Final Document

Top Down Long Run Average Incremental Cost (LRAIC) Model Specification Paper

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Maintenance History		
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December 22, 2009	Second Draft, incorporates revisions in response to submissions from concessionaires made in first round of consultation	0.2
March 1, 2010	Final version, incorporates revisions in response to submission from concessionaires made in the second round of consultation. Annexe on data request deleted as separate formal data request will be issued shortly.	1.0
October 23, 2012	Updated version, incorporates amendments and additions required due to implementation decisions made during the LRAIC modelling in 2011.	1.1

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1 Introduction

This document describes the underlying principles and methodology applied by the Authority to implement the top down LRAIC model developed by Frontier Economics for the Authority. The LRAIC Specification Paper has been consulted upon by the Authority with all relevant concessionaires within the market.

The remainder of this section is structured as follows:

- summary of the objectives of the LRAIC model;
- decisions taken to date on the form of the LRAIC model;
- discussion of role of operators in the modelling process;
- description of the data collection process; and
- overview of the rest of this specification.

1.1 Modelling objectives

The Authority's overall requirements are set out in "*The Costing Methodology for the Telecommunications Sector*" published on the 29th May 2008. The primary objective of the LRAIC model is to provide the Authority with a standardised tool that allows making informed regulatory decisions to enhance effectiveness and competitiveness of communication services in Trinidad and Tobago. The model will be used to assist in a range of regulatory purposes, which may include, at a minimum:

- "the determination of interconnection rates for all concessionaires when required;
- the determination of rates for accessing the facilities (e.g. unbundled local loops) of any concessionaire when required;
- the determination of rates, where necessary, for any telecommunications service in which there is a monopoly or exclusive provider (un-contested market);
- the determination of rates, where necessary, for any public telecommunications service provided by a dominant provider in a contested market ; or

- any exercise by the Authority to detect unfair cross subsidies or any act of anti-competitive pricing."[1]

The Authority has decided to follow a long run average incremental cost approach in order to set and monitor prices where competition is not sufficient or may be distorted, to establish prices at a welfare maximising level.

Incremental costing models attempt to understand the cost of delivering an increment of demand, that is, the change in cost resulting from adding or subtracting an increment thereof. 'Long-run' signifies that the incremental cost calculation should include both costs that may vary in the short-run (for example, operational expenditure) and costs which vary in the long run (such as capital costs). Costs that are fixed or common across increments will not form part of the incremental cost[2] as such, but may be added through a mark-up, to ensure investors receive a reasonable return overall.

'Long run average incremental cost' refers to a modelling approach that calculates prices with respect to increments such as total demand, and hence which set service prices based on "average" prices across this increment of total demand.

1.2 The Authority's requirements

In the Costing Methodology, the Authority defined some key characteristics of the top down LRAIC model. These are set out below.

- The top down approach requires the use of cost information that initially consists of historic, most likely statutory accounts data. The data that is used for the model however, is required to reflect current cost on the basis of modern equivalent assets (MEA).

- Depreciation of assets should follow the tilted straight line approach.

- The cost of capital is to be determined on an annual basis using the weighted average cost of capital (WACC) approach.

- Cost volume relationships (CVRs) should be based on engineering models and activity based costing (ABC).

- Network element costs will be attributed to services on the basis of service volumes and routing factors. Routing factors for all network elements

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1 See Section 1.1.4 of the Costing Methodology

2 Fixed and common costs are typically recovered through mark-ups to ensure that an operator is able to recover its total costs

should be established and justified by concessionaires for the use in the model. Alternatively, the Authority may estimate efficient routing factors for individual network types on the basis of the data concessionaires have provided.

- Common costs which would otherwise not be included in the service cost in a pure LRAIC approach should be included by applying an equi-proportionate mark up (EPMU).

However these characteristics alone are not sufficient to determine fully the approach to be taken. This specification builds on and develops these key principles in order to provide a more complete view of the implementation of the model. This development is based on international best practice drawn from top down LRAIC models implemented in other jurisdictions, such as the United Kingdom. The specification also takes account of the relatively small size of Trinidad and Tobago and hence the resources available to both the Authority and the concessionaires in implementing the model. The approach has been simplified as far as possible whilst remaining consistent with the Costing Methodology and meeting the requirements of the Authority.

1.3 Need for operator input

The Costing Methodology sets out the requirements for concessionaires to implement a costing system. All of those concessionaires who are dominant in a relevant market need to implement a costing model. More specifically, the Costing Methodology states, "a concessionaire that provides interconnection service shall be considered dominant in providing termination services on its network." In addition, the costing model is developed as per requirements set out in the Telecommunications Interconnection Regulations, Pricing Regulations and Access to Facilities regulations.

Based on a common model template, a model is prepared for a concessionaire, reflecting their relevant network structure, costs and demand for services. The results for each concessionaire thus represent the costs for that concessionaire. This approach differs from that used in some other jurisdictions where a single hybrid industry model representative of a number of networks (for example mobile networks) has been developed with the results being a representative "average" cost for the industry.

Given the range of network topologies currently used by concessionaires, the template LRAIC model will be sufficiently flexible to reflect the different networks used while harmonising the principles and methodology as far as possible.

Given that the LRAIC model has been constructed on a top down basis using the costs of the networks and associated assets of concessionaires, , concessionaires are required to submit data relating to both operating costs and

capital costs. In addition, the concessionaires need to supply information necessary to model the relationships between costs and demand, for example cost volume relationships. A high level view of the data required is described below and set out in further detail in Section 6.

The model will be populated on an annual basis covering each concessionaire's financial reporting year.

1.3.1 Capital costs

Concessionaires need to provide cost estimates for all their assets used for the provision of fixed and mobile services in Trinidad and Tobago. The role of concessionaires is fundamental to ensure that the model inputs, and therefore the model results and any regulatory decisions based on the results, reflect the operating environment faced by concessionaires in Trinidad and Tobago.

The LRAIC model requires asset valuation (including installation costs and import duties) and the associated depreciation and amortisation charges to be calculated on a current cost accounting (CCA) basis. Therefore, the Authority conducts a CCA study for each concessionaire to revalue their relevant assets each year, based on information provided by concessionaires. The process required is described in the separate CCA Reference Paper[3] which complements this specification document

Concessionaires are also required to provide information on the level of working capital (i.e., their current assets and liabilities). This however resembles a categorisation exercise with no change in the reported level of costs.

1.3.2 Operating costs

Concessionaires further need to take operating costs from their financial systems (general ledger) and categorise them into the appropriate cost categories. However this again is a categorisation exercise with no change in the reported level of costs.

1.3.3 Volume data

In order to model the impact of changes in demand on costs, the model requires information on the current level of demand in terms of services delivered to end users or other concessionaires.

In addition, information is required on the volumes relating to the internal operations of the business, such as head count.

[3] CCA Reference Paper - April 26th 2012

1.3.4 Cost volume relationships

Key network cost volume relationships (CVRs) are based on information supplied by concessionaires to ensure these CVRs reflect the networks deployed in Trinidad and Tobago. Due to the limited resources available to concessionaires in Trinidad and Tobago, the model has been designed to minimise the number of CVRs required. For some concessionaires, there will be no requirement to submit CVR data while for those concessionaires required to submit CVRs, the CVRs will only need to be updated when the cost structure of the network has materially changed.

In the absence of concessionaire-specific information, international benchmark data will be used to inform the CVRs.

1.4 Overview of the LRAIC modelling process and the CCA revaluation study

To ensure that regulated charges are in line with the current market environment and concessionaires' cost structures, the LRAIC model will be regularly updated. Concessionaires will be required to submit new input data for each update. This is an annual exercise and concessionaire-specific LRAIC and CCA data will be required within six (6) months of the concessionaire's financial year end. Such information must include Audited Financial Statements. In the event that audited financial statements are not available within this time, concessionaires may submit unaudited statements until the audited information become available.

Within each revision, the Authority will update the CCA studies for each concessionaire which will then form an input to the LRAIC modelling process.

The current versions of the LRAIC Specification Paper and CCA Reference Paper reflect the Authority's current approach. The Authority reserves the right to publish revised versions of either of these documents in the future, to reflect any changes to the overall market environment or other developments. This will be done in accordance with the Authority's Consultation Procedures.

The table below provides an overview of the LRAIC model development showing the roles of the Authority, Frontier Economics and the concessionaires at each stage and the anticipated timeline for each stage.

Table 1. Overview of the data collection process

Stage	Role of the Authority/Frontier	Role of concessionaire	Timeline
Issue of detailed data request	Issue data request which seeks to capture the information required to build the LRAIC model based on the specification	Seek clarification on any aspects of the data request not fully understood	**2 weeks**
Submission of initial LRAIC data	Review LRAIC data as it is submitted Request clarification of data submitted where necessary Provide clarification of data requested as required by operators Assist operators in methodological issues and identifying potential data sources	Submit data as it becomes available and before the deadline for data submission Provide clarification/validation of data requested as required within a reasonable time period	**6 weeks**
Submission of final version of LRAIC data		Submit final version of data and full documentation of methodology, sources and results	**5 weeks**
Input data submitted into LRAIC model	Input data into LRAIC model and sense check the outputs	Provide clarification where necessary	**5 weeks**

As set out in the table above, the data collection process will start with a detailed data request being issued by the Authority which consists of an Excel data template and detailed written guidelines on how to prepare data for the study.

Concessionaires are encouraged to submit data as it becomes available and to seek clarification from the Authority as and when queries arise. The Authority's staff will be available to concessionaires throughout the data collection process to assist with queries relating to the data collection that concessionaires may have.

The data collection process is an iterative process and it is envisaged that concessionaires will need to work closely with the Authority in order to prepare the requested data. Therefore, if further clarification is required with respect to the data requested and the data collection process, concessionaires should contact the Authority as queries arise rather than waiting until the final deadline for submissions

1.5 Outline of this document

The remainder of this document sets out the additional specifications required for the LRAIC modelling process. In particular:

- The overall methodological principles used to implement the approach set out in the Costing Methodology is covered in Section 2 of this document;
- The main model outputs are set out in Section 3;
- The networks contained within the LRAIC model are described in Section 4;
- The increment structure modelled is defined in Section 5;
- The input data required for the LRAIC model is set out in Section 6; and
- Section 7 provides an overview of the calculation methodology used in the LRAIC model (reflecting the specifications set out in Sections 2 - 5).

A series of annexes, setting out the structure of the LRAIC model, are attached. These annexes relate to:

- Annexe 1 sets out a glossary;
- Annexe 2 defines the network elements contained within the model;
- Annexe 3 sets out the increments defined within the model;
- Annexe 4 describes the LRAIC cost categories;
- Annexe 5 defines the CVRs within the LRAIC model; and
- Annex 6 contains a list of network services contained within the model.

2 LRAIC principles

This section introduces the LRAIC concepts and discusses the key assumptions that are applied in the LRAIC calculation.

2.1 Definition of LRAIC

Incremental cost refers to the change in cost resulting from adding or subtracting increments of demand for a product/service, where a company produces a multitude of products/services.

As a result, only those costs that would be incurred (avoided) if an increment of demand for a product or service was added (subtracted) are included in the incremental cost estimate for that increment. Costs that are fixed or common across increments do not form part of the cost of that increment.

In the LRAIC calculation, incremental cost is measured over the long run. This signifies that estimates of incremental cost should include both costs that may vary in the short run, such as operating expenditure, and also costs which vary in the long run such as capital costs.

Under a LRAIC approach, as set out in the Costing Methodology, incremental cost are estimated for increments of demand which relate to individual network elements rather than end to end services. The costs of end to end services are estimated through a combination of the LRAIC cost of the elements, service volumes and routing factors.

2.2 Summary of principles

The Costing Methodology sets out three principles that should be followed when calculating incremental cost estimates. These principles are:

1. A top down approach should be adopted.
2. Current cost and efficiency adjustments must be made to actual costs.
3. An Equi-Proportionate Mark-Up (EPMU) approach should be used to attribute common costs to increments.

A summary of the additional principles, that are also applied when building and populating the LRAIC model, are set out below and then described in more detail in the remainder of this section.

- LRAIC must be calculated based on the principle of scorched node rather than scorched earth.

