a given number of customers or a given amount of traffic). This rule tends to allocate a large share of indirect costs to services that load the network a lot (data, Internet or Video on Demand), but leads to low unit costs for services that load the network (voice services) less. As the traditional rule, the capacity based allocation rule should be implemented in the model. This allocation rule means that for each asset the capacity has to be identified and then assessed:
    - The table below identifies the capacity of the different assets that are producing network common or joints costs:

Table 1 – Capacity of the different assets

Asset	Capacity
Trenches	Ducts
Ducts	Surface of the cables inside of the ducts
Copper cables	Pairs
Fibre cables	Fibres
DSLAM	Active customers
Switch	Ports

Source: TERA Consultants

- For each of these assets, the capacity has to be derived. There are three possible approaches:
  - The capacity is computed bottom-up e.g. the number of ducts located in each trench is assessed bottom-up based on the number of dwellings and the engineering rules;
  - The capacity is provided by Chorus as part of the data collection e.g. the number of ADSL, VDSL and SHDSL customers connected to each site is provided by Chorus; and
  - The capacity is based on external data (benchmark, hypothesis or TERA's expertise). This approach should be used only in the case where the two other approaches cannot be applied.

- **The Shapley-Shubik allocation rule**[6] consists of setting the cost of a service equal to the average of the incremental costs of the service after reviewing every possible order of arrival of the increment (see example below). Such a rule may be worth considering because it gives different insights to the traditional rule. For example, with the capacity based allocation rule, voice services are often allocated a very small share of common network costs because they use much less capacity compared to other services. Therefore, voice services may bear very low costs, which could contrast with the value of the voice services as perceived by market players and consumers. In such a

[6] The Shapley-Shubik rule has also been considered by some NRAs such as ARCEP in France (decision 2008-0896) or ComReg in Ireland (decision D03/08).

case, the Shapley-Shubik allocation rule may provide a more appropriate outcome. This allocation rule however presents two difficulties:

- First of all, it is necessary to define the relevant increments. There can be different ways to define the increments. In general, in order to simplify the approach, broad increments are generally considered such as: voice service increment, broadband increment, IPTV increment and leased lines and data services increment. With such broad increments, traditional allocation approaches can still be needed to calculate costs of smaller services (for example, for call origination within the voice increment).
- Second of all, this rule requires running the cost model several times (for example, six times if there are three increments and 24 times if there are four increments). This is also why it is preferable to define broad increments.

Figure 6: Shapley-Shubik allocation in the case of a network supporting two services (voice and data)

- **Let us consider a network supporting voice and data. The standalone cost of voice is 75 and 80 for data. The total cost of the network is 100.**
- **For this 2-service Network, 2 sequential scenarios are possible:**

Scenario 1	Scenario 2
1st investment VOICE 75	1st investment DATA 80
2nd investment DATA 25	2nd investment VOICE 20

- **The cost allocation is then completed as follows (47.5% to voice, 52.5% to data):**

	Voice	Data	Total
Scenario 1	75	25	100
	+	+	+
Scenario 2	20	80	100
	=	=	=
Sum	95	105	200
%	*47.5 %*	*52.5 %*	*100%*

Source: TERA Consultants

Accordingly, the capacity based allocation rule should be used for the allocation of joint and common network costs.

Criterion 53: The capacity based rule for joint and common network costs should be implemented in the TSLRIC models.

4.1.2 Allocation of corporate overheads

In addition to network costs, an operator faces non-network common costs such as the costs of maintaining a corporate office, which are incurred to support all functions and activities. Examples of these costs include costs associated with corporate headquarters, senior management and internal audit.

Identifying the impact of an increment on corporate overheads is a very complex task. These costs are potentially material and should be recovered if relevant[7]. According to BEREC, the method traditionally used by NRAs to allocate these costs is the Equal Proportion Mark-Up (EPMU) approach[8]:

> *"In a regulatory environment it is accepted that all services should bear, in addition to their incremental cost, a reasonable proportion of the common costs. The preferred method of allocating common costs is Equal Proportionate Mark-Up (EPMU)."*

Under the EPMU approach, each service is allocated a share of the common costs in proportion to that service's share of total attributable costs.

