CONSULTATION DOCUMENT

Recommendation of the Eastern Caribbean Telecommunications Authority ("ECTEL")

To the National Telecommunications Regulatory Commission to consult on
Principles, methodologies and guidelines for the determination of interconnection rates

Consultation Document
No.3 of 2016
Date: 28th July, 2016

1. The National Telecommunications Regulatory Commission is in receipt of a submission from ECTEL containing ECTEL's **PRINCIPLES, METHODOLOGIES AND GUIDELINES FOR THE DETERMINATION OF INTERCONNECTION RATES** for its Member States.

2. The initial comments period will run from **28th July 2016 to 24th August 2016.**

3. The Comment on Comments period will run from **29th August 2016 to 16th September 2016**.

4. The comments provided to this consultation should be supported with the supporting rationale and required evidences.

5. Following the Reply Comments period, ECTEL's Directorate will revise and make a final determination on the Principles, methodologies and guidelines for the determination of interconnection rates in the ECTEL Member States.

6. All responses to this Consultative Document should be written and sent by post, fax or e-mail to:
   Managing Director
   ECTEL
   P.O. Box 1886
   Vide Boutielle
   CASTRIES
   St. Lucia
   Fax: 1-758-458-1698
   Email: consultation@ectel.int

Disclaimer
This consultative document does not constitute legal, commercial or technical advice. The consultation is without prejudice to the legal position of ECTEL's duties to provide advice and recommendations to the Ministers with responsibility for telecommunications and the National Telecommunications Regulatory Commissions.

Recommendations for new interconnection rates for the ECTEL Member States

Consultation paper on principles, methodologies and guidelines

July 27th, 2016

Contents

1. Introduction

On May 4, 2000, the Eastern Caribbean Telecommunications Authority (hereinafter referred to as 'ECTEL' or 'the Authority') was established. This Authority came into being by way of a treaty signed between the five (5) contracting Eastern Caribbean States - Dominica, Grenada, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines. ECTEL regulatory framework has a two-tiered arrangement:

- At the national level, there is the National Telecommunications Regulatory Commission (NTRC)
- At the regional level there is the ECTEL Directorate as an advisory body. Each Member State cedes some of its "sovereignty" to a regional body. The NTRC must liaise and consult with the ECTEL Directorate and the commission must act independently on all regulatory matters placed before the commission.

The Authority is able to determine the framework regarding regulatory matters that affect the five (5) entities pertaining to interconnection and pricing. In particular **Article 4 (e) of the Treaty** provides that one of the major purposes of ECTEL is to promote fair pricing and the use of cost-based pricing methods by telecoms providers in the Contracting States. Also, **Article 5(m)** indicates that one of the functions of ECTEL is to recommend a regional cost-based pricing regime for implementation by each Contracting States. Each country has its separate 'National Telecommunications Regulatory Commission' in place that works alongside with the ECTEL, based in Saint Lucia, to carry out the latter's mandate.

In 2009, the Council of Ministers that govern ECTEL approved the implementation of the Long Run Incremental Cost Models ('LRIC') for setting interconnection rates (hereinafter the 'Existing Models'). As it relates to the mobile termination rates, the implementation of the LRIC model was to result in an up to 40 per cent reduction in the wholesale rate for mobile termination in the first year and up to 60 percent reduction over the three-year period.

In 2009, the Regulations were passed in Dominica, St. Lucia and Grenada, meanwhile, St. Vincent and the Grenadines and St. Kitts and Nevis saw the passage of the legislation in 2008.

ECTEL is developing new Bottom-Up Long Run Incremental Cost (BULRIC) models (for fixed and mobile networks) to provide recommendations on new interconnection rates for the ECTEL Member States.

The main purposes of this Public Consultation paper are to consult on the principles, methodologies and guidelines and to gather the views and comments of relevant stakeholders in the telecommunications sector of all Member States.

This paper outlines the ECTEL's preliminary view on a number of key issues for the development and implementation of the aforementioned BULRIC models for fixed and mobile networks, encouraging stakeholders to give their opinion.

After receiving and considering the responses to this Consultation Document, the ECTEL plans to undertake the appropriate modelling and determine interconnection rates. In parallel, data requests will be sent to telecommunications operators (the “operators”). The data will be necessary regardless of the approach which is finally taken in the development of the BULRIC models.

1.1. Overview of the matters for consultation

This Public Consultation aims to define the methodology to be applied in the BULRIC Models to set mobile and fixed interconnection rates. The questions have been divided into the following groups:

a. Methodological issues that are common to all (section 2.1)
b. Specific methodological issues applicable to LRIC models for mobile networks (section 2.2)
c. Specific methodological issues applicable to LRIC models for fixed networks (section 2.3)

2. Methodology to be applied in the BULRIC Models

The development of BULRIC Models is generally characterised by the range of options available in their implementation. Accordingly, it is deemed necessary to set out a discussion on the methodology to be considered in the BULRIC Models to be developed.

This section introduces the main methodological issues, outlining the different possible options available, together with their description, and introducing ECTEL's proposed approach.

The methodological issues related to the cost models have been structured as follows:

- Methodological issues common to all BULRIC Models (section 2.1)
- Specific questions for BULRIC Models for a mobile network (section 2.2)
- Specific questions for BULRIC Models for a fixed network (section 2.3)

2.1. Methodological issues common to all BULRIC Models

When defining the methodology for the development of BULRIC Models there is a number of general issues that are not dependent on the type of network the model is calculating (i.e. mobile or fixed). This section contains the methodological issues that will be common for the BULRIC Models to be developed. Namely:

- Costs elements to be considered
- Treatment of OpEx
- Treatment of Capital-Related Costs
- Cost Standard
- Network dimensioning optimisation approach
- Period of time modelled
- Data sources

2.1.1. Costs elements to be considered

BULRIC Models may include a number of cost elements, which can typically be classified within the following groups:

- Network CapEx
- Network OpEx
- Licenses and frequency usage fees
- Retail costs
- G&A costs

The categories listed above are analysed in following subsections:

Network CapEx

Network CapEx includes the investment made by the licensees for developing the network. Mainly:

- Network equipment (for example, switches) purchasing, including related software
- Network infrastructure (for example, network buildings, antennas)

- Supporting IT systems such as network OSS
- One-off fees for subcontracted network services (for example, leased lines activation charges)
- Installation costs associated to the items above

The inclusion of these CapEx elements is aligned with the elements included in the Existing Models (see Annex A) and with the international practice (see Annex G).

The ECTEL proposes that all the above-listed CapEx elements related to the modelled network and its installation costs should be included in the BULRIC Models.

Please note that section 2.1.3 addresses the annualisation method which is to be applied to CapEx.

Network OpEx

Network OpEx includes the recurrent costs associated to operating the network, such as:

- Network personnel
- Outsourced maintenance services
- Power (electricity and fuel)
- Recurrent charges for subcontracted network services (for example, leased lines, dark fibre)
- Network sites rentals

The inclusion of these OpEx categories is aligned with the categories included in the Existing Models (see Annex A) and with the international practice (see Annex G).

The ECTEL proposes to consider all the categories of network OpEx listed above.

Licenses and spectrum fees

License costs and spectrum fees represent a significant cost to telecommunication licensees. They have different purposes:

- Licenses are related to the permission required to sell telecommunication services, and they can take the form of annual or one-off fees. Both options should be considered in the models. They are commonly considered a non-network common cost and included in BULRIC Models as part of G&A costs.
- Spectrum fees represent the rental of a resource that is essential for the network, and they can take the form of annual or one-off fees. Both options will be

considered in the models. They include both spectrum associated with wireless access and microwaves spectrum for transmission. These fees are commonly considered a network common cost.

In the Existing Models, the licenses and spectrum costs were included as G&A costs (see Annex A) and treated accordingly.

The GSMA states the following on licence fees:

> *"In our opinion, general licence fees are typically a common cost for the whole business and should be recovered in the same way as general business overheads. Licence fees that specifically relate to spectrum can be recovered in the same way as other radio network assets"*[1]

The ECTEL concurs with the GSMA's statement above and proposes that:

- License costs are included in the models in the same manner as the G&A costs (described later in this section). The amount will be based on the existing license fees (separately for fixed and mobile networks).
- Spectrum costs will be included in the model as a network resource (which is especially relevant for mobile operations). The amount will be based on an average fee per MHz per band.

Retail costs

The retail costs can be divided into the following categories:

- Marketing
- Sales
- Commissions to dealers
- Cost of Goods Sold (terminals, SIM cards, interconnection payments, etc.)
- Customer care
- Billing and invoicing
- Content and valued added services

In the Existing Models, retail expenses are treated as a mark-up to the network operating costs and non-network common costs (see Annex A).

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[1]GSMA, The setting of mobile termination rates: Best practice in cost modelling, 2008

Nevertheless, including retail costs in BULRIC Models is not a common practice among telecom regulators (see Annex G, Table 5). BULRIC Models are commonly used by telecom regulators for calculating wholesale charges, which is also the objective of this project as described in the introduction of this document. Since retail costs are not relevant for wholesale charges, the ECTEL is of the opinion that modelling retail costs could divert the efforts that should be dedicated to network modelling. Therefore, the ECTEL proposes to not include retail costs in the BULRIC Models.

G&A costs

G&A costs are associated with management activities and are common for network and commercial activities (human resources, finance, management, etc.). It is common practice to include G&A costs in BULRIC Models based on a mark-up on top of network costs.

This practice is consistent with the approach used in the Existing Models (see Annex A). Therefore, the ECTEL proposes to include G&A costs in the BULRIC Models based on a mark-up percentage on top of Gross Replacement Cost (GRC). This percentage will be calculated based on the data provided by the licensees (see section 2.1.7).

Cost of Capital

Costing of services typically takes into account a reasonable amount of return on the invested capital a licensee would be able to earn in a competitive market. In order to estimate this reasonable amount of return, the common practice in the telecommunications industry indicates that the use **Weighted Average Cost of Capital (WACC)** is the preferred mechanism at international level. The consideration of a WACC, the sum of the weighted cost of equity and debt, is a de-facto international standard in the implementation of BULRIC Models (see Annex G, Table 6).