- Thinning – existing transmission routes are required to provide connectivity between network nodes, independent of the scale of activity.

- Service levels – it may be assumed that existing levels of quality of service are maintained.

- Mix – the mix of demand characteristics that impact on the volume axis of a cost function should be assumed to be constant with respect to scale.

- Recovery of fixed common and joint costs – the EPMU approach is to be applied for the recovery of fixed common and joint costs individually on a cost category by cost category basis rather than as a mark-up across all costs.

These principles are widely used in other top down LRAIC models. The choice of the approach takes into account the need, as far as possible, to ensure that output LRAIC prices reflect cost causality and hence results in efficient prices. The principles have also been derived from experience in implementing LRAIC models, to ensure the implementation is based on readily available information and the implementation is proportionate. The principles are explained in more detail below.

Top down

A top down model is based on (and reconciles to) the actual costs of the business under consideration. Therefore the top down modelling approach analyses the level of costs for the modelled concessionaire's business and determines the extent to which they are incremental or otherwise with respect to the defined set of increments.

Current cost

The Costing Methodology requires that the cost models are based on current cost accounting (CCA) principles. Under CCA, charges related to fixed assets are based on the capital expenditure that would be incurred if an operator were to roll out a network today. Prices set on the basis of CCA place the incumbent and new entrant on a level footing and provide appropriate signals for entry to the market. As a result, interconnection and access charges determined using CCA asset values can provide new entrants with better 'build or buy' signals.. Therefore, CCA is generally preferred to historic cost accounting (HCA) for the determination of regulated charges.

Before LRAIC can be calculated, the HCA based costs of each concessionaire's assets reported in statutory accounts are therefore adjusted to reflect the current value of the equipment. This is undertaken in a separate CCA study, which is discussed in more detail in the CCA Reference Paper.

Scorched node

The current network structure of the concessionaires reflects the current level of demand and may not reflect the optimal network architecture if the network were designed from a "green field" scenario given a lower level of demand. As LRAIC involves calculating the avoidable costs of removing incremental volumes from the stand-alone network, it is necessary to consider how the design of the network might be affected if the network had to support lower volumes.

The LRAIC model uses a scorched node, as opposed to scorched earth assumption when reducing the network to the minimum point. The scorched node assumption states that the minimum network point equates to a notional network in which every existing network node is maintained, but at a minimum level of capacity. For example, at the minimum point in a fixed network it is assumed that all present nodes are maintained but at the smallest capacity that is technically viable. This smallest capacity network is defined to be the minimum network and the cost reflects the minimum cost of operating an equivalent network.

Thinning

In order to compute the smallest technically viable capacity, the thinning principle will be adopted. Under this principle, each route or operational function is "thinned down" to the theoretical minimum required to support the delivery of one unit of any existing product over the routes or activities that are currently serviced.

Mix

The LRAIC model has been built with the assumption that the mix of demand characteristics that impact on the volume axis of a cost function is assumed to be constant with respect to scale. That is, as volume is reduced to the minimum point, the existing demand profile (in terms of type of customers, relative demand for services, call duration, etc.) should not be altered.

Service levels

When reducing the capacity of the network to the minimum point, it is assumed within the LRAIC model that network performance and quality of service should be maintained at current levels. If the number of alternative routes is reduced, then network performance may not be maintained in some cases. For example, the percentage of dropped calls is partly a function of the number of alternative routes in the network. Therefore, it may be necessary to include some duplicate equipment at the minimum point to ensure that current service levels can be adequately maintained.

Recovery of fixed common and joint costs

One of the outputs of the LRAIC model is the cost of network components including a mark-up to cover fixed common and joint costs. This mark-up is calculated on the basis of EPMU on a LRAIC cost category by cost category basis.

Fixed common costs are those, which span more than one of the increments identified and are invariant to changes in a concessionaire's volumes.

Joint costs are also costs that span more than one increment and are predominantly variable with respect to volume, in contrast to fixed common costs. Some element of these joint costs may also be fixed. For example, the cost of transmission equipment varies according the volume of traffic carried over the network. However, there is a fixed cost associated with the minimum "thinned" network that covers all routes.

The LRAIC model has been designed so that the fixed common and joint costs between increments are recovered by use of an EPMU, whereby fixed common costs are recovered pro rata to incremental costs. The model calculates common costs for subsets of increments, (such as the network) on a cost category by cost category basis as set out below.

- For each LRAIC cost category the sum of component incremental costs (where each component is removed in turn) is compared to the incremental cost for the subset of components as a whole (where all components are removed at once).

- The difference between these two sets of costs is the fixed common and joint costs across these increments for this cost category. These common costs to the subset of components are then allocated to the components using an EPMU approach.

3 LRAIC model outputs

This section provides further discussion of the outputs of the overall costing process. The requirements for the model outputs are driven by the nature of regulation which may vary for different services. This will then feed into the definition of the increments (see Section 5 and Annexe 3) which will be determined as an output of the LRAIC modelling process.

Wholesale and retail services that are subject to *ex ante* price controls may require a full determination of the costs associated with the services. For wholesale services subject to retail minus price regulation, only the cost of the retail and customer service operation would be required. Assessing the potential anti-competitive practices may require the estimation of the incremental costs of different services or of the cost differential between retail and wholesale services. The Authority may also use the model as an input to calculate the size of any access deficit. The Authority should therefore be able to use the LRAIC model outputs to cost different components and activities to cater for these requirements including:

- network components including a division between subscriber sensitive (access) and traffic sensitive (core) components;
- costs associated with non network activities related to serving end users (retail activities);
- activities related to serving wholesale customers; and
- corporate activities.

3.1 Ex ante regulatory requirements

Where there is a regulatory requirement that a concessionaire is required to provide cost estimates for its services, with the completion of this model, these estimates must be based on the LRAIC approach.

As the relevant markets for call termination is defined as call termination on an individual operator's network, then all concessionaires offering voice services including call termination shall be dominant in at least that market and thus must produce LRAIC service costs.

In addition, and as stated in the Price regulation Framework the Authority will only consider imposing ex ante price regulatory mechanisms in those markets which have been classified as contested or un-contested. Markets with higher HHI levels will be given more consideration by the Authority in determining

whether there is need for conducting dominance assessments or whether ex ante price regulation mechanisms should be imposed. Such markets are further defined in the Table below.

Table 2. Product and service markets

	Retail	Wholesale
Domestic fixed	Narrowband (voice) access	Unbundled access
	Broadband access	Broadband access
	Voice services	Internet services
	Narrowband internet	Interconnection services – origination
	Broadband internet	Interconnection services – transit
		Interconnection services – termination
		Domestic leased circuits
International	International voice calls	International leased circuits
		International fixed termination
		International mobile termination
		International fixed origination
		International mobile origination
Domestic mobile	Voice calls	Interconnection services – origination
	Messaging services	Interconnection services – termination
	Narrowband internet	
	Broadband internet	
	Roaming	

Table 2. Product and service markets

	Retail	Wholesale

Source: "Price Regulation Framework for Telecommunications Services in Trinidad and Tobago", Telecommunications Authority of Trinidad and Tobago

The model should therefore provide inputs to costing products and services in the relevant markets defined. The model further needs to take into account any services that:

- are provided over the same infrastructure as the above, as this may change the scale of the infrastructure and hence the cost that are incremental to the above services; and
- share common cost with the above services; as this may impact the portion of common cost that is allocated to the above services.

The ex ante determination of these relevant markets, means that the output of the model process in terms of service costs is defined. However as the market develops the structure of the relevant markets may evolve. Thus the LRAIC model reflects a forward looking view of networks, as far as this is possible and proportionate.

It should be noted that the market definitions are technology neutral. The LRAIC model needs to take account of services in the same market carried using differing technology, for example voice calls carried over legacy TDM networks or as voice over IP packet switched networks or mobile calls carried over 2G, 2.5G or 3G networks. However for the purposes of service costing, the LRAIC model does not explicitly produce separate costs for services using differing technology.

While the focus of the cost modelling is on network costs, total retail specific costs are also identified separately within the modelling. Given that retail costs are typically subscriber driven rather than product driven, retail costs may be considered to be joint and common costs across services. Estimates of the costs of retail services may be estimated by applying appropriate mark ups to the costs of network services.

3.2 Ex post competition cases

In some cases adverse competitive behaviour is not pre-empted and regulated accordingly. In such cases regulators or competition authorities often face the

need to assess whether prices have been consistently set at adverse levels. Whether a pricing behaviour reflects normal competitive behaviour or only intends to harm competitors the Regulator must analyse the price relative to the cost of service provision.

Given that the nature and scope of *ex post* competition investigations cannot be defined in advance, the LRAIC model has been developed to be flexible enough to provide inputs to the process for any services or markets required.

3.3 Potential efficiency adjustments

The Costing Methodology requires the Authority to undertake an efficiency study for all dominant concessionaires as part of the LRAIC modelling process.[4] This is to ensure that the LRAIC model unit cost results reflect an efficient level of costs of providing these services.

The LRAIC model produces estimates of the costs faced by concessionaires in Trinidad and Tobago based on top down data provided by the concessionaires. Since being based on information on concessionaires' actual cost base and network structure, this data may include inefficiently incurred costs arising from potential current inefficiencies in operations or past inefficiencies in investment. Although the LRAIC model is based on current cost accounting (CCA) data (rather than historic costs), this CCA revaluation process does not control for any potential inefficiencies of concessionaires.

As such, the Authority has undertaken a separate efficiency study which assessed the need for any efficiency adjustments to the LRAIC modelling results of concessionaires.[5] This study aimed to determine, for each concessionaire, whether any efficiency adjustments to the LRAIC modelling results are needed, and if so, how large these adjustments shall be (i.e. the efficiency adjustment factors). If required, these efficiency adjustment factors may then inform the Authority's process of determining regulated prices based on the LRAIC cost results (i.e. by applying the efficiency adjustment factors to the LRAIC unit cost values).

The exact process of determining particular regulated prices will be determined on a case-by-case basis and the Authority will issue further communication on these processes closer to the time of determining the relevant prices. The Authority shall be guided by its Consultation Procedures in this regard.

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4 See Section 5.1 of "The Costing Methodology for the Telecommunications Sector", 29 May 2008

5 Methodology for an Efficiency Study, 09 May 2011

4 Networks to be modelled

A range of networks are used by the various concessionaires to provide the wholesale and retail services and the costs of these therefore need to be estimated. For fixed markets, quite different networks are deployed by concessionaires to deliver products in the same markets. For example, networks that employ twisted pair copper cable, fibre, co-axial cable and wireless technologies are all used to deliver fixed services in Trinidad and Tobago.

The LRAIC model has been designed to be sufficiently adaptable to allow costing services for all concessionaires based on their respective mix of networks whilst being sufficiently generic to ensure that cost estimates resulting from the different concessionaires are comparable.

Where an indexation approach has been used to revalue assets (the default approach), the LRAIC model reflects the current network structure and cost volume relationships. Where the CCA revaluation has been carried out on a Modern Equivalent Asset (MEA) basis the LRAIC model also reflects the MEA technology both in terms of the increments defined in terms of network components and the cost volume relationships modelled.

4.1 Access Networks

Different concessionaires will be using differing networks to deliver services. Traditional fixed wireline, CATV, fixed wireless and mobile (cellular) access networks differ clearly in terms of structure, costs and capabilities to such an extent that the model needs separate cost categories for each type of network.

4.1.1 Fixed access Networks

Even where networks offer similar services to the end user (for example fixed voice calls can be provided over traditional fixed wire line access networks, cable television networks and fixed wireless networks), the networks differ to such an extent that differing cost categories will be needed for each type of network.

Therefore, the Authority has decided to include cost categories and network elements for four principle types of fixed access networks in the model:

- traditional fixed wire line networks, using twisted pair copper to deliver services;

- traditional co-axial and hybrid fibre co-axial (HFC) cable television networks;

- fibre networks connecting directly to end user premises based on point to point connections or passive optical networking (PON) technology; and

- fixed wireless networks including broadband wireless access (BWA) networks.

A single operator may operate a range of different access technologies. For example over time it is likely the some customers currently served using traditional twisted pair copper will be migrated to fibre connections.