[7] Article 6.2.3 of the Accounting Separation Regulation dated 2 August 2004 limits un-attributable cost to less than 10% of overall costs.

[8] ERG - Recommendation on how to implement the commission recommendation C(2005) 3480 – 2005.

Table 2: Numerical example of the EPMU method (for illustrative purpose only)

Corporate overheads cost allocation in a 3-service network (Voice, Internet, Leased Lines)

- Corporate overheads: NZD 100M
- Attributable costs (i.e. direct + indirect costs):
  - Voice NZD 320 M
  - Data NZD 530 M
  - Leased Lines NZD 80 M

	Attributable costs				Corporate overheads	
Voice	NZD 320 M	34%		Voice	NZD 34 M	34%
Data	NZD 530 M	57%		Data	NZD 57 M	57%
Leased Lines	NZD 80 M	9%		Leased Lines	NZD 9 M	9%
					NZD 100 M	100%

Source: TERA Consultants

While the EPMU approach is relatively simple to implement, the main drawback of this approach is that it does not take into account efficiency considerations.

"Ramsey-Boiteux" is an alternative to the EPMU approach. With this approach, the size of the mark-up on each service is inversely proportional to the price elasticity of demand for that service, as this minimises the consumption-distorting effect of raising prices above marginal cost[9]. This approach tends to maximise the welfare but is rarely implemented in practice due to the difficulty to calculate price elasticities.

The EPMU approach has traditionally been used in cost models developed in all European countries.

Criterion 54: Corporate overheads costs should be allocated on the basis of the EPMU approach.

[9] See Laffont and Tirole, 2001, Competition in Telecommunications, Cambridge: MIT Press, for more detailed on Ramsey-Boiteux pricing.

4.2 CAPEX assessment

CAPEX are costs incurred when a telecommunications operator invests in equipment and/or designs and implements the network infrastructure. The equipment includes, for example, the DSLAMs or the switches, whereas the costs for the design and implementation of the network infrastructure can be site acquisition and civil works.

In the network cost models, CAPEX are derived from the service demand through engineering principles (see sections §2.7).

4.2.1 Equipment prices

Equipment prices are likely to vary between operators for a number of reasons including differences in underlying network structure, specification, business focus, bargaining power and bargaining ability. Where significant differences exist between the cost estimates provided by different operators, clarification may be needed to ensure that the estimates refer to equipment with equivalent specifications.

Moreover, an incumbent could be expected to have stronger bargaining power than other operators. The models should take this into account.

Criterion 55: Prices used in the TSLRIC models should reflect those that an efficient operator with the bargaining power of an operator with significant market power would face.

4.2.2 Base year

Initially, cost inputs in the model will be based on the latest available information (i.e. 2014 data). If data for one reason or another is not available for that specific year, an extrapolation should be made from relevant historic data to calculate the proper reference data for the base year.

Criterion 56: Initially, cost inputs should be based on the latest available information and subscription data will subsequently be updated to reflect 2014.

4.3 OPEX assessment

OPEX are costs incurred as a result of an operator performing its normal business operations. The OPEX to be taken into account for the cost model is network driven, i.e. the costs associated with the operation of the network, transmission, site rentals, operation and maintenance.

Several methods of operating cost assessment are possible, the choice of which depends on the goal of the modeller and the availability of data.

4.3.1 Approach 1 - OPEX from the accounts

As is the norm of top-down modelling, OPEX costs are based on the operator's actual costs and can be obtained directly from the operator's accounting records.

This type of approach is not necessarily in line with TSLRIC cost models except if the operator's costs are efficiently defrayed.

4.3.2 Approach 2 - OPEX from the accounts with efficiency adjustments

As explained in the previous section, top-down modelling reflects the actual costs incurred by an operator, but it can also incorporate network inefficiencies.

To eliminate this problem, some efficiency adjustments can be set up. E.g., the operator costs for repairing the access network can be reduced to reflect a lower fault rate of a new entrant's more efficient network.