To set the appropriate rate of return, the Capital Asset Pricing Model (CAPM) is commonly used, which is aligned with the methodology used in the Existing Models that have been used since 2009 (see Annex A).

Accordingly, ECTEL proposes the consideration of cost of capital based on the WACC. In addition to this, ECTEL proposes the use of the CAPM approach based on the information provided by the operators in the Member States.

Please note that section 2.1.3 addresses the annualisation method to be applied to CapEx, which incorporates the effect of the cost of capital, based on the WACC value.

Question 1: Do you agree that Network CapEx, Network OpEx, License and spectrum fees, G&A Expenses and cost of capital should be included in the cost base of the BULRIC Models in the manner indicated in this section?

2.1.2. Treatment of OpEx

Determination of Network-related Operations and Maintenance Costs

Network-related operations and maintenance costs commonly represent a significant part of licensees' costs. Therefore, the accurate calculation of these costs is a major factor to take into consideration when designing a BULRIC model.

There are two common methodological approaches when considering the costs associated with the operation and maintenance of the network, which are outlined below:

- **Based on percentages over CapEx**: OpEx is calculated indirectly using a percentage provided by licensees. Licensees often provide an estimation of what represents the annual operating cost expressed as a percentage of the investment. Also, some NRAs have estimated these percentages (for example, ComReg considered the OpEx related to DSLAMs as 10% of the investment[2])
- **Based on Bottom-up calculation** (unit cost per element): the cost is calculated based on technical algorithms for the modelled network. For instance, power costs can be calculated based on average kwh consumption per equipment unit and the average cost per kwh paid by the licensees in the market.

The international practice shows that both methodologies are valid approaches to determine Network OpEx (see Annex G, Table 7), and reveal that a combination of both is frequently used on a case-by-case basis. For instance, the United Arab Emirates' telecommunications regulatory authority (TRA), whose approach is based on percentages over CapEx, states in its public consultation[3] that the bottom-up approach requires a detailed examination of each of the activities undertaken by the operator in question and, as a result, models have tended to use other methodologies. On the other hand, Bahrain's TRA states in its public consultation[4] that:

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[2]See ComReg, Wholesale Broadband Access Consultation and draft decision on the appropriate price control, Document No: 10/56
[3]The Development of bottom-up LRIC Models of Telecommunications Network in the UAE, July 2012
[4]Development, implementation and use of bottom-up fixed and mobile network cost models in the Kingdom of Bahrain, May 2011

> *"Operating costs should be calculated using the operators' actual costs (top-down) with adjustments, or with a bottom-up calculation depending on the feasibility".*

In the ECTEL's view, the calculation of OpEx, based on a percentage of CapEx is not an optimal practice, especially since the ratios are commonly obtained from top-down models and may not necessarily be representative or applicable to BULRIC Models. Moreover, the use of percentages of CapEx would leverage any deviation on CapEx values, reducing the accuracy of the models.

The ECTEL proposes that OpEx will preferably be based on bottom-up calculations in those cases where such bottom-up determination of OpEx is feasible and adequate data is available. For those specific cases where there may be not enough information available, an OpEx as a percentage over CapEx may be alternatively used. This approach is aligned with the methodology used in the Existing Models (see Annex A).

Determination of General and Administrative Costs

General and Administrative costs (G&A) include the expenditure related to the management of the company and supporting departments, which are mainly the costs associated to the General Management and Finance, Human Resources and Legal functions.

The consideration of the G&A will be made taking into account that the operators may have both fixed and mobile operations under one company. Under this consideration, the G&A expenses of the reference operators will be shared between the BULRIC Models for fixed and mobile networks according to the Gross Book Value of the fixed and mobile businesses.

Additionally, not all G&A costs shall be included in the BULRIC Models. In particular, only the percentage attributable to the network should be considered. The calculation of this percentage is proposed based on the Gross Book Value (GBV) of network assets, compared to the total GBV.

Question 2: Do you agree with the ECTEL's proposal on the treatment of OpEx in the BULRIC Models?

2.1.3. Treatment of Capital-Related Costs

Assets valuation method

There are two main potential approaches to be used for assets valuation:

- A **static approach,** by which assets are valuated based on a unitary price each year that can be based on one of the following methodologies:
  - Historical Cost Accounting (HCA): unitary prices are based on the average price paid historically by the company to acquire an asset, based on the operator's book
  - Current Cost Accounting (CCA): unitary prices reflect the current and expected market value of the assets
- A **cash-flow** methodology, by which asset acquisitions are valued per the unitary price for the year when they are purchased. Unitary prices then vary over time, based on cost trends for each asset type

International experience shows that the static approach is mostly used in models which only cover one year (static), as in the case of the Existing Models (see Annex A). For BULRIC Models covering a multi-year period of time, the cash-flow approach is normally preferred (see Annex G, Table 8); however, its implementation is significantly more complex.

Moreover, when applying tilted annuities (see section **Annualisation method** below) and a yearly dimensioning approach (see section **Network dimensioning optimisation approach**), the results are equivalent between the static CCA approach and the cash-flow methodology.

The ECTEL, therefore, considers the static CCA approach as the more appropriate choice, since it sends accurate price signals in the market and avoids increasing the complexity of the model unnecessarily.

Consideration of modern equivalent assets

The concept of forward-looking costs generally requires assets to be valued using a Modern Equivalent Asset (MEA). A Modern Equivalent Asset is defined by the IRG as:

> "*The lowest cost asset, providing at least equivalent functionality and output as the asset being valued*".

These assets should correspond to the ones a new operator would be expected to employ to build a new network.

According to the Accounting Guide published by the ITU[5], it states that:

> *"Modern Equivalent Assets (MEA) should be used whenever it is possible, as it is the most accurate valuation criterion to reflect the cost of an efficient operator, since it will capture the associated costs (and efficiencies) that an entrant/alternative operator would face, if entering into the market at a specific time."*

Accordingly, the ECTEL proposes that the assets are substituted for an MEA in those cases where the existing asset is no longer available or it is not commonly installed by operators in new developments.

Question 3: Do you agree with the ECTEL's view in how assets should be valued and the proposed application of the modern equivalent assets?

Annualisation method

The pattern of cost recovery over time is critically dependent on the depreciation methodology selected. When calculating the annualised costs, the Financial Capital Maintenance (FCM) principle should be respected. The concern of the FCM is to maintain the financial capital of the company. This maintenance is achieved when the value of shareholder funds is the same in real terms at the start and at the end of the period. In practical terms, the FCM principle ensures that the costs incurred for the provision of services are recovered, including an appropriate level of profit, as discussed in section 2.1.1.

A number of annualisation methods may be used, which are compatible with the FCM principle:

- **Straight line depreciation** is the method most commonly used in financial accounts. It simply spreads the original cost of an asset evenly across its economic lifetime. The method is popular because of its simplicity, but is criticised for not reflecting economic reality. It also ignores the cost of capital, which must be calculated separately.
- **Standard Annuity** also spreads the cost of an asset over its economic life, but in addition takes into account the opportunity cost of capital, i.e. the interest forgone which would have been earned had the cash been invested elsewhere. Therefore, annuities consist of two separate elements: the annualised cost of the

[5] 'International Telecommunication Union Regulatory Accounting Guide', 2009

asset (depreciation), and a financing or cost of capital charge. In a standard annuity, the annual charge remains constant over the life of the asset. Again, the method has been criticised for failing to reflect the true depreciation profile of the asset.

- **Tilted Annuity** relaxes the assumption of constant prices. In telecommunication networks, equipment prices tend to fall over time, whereas infrastructure costs (digging trenches, for example) tend to rise over time. If, for example, the standard annualisation method ignored falling prices, Entrant 2 would have an advantage over Entrant 1 as it would benefit from lower asset prices and consequently lower depreciation charges. When asset prices are falling, a tilted annuity recovers more of the capital value in the early years (and vice versa), which ensures that two entrants with an identical asset base, though acquired in different periods, have identical depreciation charges
- **Economic depreciation / Adjusted Tilted Annuity.** Economic depreciation is defined as the period-by-period change in the market value of an asset. The market value of an asset is equal to the present value of the net cash flows that the asset is expected to generate over the remainder of its useful life. As net cash flows vary with output, assets are depreciated at a rate consistent with use, resulting in a true depreciation profile. In practice, given the difficulty of objectively determining the economic depreciation, this is approximated by an **adjusted tilted annuity**, in which the tilt in the amount of depreciation each year incorporates, in addition to the variation in the asset price, the amount of output produced by the asset

A straight line depreciation methodology was implemented for the fixed network Existing Model and a standard annuity for the mobile network Existing Model (see Annex A).

International practice shows that, although straight line and standard annuity methodologies were common in the past, tilted annuity and the economic depreciation/adjusted tilted annuity are now the most commonly used methods (see Annex G, Table 9).

In the case of economic depreciation, it is only common among the countries in the European Union, as a result of a Recommendation issued by the European Commission. Even so, not all the countries in the Union have implemented economic depreciation in their models (for instance, France implemented tilted annuities methodology). The main drawback of economic depreciation is that, apart from being more complex to implement, the demand forecasts have an impact in present results of the model, which reduces the robustness of the models.

On the contrary, tilted annuities method is less complex to implement and avoid the impact of forecast traffic in present results. Additionally, tilted annuities method is the most common methodology outside the European Union.

Based on the above, the ECTEL considers the tilted annuity approach as the accurate annualisation methodology, as it offers the best equilibrium between economic accuracy and ease of implementation. The tilted annuity allows the consideration of the evolution of network prices, while avoiding potential deviations due to traffic forecasts uncertainty which can affect the calculations in the case that an economic depreciation/adjusted tilted annuity method is used.