4.1.2 Mobile access Networks

The two principal mobile networks for voice traffic use the GSM family (GSM/GPRS/EDGE) standards. In addition, the incumbent mobile provider operates a CDMA network, principally for data services. If 3G (UMTS) services are introduced it is likely that these networks will be introduced as an overlay to the existing GSM networks, with customers with dual mode handsets using either network depending on both the availability and capability of the network.

The existence of multi-mode handsets and the sharing of towers and, in some cases, the core network between different technologies means that it is effectively impossible to separately cost networks or the services that use these networks. For voice services there is little or no differentiation between services offered by the different networks from the perspective of the user.

In addition cellular access networks tend to have similar structures across differing technologies even if the implementation of standards by different vendors may differ somewhat.

For these reasons, the Authority has decided not to distinguish between the differing technologies used currently, and technologies that may be introduced in the future, for the purposes of service costing on the basis of the LRAIC model.

4.2 Core network components

In the long term it is expected that mobile and fixed access networks will be served by a single converged packet switch network based on IP/MPLS technology. Currently voice traffic is generally switched using traditional TDM switches, while data services are carried over a range of overlay networks. In addition where operators have both mobile and fixed networks the switches for these are generally separate although there is typically some sharing of underlying infrastructure such as buildings or transmission.

While the convergence to a single integrated IP/MPLS network carrying both narrowband voice and broadband data traffic is the long term target, this is unlikely to be achieved in the short to medium term. Indeed those operators who had hoped to be at the forefront of such a migration, for example BT with

its 21CN, are now expecting to continue to run traditional TDM switches for a number of years.

Therefore, the Authority has decided to maintain separate cost categories for fixed and mobile network components and for narrowband voice components and data components. These cost categories are set out below:

- fixed dedicated voice components such as traditional TDM switches and soft switches;
- fixed (or converged fixed and mobile) broadband data components including DSLAMs, aggregation nodes and routers;
- mobile specific voice components such as mobile switching centres (MSCs);
- mobile specific data components, such as SMS messaging centres (SMSCs).

As networks converge over time the LRAIC model will need to be populated in a way that reflects this convergence. For example, where narrowband voice traffic is carried over the packet switched network also used for broadband traffic (voice over IP), this usage of a converged network will be included through the routing factors for the relevant services. When this transition is complete the legacy components defined in the LRAIC model will no longer be needed.

5 Increments

This section begins with a high level overview of the cost categories, increments and network elements and then continues to describe them in further detail. This section also sets out the increment hierarchy within the LRAIC model.

5.1 Cost categories, increments and network elements

The LRAIC model attempts to attribute costs of each of the concessionaires to individual network services. Network services are the access and conveyance services underlying both wholesale and retail services provided to other concessionaires and end users respectively. The costs of these services exclude any retail or wholesale specific costs such as product management and customer care. In order to carry out the attribution, a number of intermediate stages are defined:

- cost categories into which the costs of the concessionaires are mapped;
- increments for which incremental costs are calculated; and
- network elements consisting of sets of network components, to which costs are attributed as an intermediate step in the service costing process on a LRAIC basis.

These concepts and the relationship between them are described in further detail below.

5.2 Definition of network elements

Network elements are one of the building blocks of regulatory cost accounting and are used to represent logical network components. Service costs are calculated by attributing the cost of network elements across the services that utilise the element based on routing and usage factors.

In order to identify the appropriate network elements, services should be separated into five broad groups of services delivered by logically separate network. These service groups consist of:

1. fixed access services;
2. fixed narrowband conveyance services;
3. fixed broadband services;
4. leased line services; and

5. mobile voice and data services;

When defining network elements, the Authority has taken into account whether a single cost driver can be used to allocate the cost of the element between services. This means that network elements do not typically include any routing within the element itself.

5.2.1 Fixed access

The fixed access network is generally considered a single network element in LRAIC models developed for fixed line incumbents, with the cost driver being the number of lines. This reflects the dedicated access nature of traditional twisted pair infrastructure, where each subscriber has dedicated capacity from their premises to the MDF

Other technologies, such as point to multi-point wireless and HFC cable TV networks include an element of shared access in the access network since a number of customers shared a fixed amount of bandwidth. The costs of these network elements are however also driven to a significant extent by the need to provide 'coverage' of customers, i.e. the ability to connect potential customers. In a fixed network there will be a relationship between the coverage of the network and the number of customers served, with increased coverage benefiting the additional customers that can be served. Recovering costs of these elements of the access network will therefore reflect both cost causality and the distribution of benefits. It will also increase the degree of comparability between the different access methods used by the concessionaires. Given the above, the Authority has defined three network elements for access networks:

- fixed dedicated access, which include traditional wireline networks, and other networks with dedicated capacity to a single customer such as point–to-point wireless and direct fibre connections;

- HFC cable access, which include those elements of access networks for cable TV networks; and

- fixed wireless access, which include point-to-multi-point technologies such as WiMAX as well as point to point systems.

The implicit separation of these network elements into subscriber sensitive and traffic sensitive elements will be dependent on the drivers used as the inputs to the related cost categories in the LRIC model. These are outlined in the table below for the three broad categories of fixed access networks

Table 3. Fixed Access Network Drivers by Network Type

Type of network	Driven by number of subscribers	Driven by both subscribers and traffic	Driven by traffic only
Fixed wireline	Copper local loop and access fibre	Local switches, DSLAMs, MSANs and optical line termination (OLT) equipment	Transmission equipment and fibre, tandem switches, routers, etc.
HFC cable	Co-axial cable network	HFC optical node	Transmission equipment and fibre, head end equipment, routers, etc.
Fixed wireless	Point to multipoint systems and point to point systems used to directly connect customers		Wireless and fibre based backhaul, routers, soft switches, etc.

Source: Frontier Economics

5.2.2 Fixed narrowband conveyance

The services in this group include voice call services: end to end calls; call origination and call termination.

A typical traditional TDM network has a four level switching hierarchy:

- remote switches/concentrators;
- local exchanges;
- transit switches; and
- international gateway switches.

Remote switches/concentrators and local exchanges to which subscribers are directly connected are further divided into the line card element which is dedicated to a single subscriber and those elements that are sensitive to traffic. There has been a trend towards flatter network hierarchies with,in some cases, local exchanges also acting as transit switches and switches acting as both national transit switches and international gateways. Within the LRAIC

methodology such 'collapsing' of layers in the network hierarchy can be achieved via the cost allocation of the relevant switch with dual functionality (for example, by allocating the costs to one or another cost category and then ensuring that the routing factors reflect the dual use).

Given that call services are routed through different levels in the network hierarchy, the corresponding transmission links between nodes will need to be separately identified.

Incumbent operators are gradually transitioning narrowband voice traffic to packet based soft switches, but the current topology is likely to endure for a number of years. During the migration from TDM networks to packet switched networks, both technologies will be in use, with a single call potentially using both technologies. Given the technology neutral approach set out in this paper, the LRAIC model does not attempt to separately cost calls carried over the various combinations of technology. Instead the routing factors reflect the mix of technologies in use for each time period with the resulting costs being a weighted average.

New entrant fixed operators who have rolled out voice networks more recently are likely to use flatter networks based on soft switches, rather than traditional TDM switches. In this case the network elements used should reflect the lower number of levels in the hierarchy, for example not including separate transit and international gateway switches.

5.2.3 Fixed broadband services

Services in this group include broadband services' typically used for internet access. Incumbent fixed operators, using ADSL to deliver the access part of the service typically have a four level hierarchy (mimicking the hierarchy in the narrowband network) consisting of:

- DSLAMs (Access Nodes);
- aggregation nodes;
- core routers; and
- broadband remote access servers (BRAS).

Each of these levels is defined as a network element, along with the transmission links between them.

Other fixed networks, such as fixed wireless access (FWA) operators have less complex network hierarchies and should map their respective network components onto the relevant network elements.

5.2.4 Leased line services

Leased line services provide end-to-end connectivity between two customer (wholesale or retail) premises. Typically they consist of two "tails" providing connectivity from the customer premises to the network and matched capacity within the core/aggregation network.

The appropriate driver for the access part is the capacity of the links. Generally the leased line will be provided over the existing fixed access network. Thus the Authority has decided not to define a separate network element for leased line access.

For the core element, leased line transmission is shared with other transmission. Thus for leased line services the Authority has decided to define a single network element: leased line transmission capacity[6].

5.2.5 Mobile networks

GSM networks

The main mobile networks are GSM and as such are highly standardised.

The base station subsystem consisting of the base stations (BTS) and base station controllers (BSCs) and the backhaul networks between them can be considered a single network element. Unlike the traditional fixed network, this is a shared access network and so the appropriate driver is traffic based rather than the number of subscribers.

The relatively small mobile networks in Trinidad and Tobago appear to have a flat switching hierarchy. As such there is no need to distinguish between types of MSC.

Other network components also need to be included as separate network components. In particular:

- location registers – the home location registers (HLRs) and the visitor location registers (VLRs) where they can be separately identified;
- the SMS message centre (SMSMC); and
- packet switched data network (SGSN, GGSN and so on).

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6 At the network level there is no distinction between leased lines bought by end users ('retail') and those bought by other concessionaires ('wholesale') although there may be differences in the types of lines bought and the level of customer care offers which may be reflected in prices.

Evolutions of GSM technology, such as 3G (WCDMA) and LTE are likely to be added to the network over the coming years. The associated equipment can be allocated to the corresponding GSM network categories.

Other mobile networks

The direct costs of other mobile networks which carry predominantly non-voice traffic, such as paging networks and CDMA networks, are separately identified.

5.3 Definitions of increments

Under a LRAIC approach the LRIC output of the model is the cost of the network elements which are then used to determine service costs. In general, the network elements are defined as the sub-increments in the costing. Larger increments, consisting of sub-sets of network elements, are also defined at higher levels in the increment hierarchy. This allows the recovery of common costs across network elements in a manner that reflects cost causality where possible.

In general, the network elements identified above are physically separate components and thus can be defined as increments at the lowest level in the increment hierarchy. However there are two principal exceptions.

- The first is remote concentrators/switches, hybrid fibre coaxial (HFC) optical nodes and local switches which sit on the boundary between the core and access networks. These elements were decomposed into logical network elements by applying appropriate Cost Volume Relationships.
- The second is the core transmission network where the same set of components, for example making up a SONET ring, is often used to deliver a range of the transmission network elements set out above.

5.3.1 Transmission

While in theory it is possible to estimate the incremental costs of the individual network elements for the transmission network, in practice the resources required may not be proportionate given the limited accuracy of the results. For the transmission network the Authority has decided to include an increment as the combined set of relevant network elements and then to allocate costs to the network elements as a separate stage.

5.4 Cost categories

Concessionaires need to categorise costs according to a defined set of cost categories for the purpose of inputting costs to the LRAIC model. For the purposes of the CCA study, assets may need to be further disaggregated than is

required for the LRAIC modelling. For example if assets in a single LRAIC cost category have different asset lives then the assets need to be separated for the purposes of calculating the CCA capital charges.

Relationship between increments, cost categories and network elements

In many cases there is a one-to-one mapping between a physical asset and an increment and hence a logical network element (for example a Mobile Switching Center). Where such a relationship exists, the cost categorisation is designed to allow the separate identification of the relevant assets and related cost categories.

However, in other cases a physical asset, for example a duct, is mapped to a number of increments reflecting a more complex causal relationship. Similarly, most network operating expenditure do not have a one-to-one mapping to increments and network elements. In this case, the cost categories are defined in such a way as to allow cost causality between the increments (and underlying network elements) and costs to be accurately captured.

5.5 Defining the increment hierarchy

The network elements or sets of network elements defined in Section 5.3 form the lowest level of the increment hierarchy. However, a number of intermediate levels (known as an increment hierarchy) are typically defined for two reasons:

- first, to provide aggregate estimates of the costs of groups of activities broadly consistent with "businesses" defined for accounting separation purposes; and

- second, to identify fixed and common costs between groups of network components in order to calculate EPMU to recover these costs.

The increment hierarchy in the LRAIC model consists of five levels as set out below.