Figure 7: Numerical example of top-down assessment with efficiency adjustments (for illustrative purpose only)

<u>Cost of faults:</u>

- Faults OPEX (accounts – top-down): NZD 10M/year
- Operator figures: 15 faults/100 lines/year
- Efficient operator figures : 10 faults/100 lines/year

Efficiency gain: -33% (15 faults vs. 10 faults)

Faults OPEX = NZD 10M x (1-33%) = NZD 6,7M/year

Source: TERA Consultants

4.3.3 Approach 3 - Mark-up on CAPEX

This way of assessment involves defining a mark-up for each asset. This mark-up would be applied to the CAPEX.

4.3.4 Approach 4 - Real bottom-up assessment based on time spent, power consumption

This approach consists in calculating the network's requirements (in energy, cooling, square meters) and to conduct a bottom-up assessment of OPEX (e.g. energy cost = kWh requirement for all networks elements x kWh price).

4.3.5 Approach 5 - Benchmarking

This way of assessment involves collecting and analysing OPEX mark-ups used by regulators in other comparable countries.

4.3.6 Conclusions

A top-down approach for the calculation of OPEX (approach 1) is not consistent with the principle of the bottom-up approach as inefficiencies and irrelevant cost may be included.

The benchmark approach (approach 5) is not country-specific and may lead to under-estimated / over-estimated OPEX in the context of New Zealand. As a consequence this approach should be used only in cases where operators' data is unavailable. Even where operator data is available, benchmarked data can be used as a cross-check of the resulting OPEX estimates.

Approaches 2, 3 and 4 tend to model the efficient costs of an operator.

Mark-up on CAPEX (approach 3) is not as precise as approaches 2 and 4 as setting the mark-up percentage is subjective and this figure is difficult to challenge.

As a consequence, operating costs should be calculated using approaches 2 and 4 depending on their feasibility (e.g. information availability):

- Energy, cooling and building costs should be calculated with a true bottom-up approach (approach 4) as required square meters and MWh can be derived from the bottom-up CAPEX model;
- Remaining OPEX categories should be calculated based on accounts with efficiency adjustments (approach 2).

Criterion 57: Operating costs should be calculated using OPEX from the accounts with efficiency adjustments, real bottom-up assessment should be performed for energy and square meters costs.

4.4 Depreciation

4.4.1 Cost of capital

The cost of capital that should be used is a nominal post-tax weighted average cost of capital.

4.4.2 Approach for modelling taxation

Most regulatory authorities use the tilted annuity (in the context of stable demand) approach to derive annual costs from the investment.

However, the tilted annuity formula does not allow the tax shield to be captured accurately. This is why the tax adjusted annuity should be used instead to derive the annual costs.

Criterion 58: A tax adjusted annuity should be used to derive the annual costs.

4.4.2.1 Time to build

The time to build of the network is six months[10].

Criterion 59: The annuity formula should reflect six months for the time to build.

4.4.2.2 Tax depreciation rates

The first step of this approach is to define for each asset class a tax depreciation rate that reflects the tax shield.

[10] Technically this reflects the time between the moment the investment is paid and the network is generating revenues

Table 3 – Tax depreciation rate

Asset class	Tax depreciation rate
Copper cables	13%
Copper joints	13%
Copper Distribution points	13%
Fibre Distribution points	13%
Fibre cables	13%
Fibre joints	13%
Ducts	4%
Trenches	4%
Poles	10%
Chambers/Manholes/Jointholes/Pits	4%
MDF/ODF	16%
Switches/routers	20%
FWA base stations	8%
FWA spectrum	20%
Submarine links (cables/landing stations)	8%
Microwave links	12%
DWDM links	13%
DSLAM (card/subrack/rack)	16%
Switches/routers (card/subrack/rack/SFP)	16%
Building/Land	3%
Power equipment	8%
Air-conditioning equipment	16%
Site equipment (e.g. security equipment)	20%

Source: Commerce Commission

4.4.2.3 Adjustment to pre-tax annuity

The prices that are derived in the model are pre-tax prices. It is therefore required to adjust the post-tax annuity in order to take into account the level of tax paid. This adjustment is based on the tax depreciation rate defined in the previous section using the following formula:

$$Adjustment\ to\ Pre\ Tax\ annuity = \frac{1 - \frac{Corporate\ Tax\ Rate * Tax\ Depreciation\ Rate}{Tax\ Depreciation\ Rate +\ WACC_{Post-Tax\ nominal}}}{1 - Corporate\ Tax\ Rate}$$

The approach to derive this formula is described in the Commission's Attachment K of the draft determination.