The useful lives of each asset class will be determined based on the data provided by the licensees, with the safeguards described in section 2.1.7 in case that the data provided presented material divergences from internationally accepted useful lives.

Question 4: Do you agree with the ECTEL's view to implement tilted annuities in the BULRIC cost models? In the case that you have a different view, please support it with rationale.

Treatment of working capital

Working capital is the amount of capital that a company uses in its day-to-day trading operations. In a more formal definition, working capital is calculated as the current assets minus the current liabilities. If positive, this working capital generates revenues; if negative, it generates financial costs for the operator.

Working capital requirements associated to network-related activities will be considered on the BULRIC Models. Working capital not related to network costs, (for example, due to the retail activities of the operator) will not be considered in the development of the BULRIC Models, consistent with the principle that retail costs will not be considered, as stated in section 2.1.1.

Network-related working capital comprises a network CapEx and a network OpEx components.

- CapEx-related working capital refers to the fact that an operator requires a certain period of time before equipment can be fully installed and operational, and thus start generating revenues. CapEx-related working capital is not being considered in the existing models. BULRIC Models to be developed by the ECTEL will capture this effect through the use of the planning-horizon concept[6]. The ECTEL thus believes that no additional mechanism is required to consider network CapEx-related working capital beyond that use.

- On the other hand, network OpEx working capital mainly reflects the liquidity that any company must maintain in order to operate all network-related payments swiftly, such as network staff or site rentals, and to finance the gap between the time these costs are incurred and revenues are generated. However, the OpEx network working capital tends to be negligible. The ECTEL considers that, in the case licensees justify that the working capital associated to network OpEx has been efficiently incurred and presents a certain level of materiality, it should be incorporated in the BULRIC Models. This working capital will be calculated as a percentage of OpEx for each year, based on information provided by the licensees.

Question 5: Do you agree with the ECTEL with the proposed approach for the consideration of working capital?

2.1.4. Cost Standard

The selected standard for network costs is a key issue in wholesale service costing. The methodological approaches that are more commonly followed for distributing network costs to services are outlined below:

- **Fully Allocated Costs (FAC):** this methodology attributes all the network costs (including common and joint costs) to services, based on the utilisation each service makes of the different network assets.
- **Pure Long Run Incremental Costs (Pure LRIC):** this methodology calculates the costs that would be saved if certain services, group of services or activities (defined as an increment) were not provided. These incremental costs are aligned with the variable costs in the long run. Using this approach, neither common costs, nor joint costs are allocated to the services.

[6] Planning-horizon concept represents that the Operators usually anticipate the purchasing of network equipment in order to capture the time encompassed between the purchase of a resource and its commissioning. This concept also takes into account that the resources are dimensioned to satisfy the demand within a period of time, without requiring capacity upgrades. Note that the planning-horizon concept already includes any required working capital term related to the Network CapEx, as it already accounts for the time elapsed between the purchase of the equipment and its commissioning.

- **Long Run Incremental Costs plus Common Costs (LRIC+)**, unlike the pure LRIC approach, this allows the recovery of common and joint costs that are not incremental to any given service.

Generally speaking, it is common practice nowadays to use one of the methodologies based on the LRIC approach. Under the LRIC approach, a number of increments are defined as groups of services. The pure LRIC for each increment would be calculated as the difference between the costs incurred by an efficient operator that provides all services and an efficient operator that would provide all services, except those included in the increment.

The terminology of the Telecommunications (Interconnection) Regulations is similar throughout all jurisdictions. As stated in section 13 of the Interconnection Regulations state as follows:

> *(4) The reference interconnection offer provider shall apply the appropriate interconnection tariffs, terms and conditions when providing interconnection for its own services or those of its affiliates, subsidiaries or partners.*
>
> *(5) The charges of the reference interconnection offer shall be sufficiently unbundled to ensure that the interconnecting operator requesting interconnection is not required to pay for services not related to the service requested.*
>
> *(6) Interconnection rates set out in the reference interconnection offer shall be* ***cost-oriented****.*
>
> *[...]*
>
> *(8) The Commission has the authority to ensure that a reference interconnection offer is compliant with the Act and Regulations and contains rates that are* ***cost-oriented****.*

Additionally, section 3 establishes:

> *3. In these Regulations-*
>
> ***"cost-oriented"*** *means those charges equal to the long-run incremental cost of an efficient provider plus an appropriate portion of shared and common costs.*

Based on the above, the ECTEL proposes to use LRIC+ methodology. This is consistent with the methodology implemented in the Existing Models (see Annex A).

Question 6: Do you agree with the use of LRIC+ standard?

Allocation of common and joint network costs for the LRIC+ standard

As indicated above, the LRIC+ cost standard incorporates a share of common and joint costs. Thus, a methodology needs to be defined to establish the criteria for cost allocation to services.

A number of potential methodologies have been found to allocate common costs to services:

- **Equi-Proportional Mark-Up (EPMU)**, allocating common and joint costs to services in proportion to their incremental costs. This method is very commonly used and it is simple to implement.
- **Effective capacity,** allocates common and joint costs based on the capacity used by each service at the busy hour.
- **Shapley-Shubik**, which consists of setting the cost of a service equal to the average of the incremental costs of the service after reviewing every possible order of arrival of the increment.
- **Ramsey Pricing**, which recovers common costs from the services, based on the services' relative marginal cost of production and price elasticity.

The Ramsey Pricing approach is generally perceived as the most economically relevant approach for common costs recovery, however the high level of complexity and data involved in its calculation has proven to be a considerable burden in its implementation. No NRAs are known to have adopted this approach in practice (see Annex G, Table 12).

Alternatively, the EPMU approach is commonly employed as a considerably more workable solution, and it has been used in the previous models for the ECTEL (see Annex A).

While the EPMU approach has the advantage of simplicity, it may also present limitations, particularly in cases where common and joint costs represent a significant amount of the cost base.

A main difficulty using the EPMU approach may arise when there are common and joint costs that may be common to several increments, but may not necessarily be relevant for all services. This is often the case of common and joint costs related to the network. The following exhibit illustrates this phenomenon in the particular case of a mobile BULRIC model, showing how there are different types of common and joint costs that may be relevant to different increments and services:

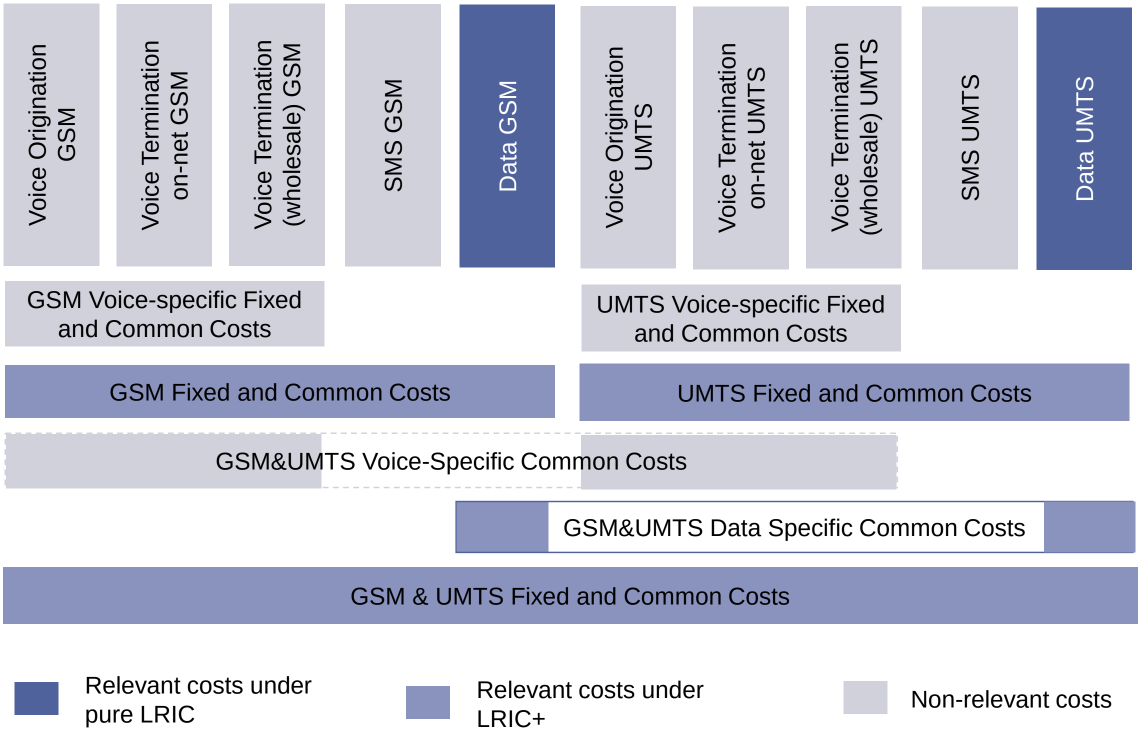

Exhibit 1: Example of relevant incremental costs under both the pure LRIC and LRIC+ standards of mobile voice termination. [Source: Axon Consulting]

It would be inaccurate, in such cases, to allocate all common and joint costs indistinctly based on a simple mark-up of purely incremental costs. A potential solution to this problem is the use of combinatorial analysis, by which different combinations of increments are run to more accurately identify those costs that are common, only to a sub-set of increments or services. This, however, results in a significant complication in the design of the BULRIC model and reduced transparency of cost calculations.

On the contrary, the efficient capacity approach involves the recognition of the different use made by the services of each resource or group of resources, which outcomes the limitations found in EPMU approach while keeping a reasonable level of complexity.

Based on the above, the ECTEL considers the efficient capacity approach, which also belongs to the ‘proportional rules’ family, to be the option that more accurately represents how network-related common costs should be shared among services.

Allocation of non-network common-costs for the LRIC+ standard

As indicated in section 2.1.1, the Authority intends to include G&A costs as part of the cost base to be considered in the BULRIC Models.