- **Level 0** – at the highest level the whole enterprise can be considered as a single increment, with the incremental cost equal to the total cost of the business;

- **Level 1** – the total business can be divided into the network increment consisting of the cost of operating and maintaining the network, the "Retail and other" increment which consists of non-network activities;

- **Level 2** – the network can be divided into mobile networks and fixed networks. As in integrated fixed/mobile business the fixed network makes greater use of the transmission network, in this case the transmission

network can be included in the fixed network. The "Retail and Other" increment can be divided into "Retail", "Wholesale" and "Other";

- **Level 3** – the mobile and fixed networks are divided into "core" and "access" networks;

- **Level 4** – the lowest level of increments (in most cases corresponding to network elements).

6 LRAIC model inputs

This section discusses the inputs to the LRAIC model and how they integrate to calculate the LRAIC of the defined increments.

The basis for construction of a top down model is that for each activity which gives rise to costs, a cost driver must be identified. The cost driver must be a measure for each activity and the cost of the activity should be wholly dependent on the level or volume of the cost drivers. Thus the identification of appropriate cost drivers for each cost and applying the defined relationship between the costs and their respective drivers is the primary task of the top down model.

This means that the LRAIC model requires the following key inputs:

- base cost information used in the model;
- the cost of capital applied to the mean capital employed;
- LRAIC cost categories;
- cost drivers;
- CVRs;
- hierarchy of dependencies; and
- increment specific fixed and common costs (ISFC).

6.1 Base cost

As part of CCA and LRAIC modelling processes, concessionaires are required to provide information on their current, annual cost base, including amongst others annual operating expenditure, HCA-based information for fixed assets and balance sheet items. The fixed asset data forms the input to the CCA study undertaken by the Authority, the results of which then feed into the LRAIC model.

To facilitate this data collection process, the Authority has prepared a data request template file and accompanying guidelines which are published and resubmitted to concessionaires each year.

Operational expenditure, direct costs and cost of sales

Concessionaires are required to provide operating expenditures, direct costs and cost of sales based on a specified template provided to them by the Authority as part of the LRAIC data request.

Depreciation

The depreciation charges included in the LRAIC model are based on CCA and form an output of the CCA study undertaken by the Authority for each concessionaire. The methodology for this is set out separately to this document in the CCA Reference Paper.

Capital employed

The value of capital employed included in the LRAIC model for fixed assets is the Net Replacement Cost (NRC) taken from the outputs for the concessionaire-specific CCA study undertaken by the Authority. For current assets and current liabilities the values are taken from the balance sheet and will be classified into the appropriate cost categories. The methodology for this is set out separately to this document in the CCA Reference Paper.

Taxation and Finance Costs

The model excludes all direct costs relating to financing of the business and taxation, for example interest payments, foreign exchange gains/losses, taxation and the working capital associated with these cash flows. The cost of capital, which is calculated pre-tax, implicitly provides for the recovery of these costs, implicitly including a premium to take account of issues such as exchange rate risks.

Other financial costs relating to the operation of the business, for example collection costs associated with customer billing should be included in the relevant operational expenditure category. One off exchange rate adjustments, both positive and negative, are excluded from the cost base used as input to the LRAIC model.[7]

6.2 Cost of capital

The cost of capital estimates the return that a concessionaire must be expected to earn on the capital it employs in its business in order to attract investment funds. As such, it plays a key role in estimating the overall cost of the business and hence of services. The cost of capital is typically measured using a weighted

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7 Currency adjustments are by their nature unpredictable, with the possibility for the adjustments to vary over time or even change sign from one reporting period to the next. There is no reason to believe that the level and direction of currency adjustments in a given accounting period provide any information on the direction or level of future currency adjustments. The Authority therefore considers zero to be a reasonable expected exchange rate adjustment forecast. Given that the aim of the LRAIC model is to estimate the level of forward looking efficient costs for services excluding currency adjustments is likely to provide a more accurate estimate of these forward looking costs.

average cost of capital (WACC) and includes both the cost of equity and debt finance, weighted by the assumed debt to equity ratio for a company.

The Authority has undertaken a separate study to determine the WACC values for different groups of concessionaires[8]. These values form an input to the LRAIC model. The WACC study may be updated as networks evolve and the most recent publication should therefore be referred to.

6.3 LRAIC cost categories

In the LRAIC model the cost data is supplied on the basis of LRAIC cost categories. To group cost information together into a LRAIC cost category it is necessary that:

- costs included share the same driver; and
- costs included have the same dependencies with regard to other cost drivers further down the driver hierarchy.

The LRAIC cost categories are grouped into nine categories:

- fixed and mobile network components;
- network infrastructure and support equipment (such as network power equipment and network buildings);
- non-network assets (such as office furniture and billing systems);
- network activities (including network maintenance);
- product management (for example, interconnect product management);
- support activities (such as human resource and finance department costs);
- network Opex
- general and administration expenditure
- direct costs, cost of sales, and so on (such as interconnection out payments); and

[8] The Weighted Average Cost of Capital, May 9th 2011

- balance sheet items.

Annexe 4 contains a full list of the cost categories.

6.4 Drivers

For each of the LRAIC cost categories, a cost driver, or in a small number of cases two cost drivers, have been identified. The cost driver of a LRAIC cost category is considered to be the variable(s) which influences the level of costs in the cost category through the volume or dimension of the network component or activity purchased. The respective unit cost of the cost category is not a direct input to the LRAIC model (although may form an input to the CCA valuation).

Drivers can be classified into two broad groups.

First, exogenous drivers are directly dependent on levels of demand for services as specified by the increments. For example, the cost of a mobile network BSS is driven by the volume of BSS traffic.

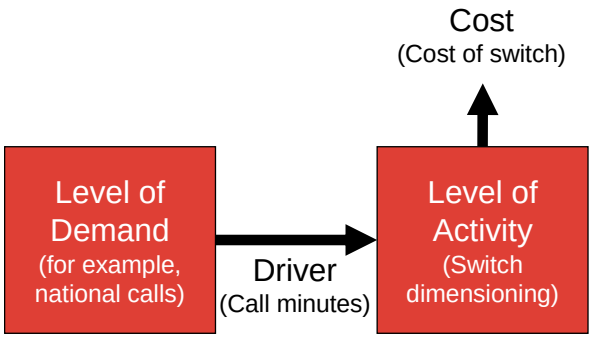
Second, endogenous drivers are dependent on internal demand from other activities within the concessionaire's business and their related cost categories. For example, the cost of HR (human resources) department is driven by the number of employees in the business, which in turn will depend indirectly on the demand for services as defined by the increment.

These two broad groups are described in further detail below.

6.4.1 Exogenous cost drivers

Some activities and hence costs are driven directly by the level of demand as shown below. Activities or cost categories that are driven directly by demand are only dependent on the level of the increments. Such drivers are "exogenous" drivers, i.e. the level of the drivers is dependent on demand which is external to the concessionaire.

Figure 1. Exogenous cost drivers



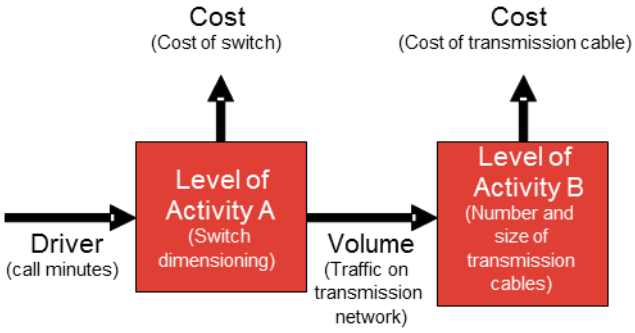
The increments have been specified so that exogenous drivers are dependent on a single increment. For instance, BSS equipment cost is driven by the volume of BSS traffic. As a result these drivers are set either at 100% or 0% of current demand during the calculation of incremental costs.

6.4.2 Endogenous cost drivers

Endogenous cost drivers are those that are dependent on internal demand for activities and only indirectly on external demand.

For many activities and hence costs, the causal link between demand and the level of costs is indirect. For these activities (e.g. Activity B below), the level of their corresponding drivers is dependent of the level of other activities (Activity A below), which in turn is dependent on the input drivers for these other activities as illustrated below. Such drivers are endogenous, i.e. dependent on demand which is internal to the operator.

Figure 2. Endogenous cost drivers



The LRAIC model uses five different types of endogenous drivers:

- endogenous network drivers;
- non-network endogenous drivers;
- employee drivers;
- gross replacement cost drivers; and
- other cost drivers.

Endogenous network drivers

Endogenous network drivers drive the costs of network support cost categories. As the dimension of network components (such as MSCs) vary in response to changes in demand, the demand for network support functions will also vary. Linear relationships are used to drive the relationship between the dimensioning of network components and the demand for network support equipment. For example, network floor space is is proportional to an endogenous network driver, namely the floor space requirements of network components which in the model is proxied by the replacement cost of the associated equipment.

Non-network endogenous drivers

Non-network endogenous drivers drive the cost of some non network activities. For example demand for vehicles is driven by a combination of network operations and other commercial and administrative activities. These drivers are defined by the base level of the driver associated with each activity (for example

the number of vehicles in each department) and the relationship between demand for the activity and the level of the driver.

GRC drivers

GRC is used as a driver where it is believed that the driver for a cost category (typically a network support cost category), can be a reasonable proxy of the total acquisition cost of the equipment it supports. Intuitively, it seems reasonable that there will be a strong degree of correlation between the support costs of equipment (which will increase with the number and complexity of network components), and the replacement cost of the equipment (which will also increase with the number and complexity of network components). Using GRC as a driver also has the following advantages:

- it is a common cost driver that can be applied to all assets; and
- a common CVR can be used because GRC can be assumed to vary in the same manner as annualised costs.

Employee drivers

Employee drivers are used for LRAIC cost categories for which the values are expected to vary in relation to the number of staff, either in total or for a department or group of departments. Examples of LRAIC cost categories driven by employee numbers include HR costs or the cost of office machinery (PCs, office furniture, etc.).

Other cost drivers

Some activities, for example finance, can be considered to be driven directly by the total costs of a given subset of activities (or in the case of finance, all activities). The drivers here are thus the costs of the relevant activities calculated in the LRAIC model.

6.5 CVRs

In order to calculate LRAIC, it is necessary to understand how costs vary according to the volume of services produced. CVRs are used to define how costs change as the volume of the driver also varies. The quantification of the relationship between the volume of services offered and the cost of providing those services is fundamental to the calculation of LRAIC.

CVRs are typically expressed as two-dimensional charts, plotting the relationship between the value of the volume driver and the value of the affected cost category. The relationship can be mapped with cost driver volumes on the X-axis

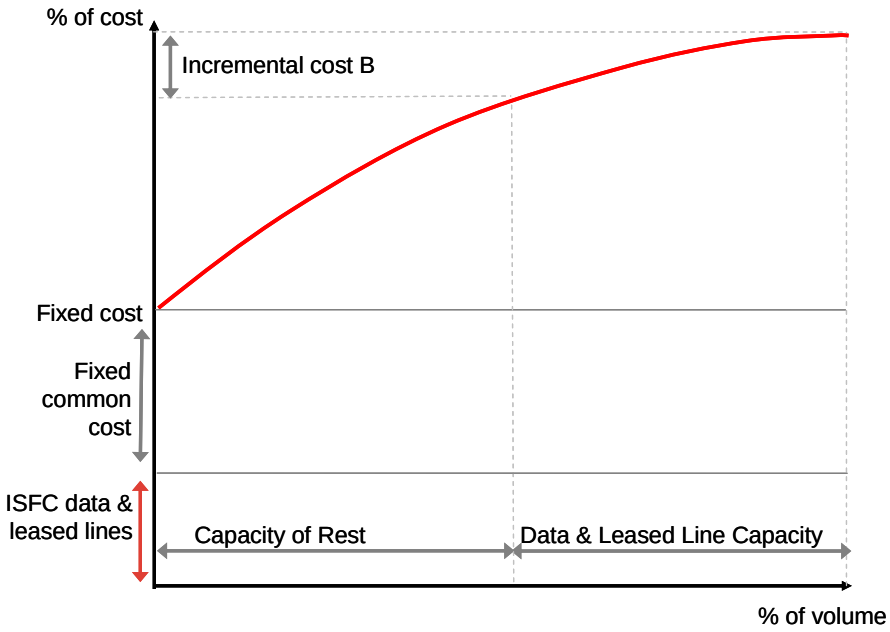
and the costs, caused by the cost driver, on the Y-axis, and with both costs and volumes expressed as percentages of current values.