4.4.2.4 Post-tax real WACC

The third step is to derive a post-tax real WACC based on the post-tax nominal WACC. This is achieved by using the following formula:

$$Post\ Tax\ real\ WACC = \frac{1 + WACC_{Post-Tax\ nominal}}{1 + Price\ Trend} - 1$$

4.4.2.5 Annuity

The final step is to determine the annuity. It is obtained by computing the annuity of the total investment using:

- the interest rate as defined by the post-tax real WACC;
- the asset life; and
- the annuity, which is corrected by the adjustment to pre-tax annuity.

The formula used is therefore the following one:

$$Annuity = Investment * \ PMT(Post\ Tax\ real\ WACC, Asset\ life, -1) * Adjustment\ to\ Pre\ Tax\ Annuity$$

5 Regulatory period

The price control period should be a five year period starting in December 2015. Individual prices for each year of the price control period should be calculated.

Criterion 60: The price control period is the 2015-2020 period.

Criterion 61: Different prices over the price control period for both UBA and UCLL services should be calculated.

6 Checking the model

As part of the quality process, the model should be checked.

6.1 Internal review

The model should be reviewed by both TERA and the Commission in order to ensure no modelling errors remain and to ensure that the relevant inputs and parameters are used.

6.2 Comparison with existing networks

The outputs of the model should be compared to existing networks in order to ensure the consistency of the modelling.

6.3 Sensitivity analyses

Sensitivity analyses should be carried out to ensure that the model reacts as expected when the inputs are changed and to test the sensitivity of the results to the variations of the inputs.

6.4 Benchmark with publicly available information

The inputs, especially the unit costs but also when relevant and possible engineering rules, should be benchmarked with publicly available information in order to ensure that the inputs used in the model are reasonable. These benchmarks can be based on local data or international data.

However, there is some data where an international benchmark is not fit for purpose as the data should rely on the local specificities.

6.5 Reconciliation with top-down models and with top-down data

The outputs of the modelling should be reconciled with the top-down data provided by the operators.

7 Appendix: list of the criteria

Criterion 1: Access and core networks should be modelled separately.

Criterion 2: The scope of the access model is the local loop, from the External Termination Point (ETP) (excluded) to the Main Distribution Frame (MDF). The physical links that are part of the core network are modelled in the access network and should feed the core network cost model.

Criterion 3: The TSLRIC methodology should be used to price the different regulated services.

Criterion 4: Replacement costs in the model should correspond to the costs of buying new equipment in the base year.

Criterion 5: International part should be disregarded.

Criterion 6: The red zones in the Christchurch area should be disregarded.

Criterion 7: The MEA of the UCLL is the cost-efficient way of providing the UCLL service.

Criterion 8: The MEA of the UCLL is based on a mix between a point-to-point fibre network and a FWA network.

Criterion 9: The cost of the MEA should be adjusted to reflect the cost difference between the MEA network and the copper network.

Criterion 10: In order to compute the cost-adjustment, a copper access network and a fibre + FWA network should be modelled. The adjusted cost of the MEA network is the cheapest network selected at the national level between the two scenarios identified.

Criterion 11: The access network starts at the ETP and stops at the distribution frame.

Criterion 12: The fibre network should be a PTP network.

Criterion 13: RBI sites should be considered as a relevant proxy to assess the cost of FWA.

Criterion 14: The FWA sites should be connected to the nearest exchange. Customers located on the way from the FWA sites to the exchanges should be connected by the FTTH-network.

Criterion 15: The FWA should use the LTE technology.

Criterion 16: The FWA coverage should be inferred from the distance to active nodes in the copper network.