Unlike network-related common and joint costs, those common costs related to G&A are normally not relevant only to a particular set of services. Establishing a measure of 'efficient capacity' for such costs is often not obvious. The Authority thus considers to employ an EPMU to allocate G&A common cost to services under the LRIC+ standard, as in the methodology used in Existing Models (see Annex A).

Question 7: Do you agree with the suggested treatment of common cost under the LRIC+ standard in the BULRIC Models?

2.1.5. Network dimensioning optimisation approach

In BULRIC Models, two different approaches are generally identified for the dimensioning and optimisation of a network, which may have a direct impact on the services' cost:

- Yearly approach: It estimates the number of assets for a given year without taking into consideration the network status in previous years.
- Historical approach: Dimensioning relies on the network built in previous years.

The historical approach is not commonly used by regulators (see Annex G, Table 13), mainly due to its complexity and because this methodology may result in inefficiencies that would be translated to the regulated prices.

On the contrary, the yearly approach is commonly accepted and consistent with the existing models. Therefore, the ECTEL considers the yearly approach as the most appropriate to send the accurate pricing signals in the market, due to the fact that its results represent the optimum network for each year.

Additionally, the yearly approach avoids introducing unnecessary complexity into the models. At the same time, it should be noted that when traffic demand is increasing year on year, these two approaches tend to produce similar results.

Question 8: Do you agree with the use of a yearly approach for network optimisation?

2.1.6. **Period of time modelled**

The Existing Models cover one year (see Annex A). This was typically the common practice in the past. However, modelling technics have evolved in the last few years and most of regulators are now using multi-year models (see Annex G, Table 14).

Multi-year models allow regulators to understand the economics of telecom operators in a changing market. Broadband services booming (in both fixed and mobile networks) is a reality around the world and impact significantly in the economies of scale reached by the operators. Understanding the impact of this evolution in the regulated services (such as interconnection) is right now a priority for most telecom regulators and allows providing regulatory certainty. Therefore, the ECTEL considers important to implement multi-year models.

Once a multi-year approach is selected, the following decision involves which years should be included in the model. The ECTEL is of the opinion that some history should be included in the models to be able to compare the results with the latest closed financial year (i.e. 2015) and ensure that the models' results are representative of the local operations. Including previous years would require additional burden on the operators which would be required to provide detailed information for older years.

On the other hand, covering several future years would not provide much value, since the accuracy of the forecasts for the far future would be of limited accuracy. Therefore, the ECTEL proposes to cover 5 forecasted years (2016-2020) which is aligned with the international practice in those cases where economic depreciation is not used[7].

In summary, the ECTEL proposes that the BULRIC Models cover a 1-year historic period and a 5 year forecast period (i.e. 2015 to 2020).

Question 9: Do you agree with the time period defined (i.e. from 2015 to 2020)?

2.1.7. **Data sources**

BULRIC Models require a significant amount of inputs to be able to model the network accurately and to reliably represent the specificities of ECTEL member states markets. Data required includes, inter alia, information about traffic volumes, traffic

[7] Economic depreciation requires to cover several years to ensure the entire useful life of all the assets is covered.

statistics and patterns, network coverage, number of network elements, location of network sites, network dimensioning rules or CapEx and OpEx unit costs.

The ECTEL plans to use the information provided by the operators as a primary and preferential source to populate and calibrate the BULRIC Models. To do so, the ECTEL shall issue a data requests and engage the operators to facilitate the exchange of information. It is expected swift and close co-operation by all operators concerned to ensure the completeness and accuracy of the gathered data.

The operators should indicate which of the information provide should be considered as confidential. Information which is already in the public domain will not be considered as confidential.

In the case that a piece of information is not available, or is not provided by the operators, the ECTEL shall resort to the use of international benchmarks as alternative data source.

In the case that a particular piece of data provided by the operators is not considered to be sufficiently reliable (for instance, in the case of a material deviation versus the international norm) the ECTEL will request that the operator justifies the value provided with supporting evidence. In the event that such justification is not deemed acceptable, and thus the provided data is not considered to be sufficiently reliable, the ECTEL may resort to the use of international benchmarks as preferred alternative data source.

The illustration below shows the decision tree that the ECTEL will apply in determining the appropriate data sources for the implementation of the BULRIC Models.

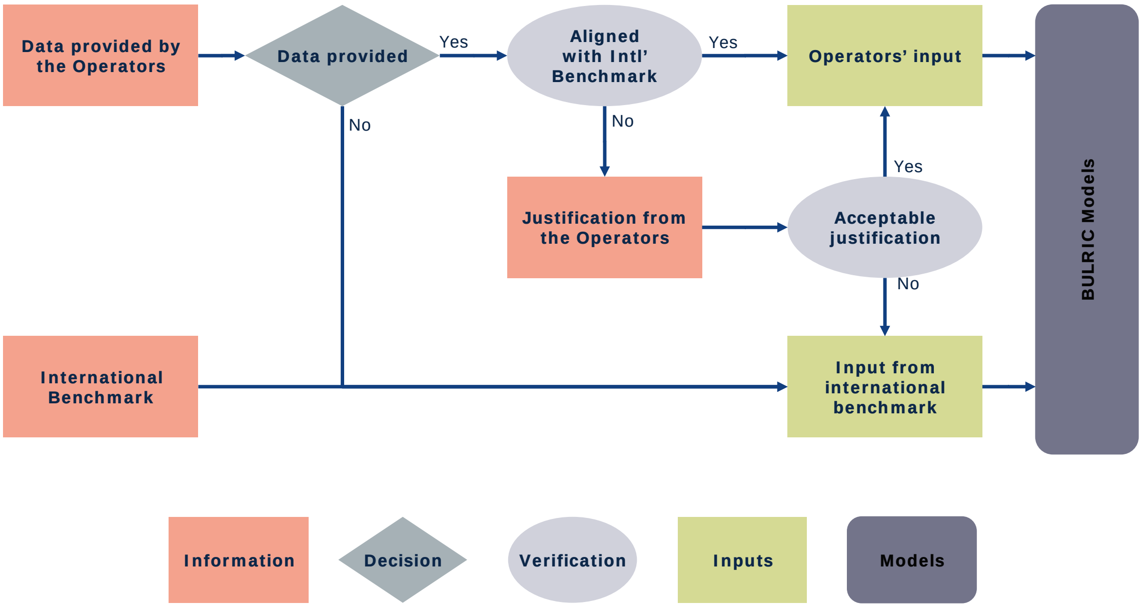

Exhibit 2 Diagram of Axon's data revision process. [Source: Axon Consulting]

Additionally, the BULRIC Models are planned to cover up to 2020 (see section 2.1.6) and, therefore, forecasts should be required, especially for traffic demand. The operators are the most appropriate source of this kind of information as demand forecasting is an activity required for the preparation of business plans.

However, the reasonability and feasibility of the forecasts provided by the Operators will be assessed by the ECTEL to ensure they are aligned with recent and expected market trends. In case the forecasts provided are considered as non-reliable, the ECTEL will use its own knowledge of the market to estimate a reasonable level of demand for future years.

Therefore, the ECTEL proposes to rely on the forecasts developed by the operators as primary and preferential source for the development of BULRIC Models.

Question 10: Do you agree with treatment of data sources described in this section?

2.2. Issues specific to BULRIC Models for a mobile network

This chapter describes a number of issues that are specific to a BULRIC model for mobile networks, namely:

- Definition of reference operator

- Mobile services and increments
- Mobile network design

2.2.1. Definition of the Reference Operator

One of the most important methodological issues to be defined for the development of BULRIC Models is the kind of operator that will be modelled, the so-called Reference Operator(s). One of the following options can be followed:

- Developing one BULRIC model for each Mobile Network Operator (MNO) in the market, each capturing the most relevant features of the operations of that particular MNO, such as amount of traffic, spectrum available or coverage. This option may be preferred in markets where substantial differences among operators exist and in particular where, in the view of the regulatory agency, asymmetrical regulatory remedies might be required
- Developing a BULRIC model for a generic reference operator representing a hypothetical efficient operator, with specific demand, coverage, etc. This option is commonly used in mobile markets in which differences between operators are not considered to be substantial enough or where, in the view of the regulatory agency, such differences in case that they do exist do not need to be translated into asymmetrical regulatory remedies.
- Developing a BULRIC model for a hypothetical new entrant, meaning a generic reference operator which would be presumed to have a reduced scale and start operations at a certain date – normally at the start of the considered period. This option may be a reasonable choice in nascent mobile markets or in cases where the regulatory agency wishes to establish price signals under a strict perspective of efficient new entry.

Modelling a generic reference mobile operator is common among regulators (see Annex G, Table 15) and consistent with the existing models (see Annex A).

Based on this, the ECTEL proposes to use a generic reference operator or a hypothetical efficient operator, i.e. similar to one of the existing operators yet one that is not expected to match the characteristics of any particular individual operator.

In this context, it is required to define the concept and characteristics of the reference operator. The relevant topics to approach this concept are described in the following subsections:

- Demand
- Spectrum

- Coverage

Demand

The demand is the volume of services provided by the reference operator. In the particular case of mobile networks, demand includes subscribers, voice minutes, data Megabytes, video-call minutes, number of SMSs, etc.

The demand satisfied by a reference operator is commonly based on its market share. The following two approaches are commonly used to calculate the reference operator's market share:

- **Average operator:** According to this approach, the market share or reasonably efficient scale is defined as 1/n; "n" being the number of existing or expected mobile network operators in the medium term; which offers a practical and workable view of a long run equilibrium. This option is the most commonly used.
- **New entrant with minimum efficient scale:** According to this approach, the minimum efficient scale concept is based on the minimum market share of the reference operator, that can be interpreted as when the initial coverage has been served. For example, the European Commission recommended that:

  "to determine the minimum efficient scale for the purposes of the cost model, and taking account of market share developments in a number of EU Member States, the recommended approach is to set that scale at 20% market share"[8].

  This approach is suitable for markets where some operators may have a relatively small market share.