The two key characteristics of CVRs are:

- the shape of the curve, reflecting the relationship between variable costs and volumes; and
- the extent of fixed (and/or common) costs exhibited in the relationship (the X-axis intercept).

In Figure 6, two increments, A and B, drive the total volume of the cost driver. The incremental cost of B is shown given that increment A is already produced.

Figure 3. A typical CVR



For some LRAIC cost categories there are fixed costs. That is, costs do not fall to zero as the volume of the cost driver falls to zero. The intercept with the y-axis of the CVR represents the fixed cost associated with the cost category. A fixed cost may either be uniquely associated with the production of one increment or shared between increments.

Increment specific costs

That portion of the fixed cost that is not shared with any other increment is known as increment specific fixed costs. These costs are included as part of the incremental costs of the increment they are associated with.

Shared fixed costs

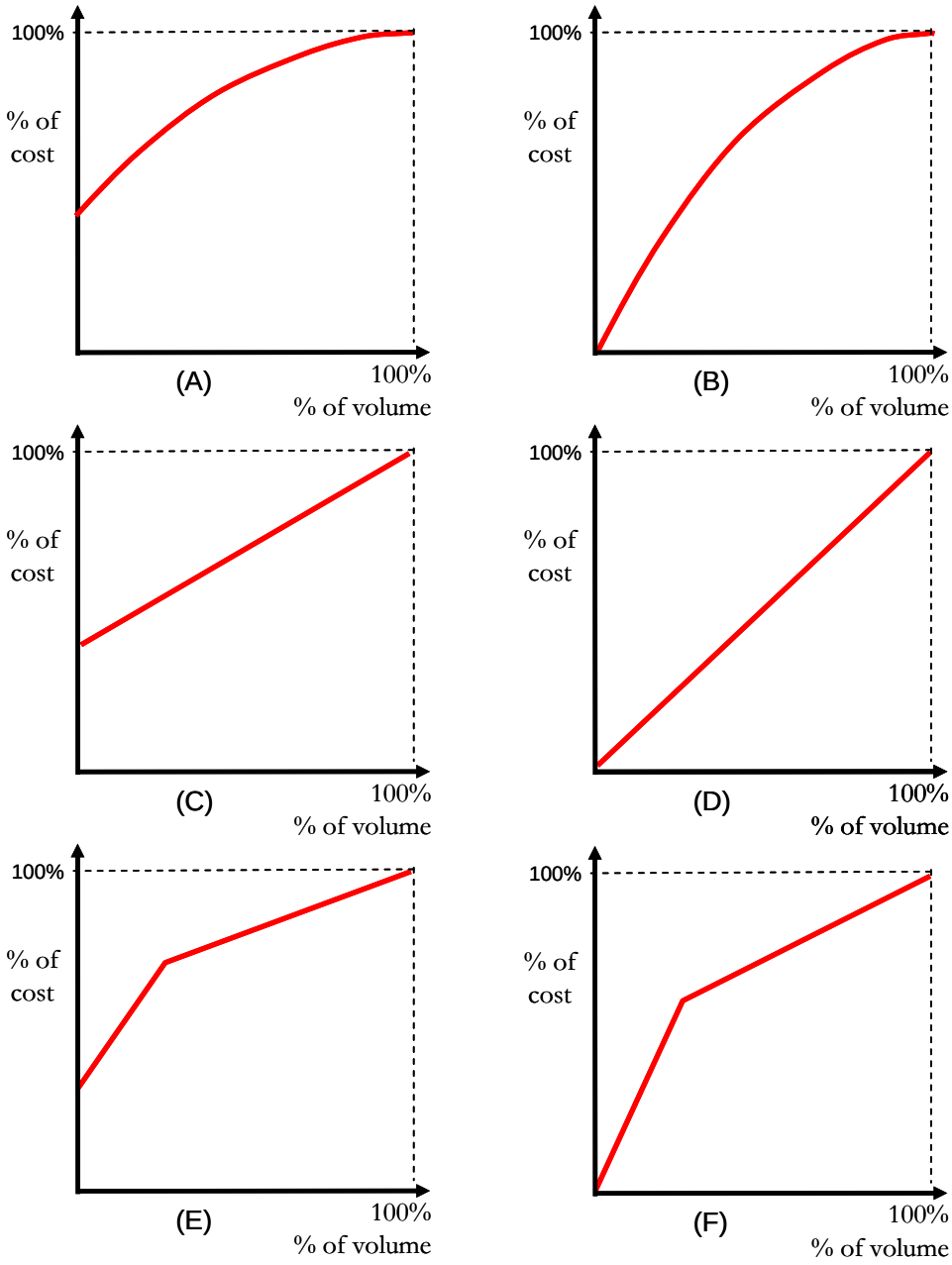
Fixed costs which are not increment specific are called fixed and common costs. The existence of such costs indicates the presence of economies of scope[9].

The mapping of CVRs to cost categories can be one to one or one to many, as different cost categories may share the same cost driver and the same CVR. However, a CVR can only be shared by cost categories where the cost causality for each cost category is identical.

CVRs can take many forms, a selection of which are represented graphically as shown in **Figure 4**.

[9] Economies of scope are present when it is more cost effective to produce two or more outputs together rather than separately.

Figure 4. Typical CVR functions



In order to simplify the information requirements and the calculation, the Authority has made the assumption that all CVRs are linear with a fixed cost [(C) above]. The input data for CVRs of this form is reduced to the percentage of the cost that can be avoided when the relevant cost driver has zero value, i.e. the intercept with the Y-axis.

In developing the cost model, the Authority has paid regard to the need to minimise resources required to develop CVRs where appropriate, by making simplifying assumptions:

- CVRs are not required for those cost categories driven by a single exogenous cost driver, as this driver is either set to the current level of demand or to zero, at which point the modelled cost of the cost category is zero. This results in a significant reduction in the amount of resources required to develop CVRs compared to the practice in other countries, such as the UK, where CVRs are required for all cost categories.

- In the current version of the model it is assumed that that CVRs for cost categories driven by endogenous cost drivers are linear with no fixed costs (i.e. costs are directly proportional to the driver), unless specified otherwise by the concessionaire.

- CVRs are required for all cost categories driven multiple cost drivers. These have been defined in terms of the value when each of the drivers in turn has been set to zero, that is the degree to which costs are avoidable due to reductions

As a result inputs are only required for CVRs for those cost categories driven by more than one driver. These are set out in Annex 5.

These CVRs are only required for a subset of concessionaires and hence not all concessionaires are required to submit CVR information. Where relevant concessionaires are not able to provide the required information to derive CVRs, the Authority will develop CVRs based on benchmarking data from other jurisdictions.

6.5.2 Development of CVRs

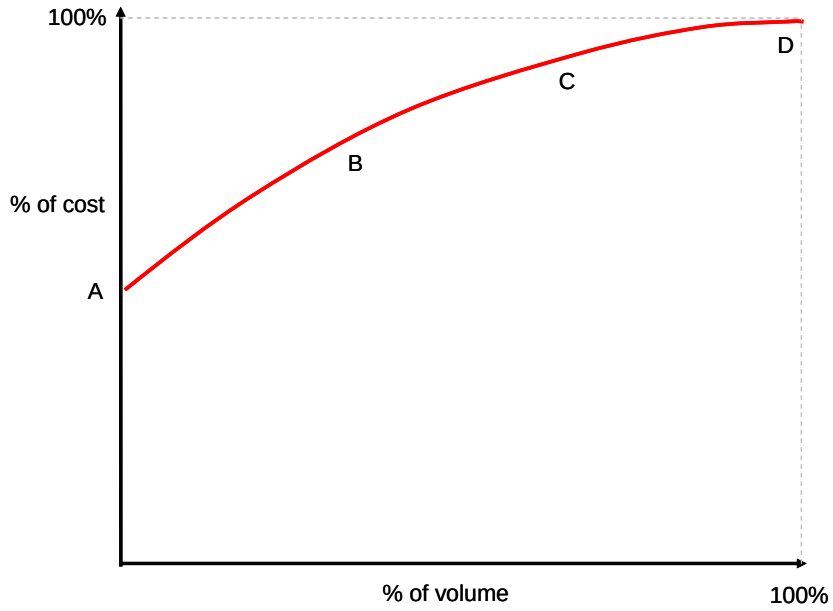
For each concessionaire the number of CVRs within the model depends on the networks used.

For each CVR required it is necessary to identify:

- the minimum point [Point A in Figure 5], as defined within the scorched node assumption;

- the maximum point [point D] which is the actual cost for the cost category or price of equipment.

Figure 5. CVR construction



The following process is undertaken for estimating each CVR required for a concessionaire:

- the current cost and equipment quantity relating to the CVR category is established. The current cost values and quantities are based on operator input; and
- the amount/volume of equipment relating to the minimum point is determined, which is then expressed in cost terms.

Sources of information

Whilst the maximum point of a CVR is obtained from inputs to the LRAIC model, it is necessary to estimate the minimum point. There are two main methods to do this:

- engineering simulation models(which is most likely to be initially used to estimate most inputs); and
- interviews and field research.

Engineering simulation models: For the required CVRs for network components, concessionaires are required to estimate the reduction in cost from moving drivers toward zero. This will require implementing engineering models.

The steps in the modelling process are as follows:

- break down the cost category into its components (for example, breaking the remote concentrators into individual components such as line cards, power supplies, etc.);
- determine the unit cost for each of the components;
- populate a model with data reflecting demand driving the component volumes;
- establish dimensioning rules linking demand to component volumes;
- apply the relevant unit costs to each asset component, in order to capture any difference in the mix of component parts; and
- modify the volume of the identified cost driver to derive a cost volume relationship.

Information from concessionaires (interviews and field research): By interviewing experts within each area that contributes towards the cost of a cost category, the concessionaries should be able to estimate the fixed and variable cost and hence the shape of the CVR. This relationship also takes into account reasons why costs may change as volume alters, such as vendor discounts and the impact of outsourcing services.

6.6 Hierarchy of dependencies

All costs within the LRAIC model are directly or indirectly related to the volume of output of the increments. However, while certain costs are directly related to those volumes, others only have an indirect relationship to the volume of increments, mediated through other intermediate cost drivers and volume-volume relationships.

Exogenous cost categories

Exogenous cost categories are those, whose volume driver has a direct relationship to the external demand for an activity, i.e. they are not dependent on any other cost categories. The cost driver volume for an exogenous cost category is exogenous to the model and known without calculation.

Endogenous cost categories

Endogenous cost categories are intermediate cost categories. These do not have a direct relationship with an exogenous cost driver, but are dependent on other cost categories. Consequently, before the incremental cost can be calculated, the cost categories feeding into the relevant cost driver volumes must be calculated. Endogenous cost drivers are typically used for indirect and support costs.

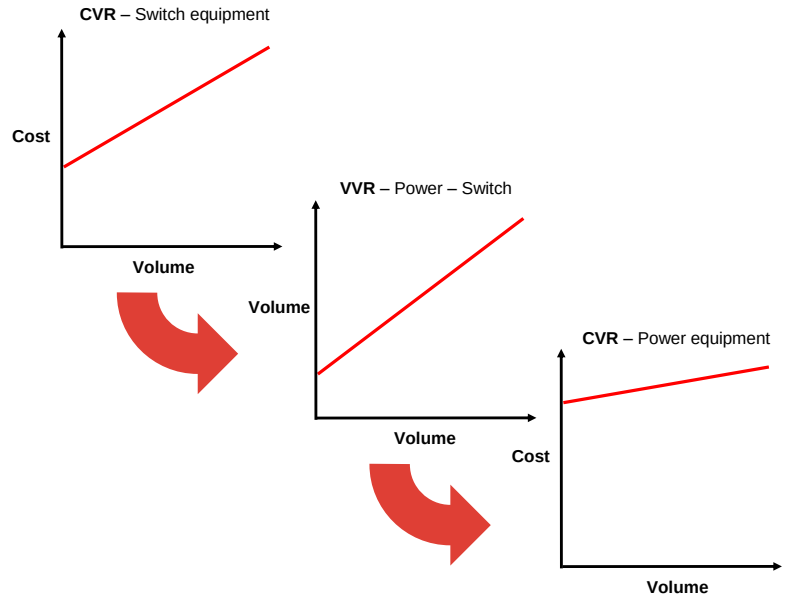
In order to capture the full set of costs, it is necessary to define hierarchies of relationships within the LRAIC model. This allows for those costs that are driven directly by exogenous drivers to be calculated first, with successive interdependencies being rippled through the model. The dependency hierarchy is defined in such a way as to ensure there is no circularity in the dependencies.