Criterion 17: The capital cost of the access network should be computed over the TSO-areas, including the cost of connections outside the TSO-area for the part of those connections that is within the TSO-area. It is assumed that the capital contributions cover exactly the cost of the non-TSO areas. The operating costs of the access network should however be computed over a nationwide network.

Criterion 18: The access network cost model should derive the cost of the UCLL and SLU based on the cost of the ULL and the cost of the SLUBH.

Criterion 19: The Chorus UFB demand should be included in the UCLL demand.

Criterion 20: The HFC and LFC demand should be included in the UCLL demand

Criterion 21: The UCLL demand should be constant

Criterion 22: An optimally structured network based on Chorus' copper network with optimised exchange boundaries should be modelled.

Criterion 23: The MDF nodes of the current copper network should be used as the location of the ODF nodes. Exchange boundaries should be optimized.

Criterion 24: For the copper network, the cable length-based optimisation approach should be followed for the modelling of the copper network.

Criterion 25: For the fibre network, the length-based optimisation approach should be followed for the modelling of the fibre network.

Criterion 26: The starting point when building the bottom-up model is the level of demand in New Zealand for all the services.

Criterion 27: The engineering rules as provided by Chorus are the starting point of the modelling, except if very different from standard practice elsewhere.

Criterion 28: The access network cost model should derive a total investment and an annualised cost.

Criterion 29: Operating costs, corporate overheads and indirect costs should be included when relevant.

Criterion 30: The core network should start at the DSLAM (located either at the exchange or in the active cabinet) and stop at the first data switch (FDS).

Criterion 31: The handover points and the inter-exchange links should be modelled.

Criterion 32: The cost of the DSLAM included in the RBI program should not be recovered by Chorus through UBA.

Criterion 33: The MEA for UBA is the copper/FTTN access network architecture with an NGN Ethernet core network to support broadband.

Criterion 34: The LFC demand should not be taken into account in the demand assumption for UBA.

Criterion 35: The FWA RBI demand should not be taken into account in the demand assumption for UBA.

Criterion 36: The HFC demand should not be taken into account in the demand assumption for UBA.

Criterion 37: The unbundled lines demand should not be taken into account in the demand assumption for UBA.

Criterion 38: The UBA demand should be constant.

Criterion 39: The model should include all the regulated broadband services.

Criterion 40: The model should include all the non-regulated broadband services.

Criterion 41: The model should capture the economies of scope of the SLUBH.

Criterion 42: The core network model should include the handover connection service to dimension the FDS and capture the relevant economies of scope.

Criterion 43: The core network model should be an Ethernet network.

Criterion BU 44: The model should not include Chorus' existing microwaves links.

Criterion BU 45: The model should include Chorus' existing submarine links.

Criterion BU 46: The models should include only DWDM links for long distance links.

Criterion 47: An optimally structured network based on Chorus' copper network with optimised exchange boundaries should be modelled.

Criterion 48: The starting point when building the TSLRIC model is the level of demand in New Zealand for all the services using the core network of the incumbent in accordance with §3.3.

Criterion 49: The engineering rules as provided by Chorus are the starting point of the modelling.

Criterion 50: The core network cost model should derive a total investment and an annualised cost.

Criterion 51: Operating costs, corporate overheads and indirect costs should be included when relevant.

Criterion 52: The different services under scrutiny will include all the different cost categories.

Criterion 53: The capacity based rule for joint and common network costs should be implemented in the TSLRIC models.

Criterion 54: Corporate overheads costs should be allocated on the basis of the EPMU approach.

Criterion 55: Prices used in the TSLRIC models should reflect those that an efficient operator with the bargaining power of an operator with significant market power would face.

Criterion 56: Initially, cost inputs should be based on the latest available information and subscription data will subsequently be updated to reflect 2014.

Criterion 57: Operating costs should be calculated using OPEX from the accounts with efficiency adjustments, real bottom-up assessment should be performed for energy and square meters costs.

Criterion 58: A tax adjusted annuity should be used to derive the annual costs.

Criterion 59: The annuity formula should reflect six months for the time to build.

Criterion 60: The price control period is the 2015-2020 period.

Criterion 61: Different prices over the price control period for both UBA and UCLL services should be calculated.