The Existing Models considered one third of the demand, based on the objective of attracting new entrants (see Annex A). At this moment, there are two mobile operators in each member state, with the exception of Grenada and Saint Kitts and Nevis where there are three. The ECTEL proposes to use of the average or reasonably efficient operator, and therefore a demand of 33% for the reference operator in all Member States, with the objective of making the market more attractive to a possible new entrant in those Member States with two operators.

[8] European Commission – Explanatory note on the recommendations of TR - 2009

Spectrum

Spectrum represents one of the most important resources for the development of a mobile network. Moreover, the amount and technical features of the spectrum (band and distribution) impact significantly on the amount of equipment needed (mainly radio sites) and, therefore, on the costs incurred for the provision of mobile services.

For an operator to be efficient in the provision of mobile services, it should ideally have a sufficient amount of spectrum in light of its demand and access to spectrum in bands with adequate radio propagation characteristics, to be able to deploy the network efficiently.

The ECTEL proposes that the reference operator has a percentage (%) of the spectrum available in each band in the market, which is consistent with the market share. Moreover, the ECTEL proposes to consider the spectrum currently available, plus any expected amount of spectrum to be licenced in the future.

Network Coverage

The network coverage is the geographical extension of the mobile operator’s network. Coverage can be measured on the basis of the population covered (meaning population having access to the mobile network at their place of residence), or in terms of the geographical area covered.

For the implementation of the mobile BULRIC Model, the ECTEL will use the population coverage as a fundamental metric, in order to determine the extension of the network. Coverage will be varying over time and will be defined separately for each of the mobile technologies considered.

The reference operator will be the operator whose coverage is calculated as the average of the existing MNOs, for each technology modelled (for example, 2G, 3G and 4G), ensuring that any existing coverage obligations are satisfied.

Regarding the future evolution of network coverage, the average would be decided based on the operators’ own forecasts, ensuring that the coverage is aligned with the license obligations.

Question 11: Do you agree with the reference operator and its characteristics (e.g. demand, spectrum, coverage) described above?

2.2.2. Mobile services and increments

List of services considered in the BULRIC Model

The BULRIC model will include the network services provided by MNOs in the ECTEL Member States at a level of disaggregation that allows an accurate modelling of the networks and their costs. On the other hand, it is important to not over-split the services to avoid unnecessary complexity. Specifically, services will be individually considered in the BULRIC model on the basis of the following criteria:

- **Materiality:** services representing a significant number of connections or amount of traffic should be incorporated in the model
- **Technical Singularity:** Services whose provision implies relevant technical differences in the use of network resources should be treated separately

According to the above rationale, the ECTEL considers that a first separation of services will be made based on the service category. The BULRIC mobile model will distinguish between the following service categories:

- Voice
- Data
- SMS
- MMS
- Video calls

From the services listed above, those related to traffic between subscribers (Voice, SMS, MMS and Video-calls) will be further split according to the destination/origin, into the following services:

- On-net
- Outgoing to other network (off-net), separated into destinations
- Incoming from other network (termination)

Annex B provides a detailed list of the proposed services to be modelled.

Please note that the services will be split internally in the model into access technologies to accurately model the network requirements.

Definition of the increments

Grouping services into increments is required when using a LRIC or LRIC+ cost standard. Three main approaches have been identified for the definition of increments:

- **Based on technology**: services are grouped into increments according to their technology (i.e. GSM, UMTS, LTE). This approach is more commonly used by operators for supporting profitability systems and pricing (estimation of variable costs).
- **Based on services type**: increments are defined for the main services group (for example subscription, voice, data and other services). This alternative is more common among NRAs, as the main concern is to identify those costs that are directly attributable to certain service classes operator (see Annex G, Table 24). For example, the SMS-Centre will be only associated with SMS services, regardless of technology. Additionally, in some cases, increments are defined as groups of retail or wholesale services. This is, for instance, the approach proposed by the European Commission[9], which specifies that voice interconnection services be defined as the relevant increment for the determination of pure incremental costs

Under the ECTEL's view, it is not appropriate to draw a differentiation between retail and wholesale services when defining the increments because such differentiation may induce artificial rate differentials and could distort the market.

With regards to the distinction by class of service, despite the increasing substitutability between voice and data communication services, there is still a relevant and clear distinction between these service types, and in particular between voice and data, which is likely to be significantly sustained over the considered period of time. Based on the above, the ECTEL plans to define separate increments for voice and data services.

Finally, there is some merit in distinction by technology, given that this distinction may resemble the investment process of mobile operators, by which subsequent decisions are made on whether, and at what pace, successive technologies are deployed in the market. However, for regulatory purposes, mobile wholesale services are not regulated on the basis of the underlying technology. Based on the above, the ECTEL does not expect to define increments on the basis of technology; unless such distinction is justified, given the intrinsic differences in the services provided.

Based on the above, the ECTEL expects to define the following increments:

- Voice services

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[9] Commission Recommendation of 7.5.2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU

- Data and other services[10]

Question 12: Do you agree with the proposed list of services and the grouping of services into increments for the BULRIC model for mobile networks?

2.2.3. Mobile Network Design

This section describes the following issues related with the design of the modelled mobile network:

- Network topology design
- Geographical modelling
- Technologies considered
- Network Sharing

Network topology design

The topology of the network to be designed is mainly defined by the locations of the nodes. There are three common approaches used for the network topology design in BULRIC Models:

- **Scorched node**: this uses the location of existing network nodes. Please note that the equipment estimated in each node will be calculated based on demand and on an efficient use of the network. This option is relatively simple to implement but it may include potential inefficiencies in operators' networks.
- **Modified scorched node**: this is a variant of the scorched node approach. With this approach, the location of network nodes is not strictly equal to operators' network but is based on the existing nodes. Under this methodology, locations may be modified in case any inefficiency is identified. The implementation complexity of this option is similar to the previous one, but allows the elimination of some inefficiency.
- **Scorched earth**: this approach estimates the locations of an optimised network without restrictions of the existing network. This option allows the calculation of a theoretical efficient network, not relying on existing networks. However, this option is significantly more complex to implement.

[10] Data services would include other non-voice services such as SMSs and MMSs.

Exiting models are based on a scorched node approach (see Annex A). However, the ECTEL is of the opinion that different considerations should be made depending on the network block:

- **Access network**: in the case of the access network (mainly radio sites and backhaul), the number of nodes is relatively high and its exact position is not relevant for cost modelling purposes (number of nodes and average installed equipment is sufficient). Additionally, the use using a scorched node (or a modified scorched node) approach limits the sensitivity of the model to demand variations. This limitation is especially relevant in multi-year models, reducing the accuracy of the future results. Moreover, the current modelling techniques are able to accurately model mobile access networks without the need of relying on real nodes' positions.

  The ECTEL envisages the implementation of a Scorched earth approach, by following the dimensioning steps described below:

  1. The model will estimate the number of radio sites required per technology and geotype, in order to meet the coverage needs, by considering the cell radii of coverage for different geotypes and the area to be covered in each geotype
  2. The model will calculate the radio equipment required per technology and geotype, in order to ensure enough capacity to satisfy the demand

- **Core network**: in this case the position is more relevant (especially for the dimensioning of the backbone links) and may depend on political, economic, demographic and geographic issues. Therefore, the modified scorched node approach is perceived as the best alternative to dimension the core network, as the common international practice (see Annex G, Table 22). This means that the number and location of the core nodes will be based on operators' existing nodes

Geographical Modelling

The design of mobile access networks is highly dependent on the geographical characteristics of the zones to be covered as well as the demand density.

In order to correctly reflect such characteristics onto the model, the ECTEL will conduct a geographical analysis of the ECTEL Member States, based on the information available, so as to aggregate the areas with similar characteristics into geotypes. More specifically, the municipalities included in a single geotype will share a set of relevant characteristics. These will be defined by the following parameters:

- Population
- Population density
- Population centres per km^2
- Orography delta (measured as the difference between the highest and lowest elevation points close to a population centre)

According to the different combinations of these parameters, the Authority intends to aggregate the population centres with similar characteristics into a total of 8 geotypes, as represented below.

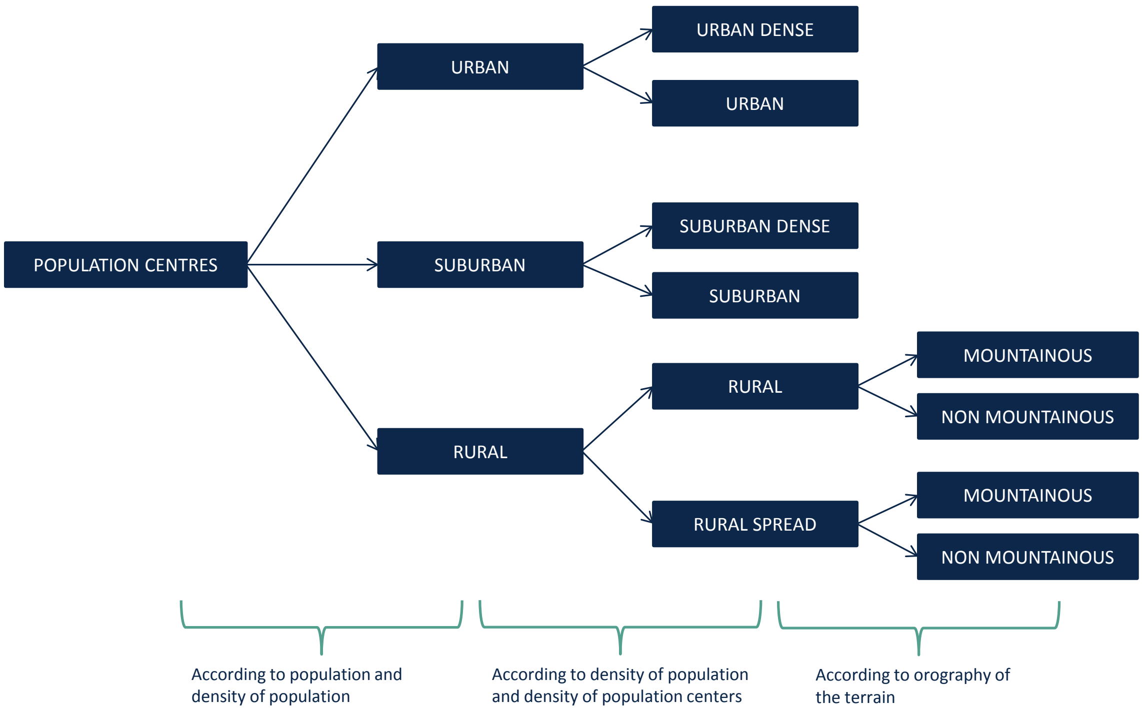

Exhibit 3: Classification of municipalities into geotypes. [Source: Axon Consulting]

The aggregation of municipalities into each geotype will depend on the specific criteria defined, which will be adjusted in order to reflect the characteristics of the ECTEL Member States.