The guiding principle is to define those costs that are specific to network assets at the top of the hierarchy (since these are generally the costs which are driven by exogenous variables such as call and line volumes). Following this it is possible to define those costs that are driven by endogenous drivers.

An example of a dependency hierarchy is shown in the figure below. In this example, based on legacy TDM technology, it can be seen that:

- the volume of switch minutes (an exogenous variable) drives switch costs;
- the volume of switch minutes also drives the requirement for network power; and
- the demand for network power (an endogenous variable) drives the cost of network power equipment.

Figure 6. A typical dependency hierarchy



6.7 Transmission allocation

As noted in Section 5.3.1, transmission equipment and infrastructure is used to support links that in turn support a range of services. Given the high proportion of joint and common costs it is difficult to precisely attribute costs to individual links and hence services through an incremental costing approach and such an approach would require a disproportionate amount of resources.

The approach adopted in the LRAIC modelling is to define two increments for the domestic transmission network:

- Domestic transmission (capacity dependent). This consists of those network components whose costs are dependent on the number and capacity of links but largely independent of the length of links. Examples include transmission terminal equipment, cross connects, etc.

- Domestic transmission (length dependent). This consists of network components whose costs are dependent on the length of links they serve (which may also be dependent on the number and capacity of links). Examples include fibre cables and the duct housing the cables and may include wireless links where multiple hops are required or where longer distance links require more expensive equipment and/or frequency.

The costs of these two increments are then allocated to the defined transmission network elements on the basis of the relevant volumes of each network element:

- The total capacity of links for each network element expressed as the number of T1/E1 equivalents; and
- The sum of the capacity multiplied by length of the links for each network element expressed as T1 km equivalents. For example a T1 link of 10 km length being recorded as 10 T1 km equivalents.

Ethernet versus SDH networks

Next generation networks may use packet switched transmission (e.g. Gigabit Ethernet links over fibre) in addition to legacy TDM transmission links (e.g. SDH). While the two transmission technologies may provide substitute functionality, the cost allocation to services will be more accurate if the costs of the two technologies are separately identified and allocated. Where concessionaires operate both technologies they should provide data on the costs of the related transmission equipment separately.

6.8 Service volumes, conversion and routing factors

The costs of network elements are allocated to network services on the basis of the total volume of each service combined with the average usage that each unit of the service makes, of a given network element.

The defined network services are set out in Annex 6.

A discussion of each of these elements follows.

6.8.1 Volume of services

The units used for the total volume of service are typically:

- conversation minutes in the case of circuit switched services;
- messages in the case of SMS services;
- bytes in the case of packet switched services.

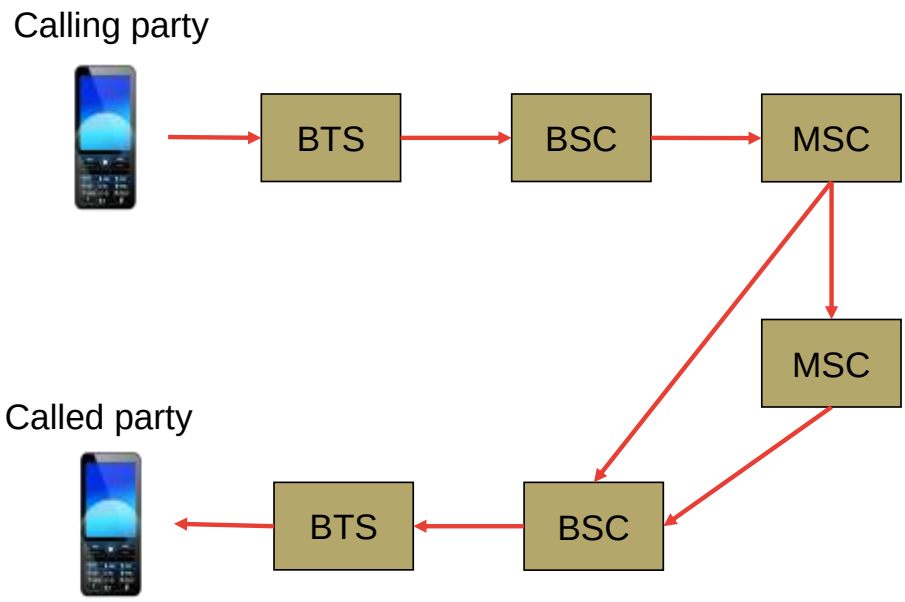
Care must be taken when measuring volumes of similar services, to ensure a consistent approach is used or to ensure the estimates are adjusted to take account of differences in measurement. For example, data from retail billing systems often present data in terms of "billed minutes" where conversation time is rounded up to the nearest billing increment, while interconnection minutes are usually billed on a per second basis and so output from interconnection billing systems is generally on a per second basis. In the case where retail billing

increments are of similar duration to average call length, there can be a significant difference between "billed" minutes from the retail billing system and minutes on a per second basis from the interconnection system, with "billed" minutes being materially higher than minutes on a per second basis. In this case, a conversion factor should be used to convert to a per second basis. Conversion factors are discussed in 6.8.3 below.

6.8.2 Routing factors

For services delivered over networks with a complex hierarchy such as voice calls, different services may use greater or fewer network elements. Routing factors are used to describe the way in which a call makes use of different network elements. The figure below shows a simplified diagram of how mobile calls are routed in different ways over the mobile network and therefore make different use of network elements in order to explain how concessionaires should calculate routing factors.

Figure 7. Simplified network diagram



Source: Frontier Economics

In this simplified example, an on-net call could be routed in two different ways, either:

- It would be routed via a BTS, a BSC, an MSC and then directly to the BSC and BTS of the called party (A); or

- It would be routed via a BTS, a BSC, an MSC and to another MSC before being routed to the BSC and BTS of the called party (B).

If 70% of on-net calls are routed in the first way (A) and 30% in the second way, (B) the routing factors would be calculated as set out in the table below.

Table 4. Simplified calculation of routing factors for an on-net call

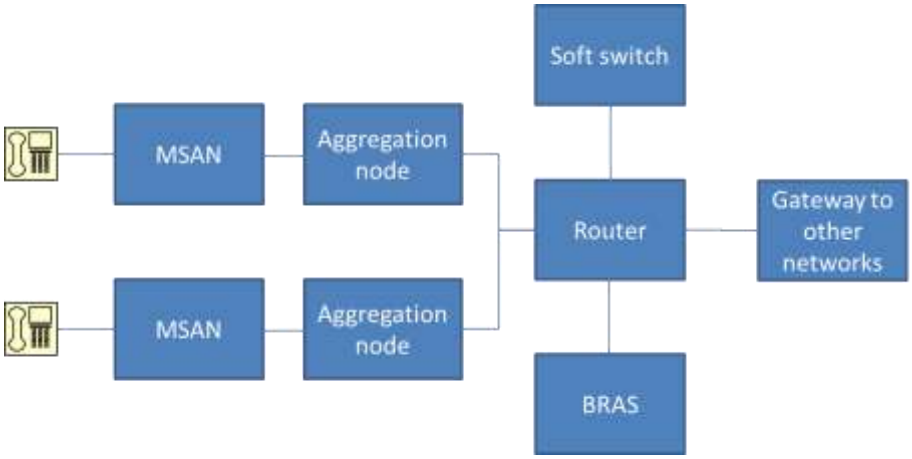
	BTS	BSC	MSC	% of on-net calls routed in this way
On-net call (A)	2	2	1	70%
On-net call (B)	2	2	2	30%
Average on-net call	2	2	1.3 =(1*0.7)+(2*0.6)	n/a

Source: Frontier Economics

Routing factors should be an estimate of the **average** number of each type of network components used for a given type of service. Where a number of potential routings exist for a service the routing should be a weighted average of the number of components used for each route, with the weights based on the proportion of traffic (by volume) taking each route.

Under NGN the network structure of fixed networks is also converging to a simple structure with typically one layer of routing, rather than the complex switching hierarchies that were typical in TDM networks. As a result routing tables tend to be relatively simple with for example calls traversing one MSAN if the call is originated r terminated off net, or 2 if the call is both originating and terminating on-net.

Figure 8. Structure of fixed NGN



Source: Frontier Economics

6.8.3 Conversion factors

While the routing factor shows how many times a given service on average uses a component, this does not form a useful basis for allocating costs in a mobile network as different services are measured using different metrics (minutes/messages or bytes). In addition there may be differences in the relative load placed on network components by different services even where they are measured on a consistent basis. In order to convert network usage to a consistent basis, conversion factors are applied.

Where volumes of services using the same network components are measured using different units, for example voice, SMS and GPRS traffic using the GSM air interface, conversion factors are necessary to convert the usage to a consistent basis. These conversion factors may vary depending on the component, for example while an SMS may use minimal capacity in the air interface, the load it may place on an MSC processor may be comparable to a call set up.

7 LRAIC model calculation

This section of the specification provides an overview of the LRAIC model calculation process.

7.1 Model overview

The LRAIC model can be broadly split into two parts:

- An incremental costing module, which has as its output the incremental cost of a set of network components;
- A service costing module which allocates the incremental costs of the components to services to give LRAIC estimates.

The incremental costing module is split into four sections:

- a section where the overall structure of the model is established, consisting of the relationships between costs, CVRs and drivers (see as described in Section 7.2);
- a section where the input data in terms of base costs, base driver volumes and CVRs are entered (see Section 7.3 and Section 6 for more detail);
- a section which calculates the level of costs for a given level of demand, defined by the increments (see Section 7.4 and Section 5 for more detail); and
- a section which calculates the incremental costs for each increment and the incremental costs including mark ups (see Section 7.5).

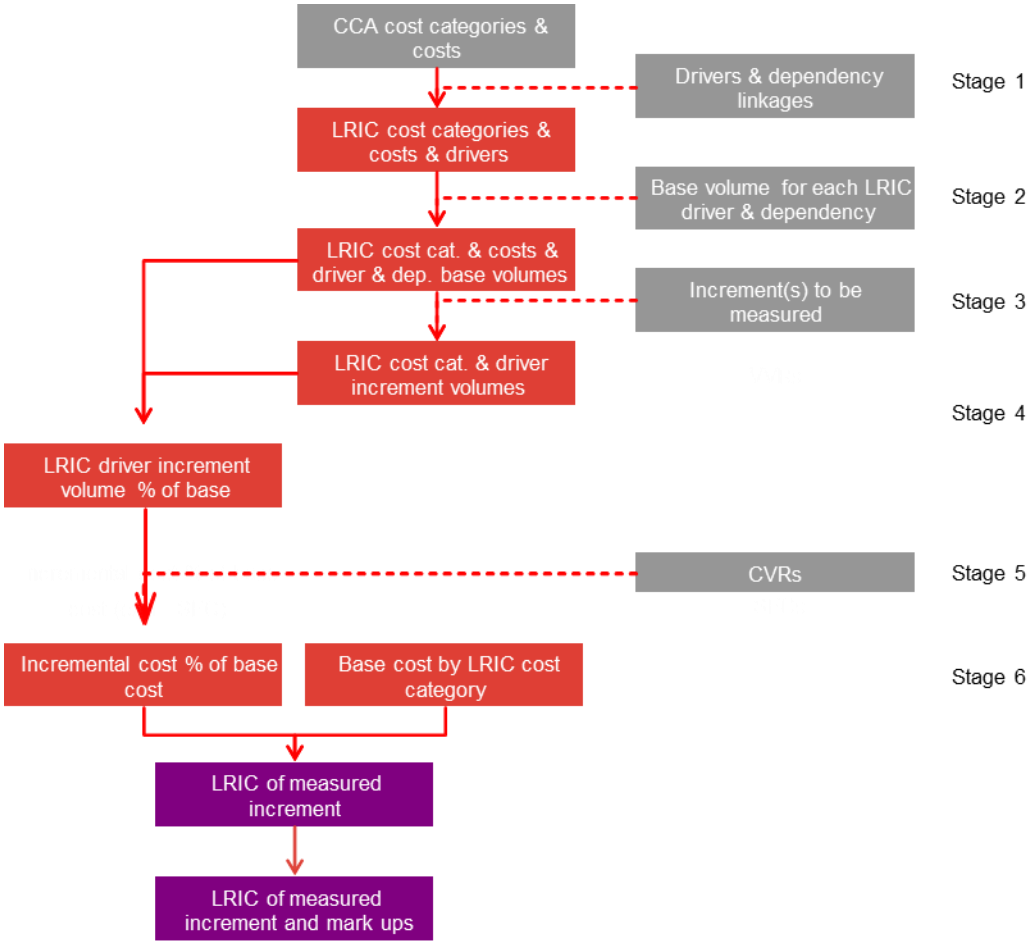
The results of the incremental costing module are then allocated to services through a two stage process:

- transmission costs are allocated across network elements based upon the usage of the transmission network by each of the network elements;
- the costs of the network elements are allocated across services based on an element based costing approach (see Section 7.5).