As a result of this highly-intensive data analysis, the ECTEL expects to obtain a proper classification of the municipalities in ECTEL member states, in order to allow a proper consideration of the operating conditions faced by the licensees.

In the existing models the geographical areas were aggregated according to the traffic distribution and coverage areas between dense, medium and rural areas (see Annex A). However, the new definition of the geotypes proposed by the ECTEL will allow a more accurate modelling of their geographical characteristics, being able to represent differences in coverage cell radii, type of sites (tower or rooftop), demand density, etc.

Technologies to be modelled

Under the proposed definition of the reference operator, the technologies to be modelled should represent technologies currently in broad use in the ECTEL market, as well as technologies likely to be implemented at a significant scale within the period of time modelled.

This section describes the technologies proposed to be modelled in the BULRIC model for mobile networks. It has been divided into the following subsections:

- Radio access technologies
- Core network technologies
- Transmission technologies

Radio access technologies

In the previous models only GSM access technology has been considered (see Annex A). Nevertheless, the ECTEL proposes to include in the BULRIC Models the following radio access technologies which are in place in at least some of the member states:

- GSM (including GPRS and EDGE)
- UMTS (including HSPA and its variants)
- LTE

Each of these technologies will be dimensioned separately, based on their own coverage requirements and traffic. The BULRIC model will take into consideration synergies among technologies, in particular when it comes to co-location of radio base stations of different technologies.

Core network technologies

According to our understanding, there are two different technologies typically coexisting in core networks:

- **3Gpp Legacy Core Network**, including the separation of the control and traffic layers (MSC-S+MGW). This core technology is adequate for GSM and UMTS. The following exhibit presents an illustrative topology of a mobile network, based on 3Gpp Legacy Core Network:

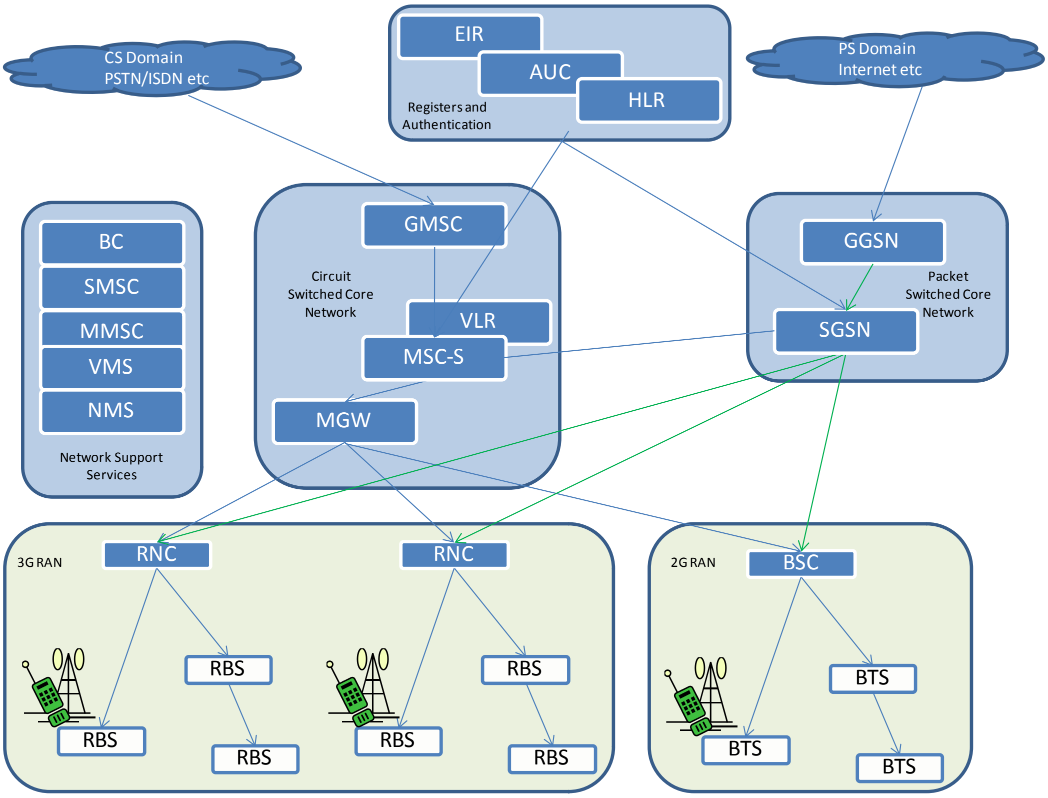

Exhibit 4: Illustrative structure of a mobile network based on 3Gpp legacy core technology. [Source: Axon Consulting]

- **Evolved Core Network**: The evolved core has the necessary equipment for supporting LTE Access networks and it is based on All-IP transmission. Additionally, it may include IMS equipment for supporting services generated by 2G and 3G access networks. The following exhibit presents an illustrative example of a mobile network, fully based on an Evolved Core Network:

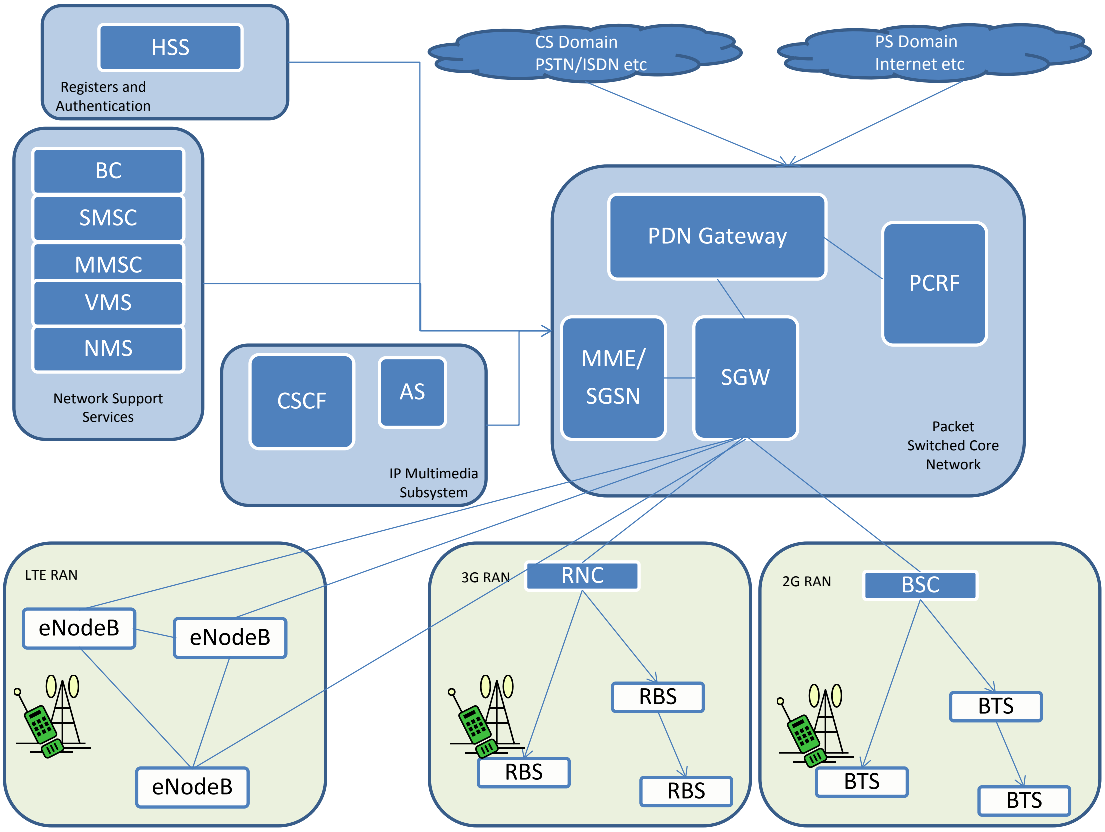

Exhibit 5: Illustrative structure of a mobile network based on Evolved Core Network technology. [Source: Axon Consulting]

Although it is likely that mobile networks are totally based on the Evolved Core in the mid-term, the ECTEL expects that both networks should coexist within the period to be modelled (i.e. until 2020). Therefore, the ECTEL proposes to model a 3Gpp legacy network for the 2G and 3G radio access networks and an Evolved Core Network for the 4G radio access network.

On the basis of the selection of technologies presents above, Annex D presents a preliminary list of the network elements which shall be considered in the mobile BULRIC model.

Transmission technologies

The following transmission technologies shall be employed in the mobile BULRIC model:

- Microwave links
- Leased Lines

Some operators in the member states combine both fixed and mobile operations. Therefore, the ECTEL proposes to model any synergy among both transmission networks as leased lines (considered as a resource in the model for mobile networks and as a demand in the model for fixed networks).

Additionally, the BULRIC model will distinguish between backhaul and backbone transmission levels, with different considerations given to each level.

Backhaul transmission network

The backhaul network comprises the transmission links between the radio sites and the network controllers, and should be dimensioned separately for each geotype. The availability per geotype of each of the transmission technologies considered should be defined according to the MNOs current operations. That is, the percentage of use of each technology on each geotype considered will be taken into account to reflect similar deployment criteria as that used by Operators, while ensuring that preference will always be given to the most cost-effective solution.

Additionally, the BULRIC model will be calibrated to reflect the backhaul network topologies used by the MNOs in each of the geotypes considered (for example, point to point links or ring connections).

Backbone transmission network

The backbone network is comprised of the transmission links connecting the network controllers and the core equipment of the MNOs. These links will be dimensioned by reproducing the actual configurations of the Operators, both in terms of topology and technology.

That is, the ECTEL will consider the current backbone links in the MNOs networks, including their distance, the technology employed and the percentage of total traffic handled.

Network sharing

There are a number of network sharing strategies used by Mobile operators to reduce costs and make more efficient use of the network. These are:

- **Site Sharing (also called mast sharing)**: this is a common practice consisting of the co-location of base stations of two or more operators in one site. This practice allows the operators to reduce costs in sites rentals, cabinets, masts and towers, air conditioning, etc. This strategy may be used within the whole network and is sometimes promoted, or even enforced by NRAs in some countries.
- **Radio-Access Network (RAN) Sharing**: this occurs when an operator deploys radio equipment (for example BTSs and TRXs) on behalf of another operator,

using the spectrum of that operator. In practice, it is similar to a network outsourcing contract. This practice is sometimes used for the development of networks in rural areas. In these cases, two or more operators split the country and each one takes care of covering their part, giving access to the other operators. Please note that this option may not be allowed due to legislation in certain countries

The practice of site sharing may be required under certain circumstances for an optimum and efficient use of resources, for instance, for providing coverage to very rural areas or when the number of suitable locations for radio sites is limited. The extent of site sharing, which may be required, varies from one market to another and in particular may be of less importance when MNOs have sufficient scale on their own.

On the other hand, the RAN sharing, which depends on the commercial strategy, legal issues and possibility to arrange collaboration with third parties, is not an essential mechanism for an efficient provision of mobile services.

Based on the above, the ECTEL will consider only site sharing in the BULRIC model. In order to do so, the average unit costs of radio sites will include the effect of site sharing.

Question 13: Do you agree with the ECTEL's approach for Mobile Network Modelling?

2.3. Issues specific to BULRIC Models for a fixed network

Similar to the previous section, the following presents a number of issues that are specific for a BULRIC model for a fixed network. Namely:

- Definition of reference operator
- Fixed services and increments
- Fixed network design

2.3.1. Definition of the Reference Operator

As was the case for the mobile BULRIC model, in principle there are three theoretical approaches for the definition of the operator to be modelled:

- Developing one BULRIC model for the relevant existing fixed operators in the market
- Developing a BULRIC model that considers a generic reference operator representing a hypothetical efficient operator
- Developing a BULRIC model representing a hypothetical new entrant

Unlike in the case of mobile networks, however, it is often difficult to define a generic reference operator for a fixed network that has enough economies of scale to be efficient. For example, the European Commission stated the difficulty in defining a generic fixed operator for BULRIC modelling:

> *"When deciding on the appropriate single efficient scale of the modelled operator, NRAs should take into account the need to promote efficient entry, while also recognising that under certain conditions smaller operators can produce at low unit costs by operating in smaller geographic areas. Furthermore, smaller operators which cannot match the largest operators scale advantages over broader geographic areas can be assumed to purchase wholesale inputs rather than self-provide termination services."*[11]

On this regard, the most common international practice for fixed BULRIC Models is representing a fixed operator with a demand and a national coverage similar to the incumbents (see Annex G, Table 25).

In the case of ECTEL Member States, there is one main fixed-line player with national coverage which is based on a copper-based access network and at least on one Hybrid Fibre-Coaxial (HFC) access network provider. Additionally, a small number of fibre accesses are present in some of the member states.

It is important to bear in mind that, since the Existing Models were implemented, the copper-access provider and the main HFC provider have merged in all Member States. As it has been informed to ECTEL, there are plans to migrate customers from the copper access networks to the more modern HFC access networks.

Based on the above, and in agreement with international practice, the ECTEL proposes to model an operator which will have similar characteristics to the national incumbent operator that combines existing copper and HFC networks. Therefore, the

[11] European Commission – Explanatory note on the recommendations of TR - 2009

reference operator will be presumed to have the demand and coverage of both copper and HFC incumbent's networks.

Question 14: Do you agree with the ECTEL that the BULRIC model for fixed networks should consider a reference operator with the characteristics described above?

2.3.2. Fixed services and increments

List of services

The BULRIC model for fixed networks will include the services provided, or those that shall be provided in the foreseeable future, by the operators in the member states at a level of disaggregation that allows the accurate modelling of the networks and their costs. On the other hand, it is important not to over-split the services so as to avoid unnecessary complexity. Specifically, services will be individually considered in the BULRIC model on the basis of the following criteria:

- **Materiality:** services representing a significant number of connections or amount of traffic should be incorporated in the model
- **Technical Singularity:** Services whose provision implies relevant technical differences in the use of network resources should be treated separately

Additionally, it is important to bear in mind that the objective of this model is calculating interconnection services. Therefore, the definition of the list of services will be focused on those services that have a direct impact in interconnection services costs. Based on this, the ECTEL considers to not include access rental services that require a significant amount of information and modelling activities that would divert efforts from the calculation of interconnection services' costs. Regardless of this, the conveyance of broadband, TV and leased lines traffic will be included at high level to ensure the economies of scale of the modelled operator are comparable to those reached by the real operators.

According to this, a first categorisation will be made based on the type of service, namely:

- Voice traffic
- Broadband
- TV
- Leased Lines and Data Capacity

In the case of voice services, they will be split into the following destinations and segments:

- Retail On-net
- Retail Outgoing to other fixed network (off-net)
- Retail Outgoing to a mobile network (off-net)
- Retail Outgoing to international destination (off-net)
- Retail calls to local DQ
- Retail calls to international DQ
- Retail calls to emergency services
- Wholesale Incoming traffic from national (termination)
- Wholesale Incoming traffic from international (termination)
- Wholesale local DQ access service
- Wholesale international DQ access service
- Wholesale emergency services access service
- Wholesale Transit
- Wholesale international call origination

Please find in Annex C a detailed list of the services proposed to be incorporated into the BULRIC model.

Definition of the increments

The definition of increments is of high relevance when developing BULRIC Models. As indicated in section 2.2.2, increments in the fixed BULRIC model shall be defined as a group of services for which incremental cost is calculated.

The international practice shows that, in fixed networks, it is common to define increments making a distinction between access and conveyance (see Annex G, Table 33), which is consistent with the increments defined in the existing model (see Annex A).

With regard to the access increment, it is not of relevance for this model, since access services are not within the scope of the model.

With regard to the conveyance increment, the ECTEL believe that – in a fixed network based on NGN architecture (see section 2.3.3) – the economies of scope for conveyance services are particularly large, much more so than in mobile networks. Thus, any split in the conveyance increment – for instance, to distinguish between voice and data services - would lead to the appearance of a large proportion of common costs and a relatively reduced proportion of incremental costs. Therefore, the Authority do not see particular merit in drawing such a distinction for the purpose of wholesale tariff setting.

Therefore, the ECTEL expects to include only one increment in the BULRIC model for fixed that includes the entire traffic.

Question 15: Do you agree with the proposed list of services and increments for the BULRIC model for fixed networks?

2.3.3. Fixed Network Design

This section describes the following issues related to the design of the modelled fixed network:

- Network topology design
- Geographical modelling
- Technologies considered

Network topology design

As described in section 2.2.3, the design of the network may be based on actual operators' nodes, or can be designed without restriction.

In the case of fixed networks, the complexity of designing an optimal network topology makes the Scorched Earth approach virtually unfeasible. Because of this, and especially in those cases where the reference operator is based upon the demand and coverage of existing operators, it is a standard practice to take the operators' existing geographical distribution of the main network access nodes as a given in the network design process. Main network access nodes refer to those facilities where wireline connection is terminated (for example, location of the Main Distribution Frame).

Maintaining the existing main access nodes does not mean that potential inefficiencies cannot, or should not, be addressed. For instance, the ERG[12], which advocates the use of existing node locations as a starting point for the fixed network design in BULRIC Models, states that:

> *"It can be appropriate to modify the scorched node approach in order to replicate a more efficient network topology than is currently in place. Such*

[12] ERG was the predecessor to the Body of European Regulators for Electronic Communications (BEREC)

> *a modified scorched node approach could imply taking the existing topology as the starting point, followed by the elimination of inefficiencies. This may involve changing the number or types of network elements that are located at the nodes to simplify and decrease the cost of the switching hierarchy. Other important issues in this respect are how to deal with spare capacity in the network and the existence of stranded costs. When the modified scorched node approach is not applicable because the elimination of inefficiencies is not practical, it could be more appropriate to use a scorched earth approach."*[13]

The Existing Models are based on a scorched node approach (see Annex A). However, a review of international practice shows how the use of the modified scorched node approach is, in fact, the most widespread methodological choice for network topology design.

Additionally, it is important to bear in mind that the reference operator would be a combination of both copper-pair and HFC operators. Therefore, the consideration of the access nodes of both operators will result in duplicities and inefficiencies in the common areas.

Therefore, the ECTEL considers that a modified scorched node approach is the most adequate methodological choice for the implementation of a fixed BULRIC model in ECTEL member states. In particular, it is proposed that the nodes considered in the model are be those in the HFC network plus the copper-based access nodes in the areas not covered by the network.

Geographical Modelling

The investment required for covering a certain area with a fixed access network depends highly on the density of premises, i.e., the density of access lines.

With the objective of representing these issues precisely, and to accurately model the reality of the network in the ECTEL member states, the Authority proposes to aggregate network nodes with similar characteristics/size into different geotypes. This approach is, in fact, the standard in BULRIC modelling.