7.2 Overall structure of the incremental costing model

This section sets out the overall structure of the LRAIC model. However, it does not include any numerical data, either on the base level of costs or drivers, or on the form of the CVRs. The data entered in this section largely defines the dependencies within the LRAIC model. The structure of the model is shown in Figure 9.

Figure 9. Outline of the LRAIC calculation process



7.3 Inputs

This section of the model includes all of the numerical data used to populate the model including the base cost information, information on base volumes for calculation of drivers and CVR and VVR inputs.

Cost input

The net replacement cost and depreciation data relating to fixed assets on a CCA basis (which, where appropriate, takes into account the costs of MEA technology) form an input to the LRAIC model. Operating cost will also be required as an input (see Sections 6.1 and 6.2). This data is then aggregated into the LRAIC cost categories as described in Section 6.3.

Base driver inputs

In addition to the cost data, a number of measures which form the base value of drivers are entered into the LRAIC model (see Section 6.4).

Currently three measures relating to employees are included as base driver inputs:

- The number of employees by department;
- The number of non-network vehicles used by department; and
- The number of IT workstations by department.

CVR inputs

For each CVR the avoidable cost when the relevant increment is set to zero is required.

7.4 Calculation of incremental costs

The LRAIC model calculates the cost of each increment in turn. As noted previously the costing is carried out in a decremental fashion with demand for the increment that is being measured being set to zero, whilst the demand for all other increments is maintained at current levels.

The calculation of the cost of the business excluding the increment is carried out in the following order:

- calculation of the exogenous cost categories;
- a number of stages, corresponding to each of the levels in the dependency hierarchy with the output from each stage being endogenous drivers used for the following stage; and
- the final calculation of costs, once all drivers have been calculated.

Each of these stages is described further below.

Calculation of exogenous cost categories

As set out in Section 6.4.1, for exogenous cost categories driven by a single increment the value of the cost category is set to 100% or 0% depending on the increment being costed. For example costs of all the core network components are set to zero if the "core" increment cost is being calculated. Demand for all other increments is set to 100%, i.e. the current level of (external) demand.

For those exogenous cost categories driven by more than one increment, the CVR must be calculated based on the avoidable cost for those increments which are set to zero.

Calculation of endogenous drivers

As set out in Section 6.4.2, most indirect cost categories can be assumed to be dependent on the level of costs for other cost categories at lower levels in the dependency hierarchy.

As a result, a number of cost drivers are dependent on other drivers. The values of these endogenous drivers are therefore calculated by the model in a number of stages.

Calculation of costs

Once all of the drivers are available, the cost of the business for the given level of demand can be calculated by applying the CVRs.

7.5 LRAIC of measured increment including mark-ups

The model calculates incremental costs by setting demand for the corresponding increments to zero, which in turn yields the cost of total business excluding the increments to be measured.

LRAIC is then calculated as:

$$LRAIC_{\text{Increment(s) to be measured}} = Cost_{\text{Corporate Entity}} - Cost_{\text{Corporate Entity excluding Increment(s) to be measured}}$$

LRAIC of measured increment including mark-ups

Common costs, and hence mark ups, are calculated by comparing the incremental cost of an increment, (e.g. mobile core) with the sum of the incremental costs of each sub increment included within an increment (e.g. MSC, VLR, SMSC, etc.) for each LRAIC cost category. The difference forms the fixed common costs (FCCs) across all the relevant sub-increments.

The model calculates and sequentially marks-up four different sets of common costs for each LRAIC cost category reflecting the four levels in the increment hierarchy.

7.6 Allocation of element costs to services - element based costing

The principle of element based costing is that component costs are allocated across services in proportion to the use made of the component by a service. In order to carry out this allocation one needs to calculate the use made of each component by each service. The use that each service makes of a component can be decomposed into three elements:

- first, the total volume of service delivered by the network measured on an appropriate basis (for example call minutes);
- second, the number of times *on average* that the service uses the component; and
- third, a conversion factor that converts the units used for each service to a comparable basis in terms of the load resulting on the component.

Annex 1: Glossary

Table 5. Glossary of terms and abbreviations

Term	Description
ABC	Activity based costing
BRAS	Broadband remote access servers
BSS	Base station
CAPM	Capital asset pricing model
CATV	Cable television
CCA	Current cost accounting
CDMA	Code division multiple access
CVR	Cost volume relationship
DSLAM	Digital subscriber line access multiplexer
DSLAM	Digital subscriber line access multiplexer
EC	European Commission
EDGE	Enhanced data rates for GSM evolution
EPMU	Equal proportionate mark-ups
ERP	Equity risk premium
FAR	Fixed asset register
FCM	Financial capital maintenance
FWA	Fixed wireless access
GBV	Gross book value
GGSN	Gateway GPRS support node
GPRS	General packet radio service
GRC	Gross replacement cost
GSM	Global system for mobile

Table 5. Glossary of terms and abbreviations

Term	Description
HCA	Historic cost accounting
HFC	Hybrid fibre co-axial
HLR	Home location register
IP	Internet protocol
ISFC	Increment specific fixed costs
LRAIC	Long run average incremental cost
MDF	Main distribution frame
MEA	Modern equivalent asset
MPLS	Multiprotocol label switching
MSC	Mobile switching centre
NBV	Net book value
NPV	Net present value
NRC	Net replacement cost
PDH	Plesiochronous digital hierarchy
PPI	Producer price index
SDH	Synchronous digital hierarchy
SGSN	Serving GPRS support node
SMSC	Short message service centre
SONET	Synchronous optical networking
TATT	Telecommunications Authority of Trinidad and Tobago
TD	Top down
TDM	Time division multiplexing
UMTS	Universal mobile telecommunications system

Table 5. Glossary of terms and abbreviations

Term	Description
VAT	Value added tax
VLR	Visitor location register
VVR	Volume volume relationship
WACC	Weighted average cost of capital

Annex 2: Defined network elements

Table 6. Network elements contained in the LRAIC model

Abbreviation	Label	Description	Maps to Level 4 increment
FAD	Fixed access network (dedicated access)	Network providing conveyance from customer premises to operator's network premises offering dedicated capacity to customers (e.g. twisted pair networks or fibre networks)	FAD
FAS	Fixed access network (shared access)	Wireline network providing conveyance from customer premises to operator's network premises sharing capacity between customers (e.g. Cable TV networks)	FAS
FAW	Fixed access network (wireless)	Wireless network providing conveyance from customer premises to operator's network premises sharing capacity between customers (e.g. Cable TV networks)	FAW
N1S	Remote narrowband access node (subscriber sensitive)	Subscriber specific part of network component providing an interface between the access network and the switched network without full switching capabilities (e.g. remote concentrator line cards)	N1S
N1T	Remote narrowband access node (traffic sensitive)	Traffic sensitive part of network component providing an interface between the access network and the switched network without full switching capabilities (e.g. switch facing ports on remote concentrator)	N1T

Table 6. Network elements contained in the LRAIC model

Abbreviation	Label	Description	Maps to Level 4 increment
N2S	Local exchange (subscriber sensitive)	Subscriber specific part of a local switch (e.g. local switch line cards)	N2S
N2S	Local exchange (traffic sensitive)	Traffic sensitive part of a local switch (e.g. local switch processor)	N2S
N3	Transit exchange	Switch only connects to other switches (i.e. which does not connected to the access network/remotes)	N3
N4	International gateway	Switch the connects to networks overseas	N4
TR-N1-N2	Transmission N1-N2	Transmission between levels 1 and 2 in the narrowband network hierarchy	
TR-N2-N2	Transmission N2-N2	Transmission within level 2 in the narrowband network hierarchy	
TR-N2-N3	Transmission N2-N3	Transmission between levels 2 and 3 in the narrowband network hierarchy	
TR-N3-N3	Transmission N3-N3	Transmission within level 3 in the narrowband network hierarchy	
TR-N3-N4	Transmission N3-N4	Transmission between levels 3 and 4 in the narrowband network hierarchy	

Table 6. Network elements contained in the LRAIC model

Abbreviation	Label	Description	Maps to Level 4 increment
B1	Broadband level 1 - access node	Network component providing an interface between the access network and the core broadband network (e.g. DSLAM)	B1
B2	Broadband level 2 - aggregation node	Network component aggregating traffic from a number of access nodes but not providing routing capabilities	B2
B3	Broadband level 3 - BRAS	Network component providing access control to the network	B3
B4	Broadband level 4 - router	Network component routing broadband traffic within the core network	B4
TR-B1-B2	Transmission B1-B2	Transmission between levels 1 and 2 in the broadband network hierarchy	
TR-B2-B3	Transmission B2-B3	Transmission between levels 2 and 3 in the broadband network hierarchy	
TR-B3-B4	Transmission B3-B4	Transmission between levels 3 and 4 in the broadband network hierarchy	
TR-B4-B4	Transmission B4-B4	Transmission within level 4 in the broadband network hierarchy	
TR-IX	Transmission interconnection links	Transmission between the operator's network and other domestic networks	
TR-INT	Transmission international	Transmission between the operator's network and overseas networks	

Table 6. Network elements contained in the LRAIC model

Abbreviation	Label	Description	Maps to Level 4 increment
M-BSS	Base station subsystem	The GSM base station subsystem and equivalents (e.g. BTS and BSC)	M-BSS
M-MSC	Mobile switching centre	Voice switches for mobile traffic	M-MSC
M-MPD	Mobile packet data network	Core packet data network for mobile	M-MPD
M-LR	Mobile location registers	Location registers in the mobile network (e.g. HLR and VLR)	M-LR
M-SMS	SMS messaging centre	SMS meesage centre	M-SMS
TR-BSS	BSS transmission	Transmission within the BSS (e.g. BTS-BSC)	
TR-BSS-MSC	BSS-MSC transmission	Transmission between the BSS and MSC (e.g. BSC-MSC)	
TR-MSC-MSC	MSC-MSC transmission	Transmission between MSCs	
TR-MPD	MPD transmission	Transmission within the mobile packet data network (e.g. GGSN to SGSN)	

Source: Frontier Economics

Annex 3: Defined increments

Table 7. Level 4 increments defined in the LRAIC model

Abbreviation	Label	Description	Maps to Level 3 Increment
FAD	Fixed access network (dedicated access)	Network providing conveyance from customer premises to operator's network premises offering dedicated capacity to customers (e.g. twisted pair networks or fibre networks)	FA
FAS	Fixed access network (shared access)	Network providing conveyance from customer premises to operator's network premises sharing capacity between customers (e.g. wireless or HFC networks)	FA
N1	Remote narrowband access node	Network component providing an interface between the access network and the switched network without full switching capabilities (e.g. remote concentrator)	FC
N2	Local exchange	Local switch	FC
N3	Transit exchange	Switch only connects to other switches (i.e. which does not connected to the access network/remotes)	FC

Table 7. Level 4 increments defined in the LRAIC model

Abbreviation	Label	Description	Maps to Level 3 Increment
N4	International gateway	Switch the connects to networks overseas	FC
B1	Broadband level 1 - access node	Network component providing an interface between the access network and the core broadband network (e.g. DSLAM)	FC
B2	Broadband level 2 - aggregation node	Network component aggregating traffic from a number of access nodes but not providing routing capabilities	FC
B3	Broadband level 3 - BRAS	Network component providing access control to the network and routing traffic onto the core network	FC
B4	Broadband level 4 - core router	Network component routing broadband traffic within the core network	FC
TR-DC	Transmission domestic (capacity)	Transmission domestic (capacity)	FC
TR-DL	Transmission domestic (length)	Transmission domestic (length)	FC
TR-INT	Transmission international	Transmission between the operator's network and overseas networks	FC
FIX-OTH	Other fixed network	Network components delivering other fixed services and capabilities	FC

Table 7. Level 4 increments defined in the LRAIC model

Abbreviation	Label	Description	Maps to Level 3 Increment
M-BSS	Base station subsystem	The GSM base station subsystem and equivalents (e.g. BTS and BSC)	MA
M-MSC	Mobile switching centre	Voice switches for mobile traffic	MC
M-MPD	Mobile packet data network	Core packet data network for mobile	MC
M-LR	Mobile location registers	Location registers in the mobile network (e.g. HLR and VLR)	MC
M-SMS	SMS messaging centre	SMS message centre	MC
M-OTH	Other mobile network	Network components delivering other fixed services and capabilities	MC
RET	Retail activities	Activities driven by the provision of retail services to end users (e.g. Sales & Marketing, Billing & Collection and Customer Care)	RAO
WS	Wholesale activities	Activities driven by the provision of wholesale services to other operators (e.g. wholesale product management and interconnect billing)	RAO
OTH	Other activities	Other activities not concerned with the provision of telecommunications services	RAO

Source: Frontier Economics

Table 8. Level 3 increments defined in the LRAIC model

Abbreviation	Label	Description	Maps to Level 2 Increment
FA	Fixed access	Fixed access network	FN
FC	Fixed core	Fixed core network	FN
MA	Mobile access	Mobile access network	MN
MC	Mobile core	Mobile core network	MN
RAO	Retail and other	Non-network activities	RAO

Source: Frontier Economics

Table 9. Level 2 increments defined in the LRAIC model

Abbreviation	Label	Description	Maps to Level 1 Increment
FN	Fixed network	Fixed network	NET
MN	Mobile network	Mobile network	NET
RAO	Retail and other	Non-network activities	RAO

Source: Frontier Economics

Table 10. Level 1 increments defined in the LRAIC model

Abbreviation	Label	Description
NET	Network	Network activities
RAO	Retail and other	Non-network activities

Source: Frontier Economics

Annex 4: LRAIC cost categories

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
Fixed network components		
ACF001	Main distribution frame	FAC
ACF002	Remote switching unit	CVR01
ACF003	Digital local exchange	CVR02
ACF004	Digital tandem exchange	N3
ACF005	International switch centre	N4
ACF006	VOIP soft switch or media gateway	N3
ACF007	Network management system	FIX-OTH
ACF008	Intelligent network platform	FIX-OTH
ACF009	Co-axial cable	FAC
ACF010	Twisted pair cable	FAC
ACF011	Access fibre	FAC
ACF012	HFC optical node	CVR08
ACF013	Point to point wireless	FAW
ACF014	Point to multi-point wireless	FAW
ACF015	Pre-wiring of client premises and first time installations	FAC
ACF016	DSLAM	CVR03
ACF017	MSAN	CVR04
ACF018	Cable head end equipment - television broadcast	TV
ACF019	Cable head end equipment - DOCSIS receiver	B2

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
ACF020	Cable head end equipment - Telephony	N3
ACF021	Packet switched aggregation node	B2
ACF022	Packet switched router	B3
ACF023	Broadband remote access server	B3
ACF024	Assets not used in T&T	OTH
ACF025	CATV Distribution hub	TR-DC
Mobile Network Components		
ACM001	Base station (BTS)	M-BSS
ACM002	Base station controller (BSC)	M-BSS
ACM003	Mobile switching centre (MSC)	M-MSC
ACM004	GPR, GGSN and SGSN	M-MPD
ACM005	Short message service centre (SMSC)	M-SMS
ACM006	Voice mail system (VMS)	M-OTH
ACM007	Home location register (HLR)	M-LR
ACM008	Network management system (NMS)	GRCD9
ACM009	Signal transfer point	M-MSC
ACM010	BTS to BSC link	M-BSS
ACM011	Assets not used in T&T	OTH
Network Infrastructure and Support Equipment		
ACI001	Duct	CVR05
ACI002	Local loop poles	FAC
ACI003	Signalling equipment	FIX-OTH
ACI004	Transmission Infrastructure	GRCD10

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
ACI005	Transmission equipment - SDH	TR-DC
ACI006	Transmission equipment - PDH	TR-DC
ACI007	Power equipment	GRCD5
ACI008	Network buildings	CVR06
ACI009	Masts & towers	CVR07
ACI010	Network land	CVR06
ACI011	Motor vehicles - network	ED03
ACI012	Fibre cables (core)	TR-DL
ACI013	Microwave transmission equipment (core)	TR-DC
ACI014	Assets not used in T&T	OTH
ACI015	International subsea cables	TR-INT
Non network assets		
ACN001	Non-network buildings	ED01
ACN002	Land - non network	ED01
ACN003	Furniture and office equipment	ED01
ACN004	Training equipment	ED01
ACN005	Vehicles - non-network	NNED01
ACN006	Payphones	OTH
ACN007	IT /General purpose computers	NNED02
ACN008	Network management	GRCD02
ACN009	Marketing, retail, customer support	RET
ACN010	Customer premise equipment - fixed	OTH
ACN011	Customer premise equipment - mobile	OTH

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
ACN012	Prepaid service platform	RET
ACN013	Billing system	RET
ACN014	Customer management system	RET
ACN015	Interconnect billing	WS
ACN016	Assets not used in T&T	OTH
Network Activities		
NA01	Network - Executive Management	ED02
NA02	Network strategy, planning and procurement	GRCD02
NA03	Network management	GRCD02
NA04	Network field operations - outside plant	GRCD03
NA05	Network field operations - core	GRCD04
Product Management		
PM01	Retail product management	RET
PM02	Marketing and communications	RET
PM03	Sales	RET
PM04	Customer care	RET
PM05	Billing and collection	RET
PM06	Wholesale product management	WS
Support Activities		
SA01	Facilities management	ED01
SA02	HR Services and training	ED01
SA03	Finance	OCD01
SA04	IT	NNED02

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
SA05	Procurement	GRCD02
SA06	General management, Corporate Affairs and Regulatory	OCD01
Network operational expenditure		
NET01	Utilities (energy and fuel)	GRCD5
NET02	Site rental costs	GRCD6
NET03	Network maintenance fees	GRCD02
NET04	Frequency fees	GRCD7
NET05	Other regulatory fees	OCD01
NET06	Network insurance costs	GRCD02
NET07	Network transportation	GRCD02
NET08	Leased transmission	TR-DL
NET09	Leased building (co-location) space	GRCD6
NET10	Leased mast/tower (sharing)	GRCD7
NET11	Other network costs	GRCD02
General and administration expenses		
GA01	Building rent (non network)	ED01
GA02	Building expenses (non network)	ED01
GA03	Consumables	ED01
GA04	Insurance costs (non-network)	GRCD8
GA05	Travel expenses	ED01
GA06	Other G&A	OCD01
Direct costs and costs of sales		

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
COS01	Customer acquisition costs	RET
COS02	Equipment buy in costs	RET
COS03	Fixed termination	RET
COS04	International termination	RET
COS05	Mobile termination	RET
COS06	Roaming charges	RET
COS07	Number portability database queries	RET
COS08	Distribution costs	RET
COS09	Marketing and promotions costs	RET
COS10	Printing, Delivery and collection costs	RET
COS11	Bad debt	RET
Balance Sheet Items		
BS01	Cash and cash equivalents	OCD01
BS02	Investments	OTH
BS03	Inventory - Network	GRCD02
BS04	Inventory - Non Network	OTH
BS05	AR - Wholesale	WS
BS06	AR - Retail	RET
BS07	Short term loans	OCD01
BS08	AP - Employees	ED01
BS09	AP - Trade Creditors	OCD01
BS10	Provisions	OCD01
BS11	Vat Payable	OCD01

Table 11. LRAIC Cost Categories contained in the LRAIC model

Abbreviation	Cost category	CVR or Level 4 Increment
BS12	Vat Receivable	OCD01
BS13	Deferred Income	RET

Source: Frontier Economics

Annex 5: Required CVRs

Table 12. CVRs for which concessionaires will be required to provide inputs

Abbreviation	CVR	Drivers
CVR01	Fixed voice (TDM) concentrator	Voice lines Voice traffic
CVR02	Fixed voice (TDM) switch	Voice lines Voice traffic
CVR03	DSLAM	DSL lines Broadband bandwidth
CVR04	MSAN	Voice lines Voice traffic DSL lines Broadband bandwidth
CVR05	Duct	Cable diameter
CVR06	Network buildings	Floorspace
CVR07	Masts and towers	Transceivers
CVR08	HFC optical node	

Source: Frontier Economics

Annex 6: Network Services

Table 13. Defined Network Services

Abbreviation	Service	Units
Fixed access services		
FAS01	Narrowband PSTN access line	Number of lines
FAS02	Narrowband ISDN BRA line	Number of channels
FAS03	Broadband access line (asymmetric)	Number of lines
FAS04	Broadcast television subscriber	Number of lines
FAS05	Metro Ethernet access	Number of lines
FAS06	Fully unbundled loop	Number of lines
FAS07	Shared access unbundled loop	Number of lines
FAS08	Domestic retail leased circuit	T1-equivalents
FAS09	International retail leased circuit	T1-equivalents
FAS10	Domestic wholesale leased circuit	T1-equivalents
FAS11	International wholesale leased circuit	T1-equivalents
FAS12	Wholesale partial private circuit - local end	T1-equivalents
FAS13	Wholesale partial private circuit - trunk segment	T1-equivalents
FAS14	Other services	Number of subscribers
Fixed call services		
FCS01	Voice - fixed to fixed (onnet)	Minutes
FCS02	Voice - fixed to fixed (offnet)	Minutes
FCS03	International call from fixed	Minutes
FCS04	Call to domestic mobile from fixed	Minutes
FCS05	Dial up Internet access from fixed	Minutes

Table 13. Defined Network Services

Abbreviation	Service	Units
FCS06	Other retail calls from fixed	Minutes
FCS07	Wholesale domestic fixed call origination	Minutes
FCS08	Wholesale internation fixed call origination	Minutes
FCS09	Domestic fixed call termination	Minutes
FCS10	International fixed call termination	Minutes
FCS11	Transit between domestic operators	Minutes
FCS12	Transit from international to domestic	Minutes
FCS13	Transit from domestic to international	Minutes
Mobile services		
MOB01	Mobile subscribers (active)	Number of subscribers
MOB02	Mobile to mobile voice calls - on-net	Minutes (per second basis)
MOB03	Mobile to mobile voice calls - domestic off net	Minutes (per second basis)
MOB04	Mobile to fixed calls - domestic	Minutes (per second basis)
MOB05	Mobile to international calls	Minutes (per second basis)
MOB06	Wholesale mobile call origination - domestic	Minutes (per second basis)
MOB07	Wholesale mobile call origination - international	Minutes (per second basis)
MOB08	Domestic mobile call termination	Minutes (per second basis)
MOB09	International call termination	Minutes (per second basis)

Table 13. Defined Network Services

Abbreviation	Service	Units
MOB10	SMS - originated	Messages
MOB11	SMS - terminated	Messages
MOB12	MMS - originated	Messages
MOB13	MMS - termination	Messages
MOB14	Packet switched data (GPRS)	Mbytes
MOB15	Packet switched data (EVDO)	Mbytes

Source: Frontier Economics