The existing models are not considering any geographical categorisation nor geotypes. Although this is feasible when basing a model on a pure scorched node approach, the ECTEL believes that the accuracy of the calculations may be limited or,

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

at least, strongly attached to the network inputs included in the model. This approach is significantly static and does not allow forecasting nor scenarios analysis. Therefore, the ECTEL proposes to group the nodes of the network according to their characteristics in order to properly recognise different traffic characteristics of each node.

According to international practice, the process of identifying similar categories is highly dependent on the information available. Thus, the Authority will perform the geographical analyses and take into consideration the level of detail available so as to ensure that it sufficiently captures the geographical characteristics of the ECTEL member states.

Based on the available information on the number and distribution of the access nodes locations, the ECTEL will aggregate the total access locations into the following geotypes:

- Urban Dense
- Urban
- Suburban Dense
- Suburban
- Rural Dense
- Rural

The geotype of each access node location will be set according mainly to the number of lines connected and the proximity to other nodes.

Additionally, the ECTEL plans to group upper level nodes based on the available information on the number of access nodes (and related demand) connected to each core location, under a number of groups such as:

- Small
- Medium
- Large
- Extra-large

The level of detail achieved through this analysis, as well as the number of samples analysed, will be highly dependent on the quality and amount of information available. Nevertheless, a sufficient number of samples for each category should be analysed, retaining a level of detail for each of them that will guarantee that the fixed network model correctly represents the geographical characteristics of the ECTEL member states.

Technologies to be modelled

This section describes the proposed technologies that are to be modelled in the BULRIC model for fixed networks. It has been divided into the following subsections:

- Core network technologies
- Transmission technologies

Core network technologies

The following core technologies are typically used by fixed operators:

- **Legacy TDM switching,** based on switching exchanges (local, secondary, nodal, tandem, etc.). This technology is only suitable for voice services and it is complemented with a packet switching network for broadband services
- **NGN core network**, core network is based on one all-IP network. The provision of traditional services (i.e. voice) is supported by dedicated servers such as soft-switches. Additionally, it is common practice to use Media Gateways (MGW) to provide TDM connectivity for interconnection with traditional networks

Although a number of incumbent operators still use their legacy switching networks for voice services, this kind of equipment is being increasingly phased out and is not easily available in the market. Moreover, new entrants develop their core networks based on an NGN approach. Additionally, in the case of ECTEL Member states, this is actually the case and NGN are already used[14].

Additionally, the merge between the copper-based and HFC based networks is expected to result in migration to a more efficient and with higher scale NGN network that covers all the subscribers.

In ECTEL's view, the NGN core network represents the MEA of the traditional fixed networks, and it is the international common practice in development BULRIC Models (see Annex G, Table 30). In that context, NGN core network is able to provide all retail and wholesale services currently sold. Therefore, the ECTEL will consider a NGN core network in the BULRIC model for the fixed network. The following exhibit presents an illustrative example of NGN core network structure:

[14] For instance, C&W migrated to NGN its network in St. Vincent & The Grenadines in 2010 (http://www.cwc.com/assets/uploads/files/Press%20Releases/St%20Vincent%20NGN_061010.pdf).

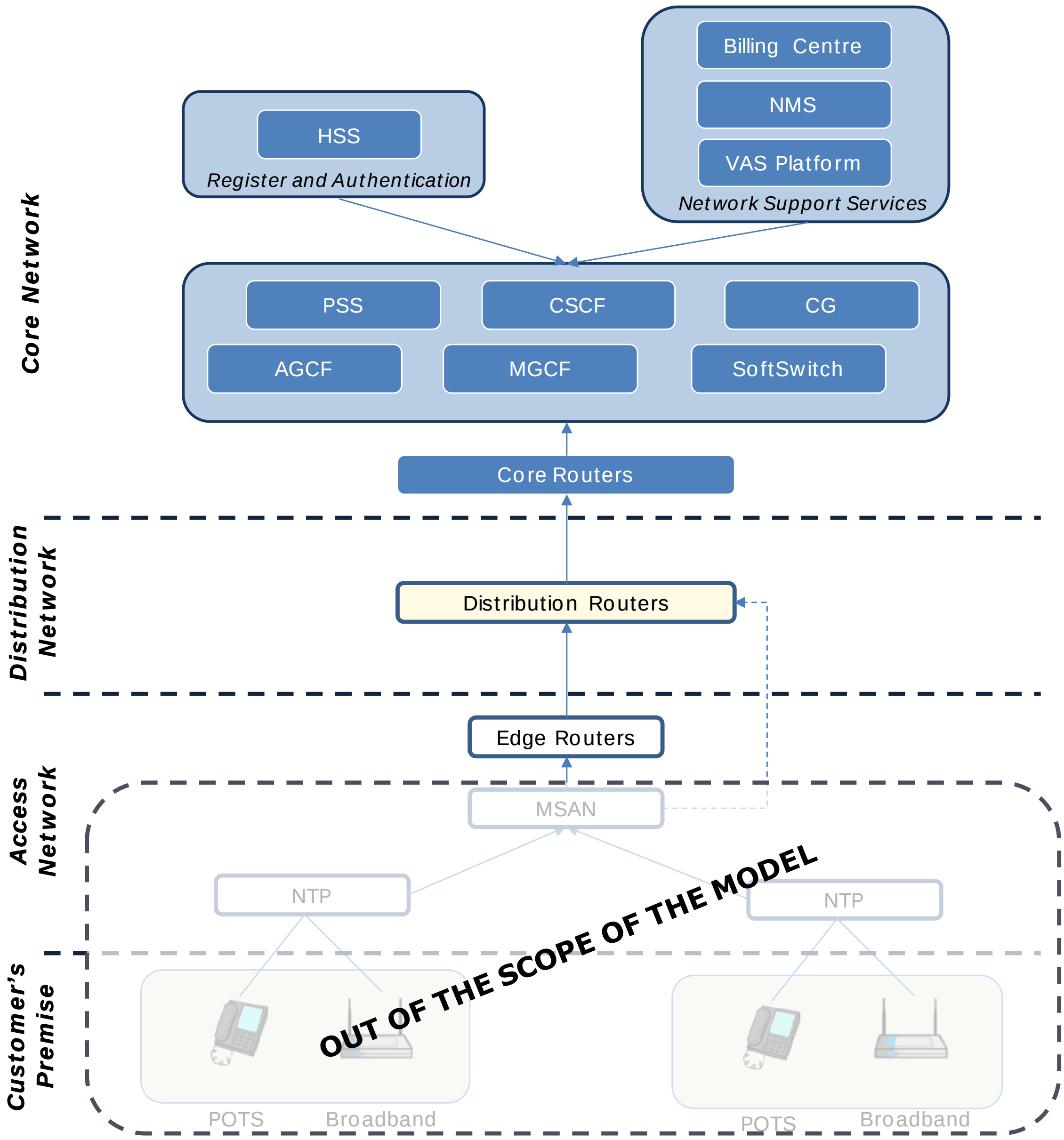

Exhibit 6: Illustrative structure of a fixed network based on NGN technology. [Source: Axon Consulting]

On the basis of the selection of technologies presented above, Annex E gives a preliminary list of the network elements which shall be considered in the fixed BULRIC model.

Transmission technologies

The following technologies can be considered for transmission dimensioning:

- **SDH Fibre Transmission** (ADM and Cross-connect equipment)
- **Native Ethernet Fibre Transmission,** assuming that the dissociation between the different traffic flows at layer 2 will be done by VLAN technology

- **WDM Fibre Transmission,** based on wavelength division multiplexing equipment

In the models currently used by ECTEL the fixed transmission network is based on SDH equipment (see Annex A). This is reasonable since SDH transmission has been commonly used by fixed operators. Nevertheless, this technology is being largely substituted by native Ethernet transmission.

Therefore, the ECTEL proposes to consider Native Ethernet fibre transmission and WDM technologies in the BULRIC model for fixed networks.

In addition to the technologies listed previously, the Authority considers that microwave links should be used for the connection of remote nodes for which this technology is more cost-efficient than fibre links.

Question 16: Do you agree with the ECTEL's approach for Fixed Network Modelling?

Annex A. Methodology used in the previous BULRIC Models

A.1. Common to all BULRIC Models

Methodological issue	Methodology used by ECTEL
Costs elements to be considered	
Network CapEx	▶ Network equipment purchasing ▶ Network infrastructure ▶ Supporting IT systems ▶ Installation costs
Network OpEx	▶ Network personnel ▶ Recurrent charges for subcontracted network services ▶ Network sites rentals
Licenses and Spectrum fees	▶ License and spectrum fees are included in the models in the same manner as the G&A costs
Retail costs	▶ Retail expenses and capital costs relating to the retail part of the business, where relevant, are treated as a mark-up to the network operating costs and non-network common costs.
G&A costs	▶ Calculated using Expense Factors (Overhead OpEx/Gross Replacement Cost)
Cost of Capital	▶ Use of WACC based on the Capital Asset Pricing Model (CAPM)
Treatment of OpEx	
Determination of Network-related Operations and Maintenance Costs	▶ Based on Bottom-up calculation
Determination of General and Administrative Costs	▶ G&A expenses will be shared between the BULRIC Models for fixed and mobile networks ▶ Calculated using Expense Factors (Overhead OpEx/Gross Replacement Cost)
Treatment of Capital-Related Costs	
Assets valuation method	▶ Static approach (One-year period).
Consideration of modern equivalent assets	▶ All equipment costs are based on current market prices. Where current market prices have not been available, the historic price has been adjusted by price trends
Annualisation method	▶ Straight line depreciation, assuming a half year depreciated equipment for the fixed network ▶ Standard Annuity for the mobile network

Methodological issue	Methodology used by ECTEL
Cost Standard	▶ Fully Allocated Costs (FAC) ▶ LRIC+
Allocation of common and joint network costs for the LRIC+ standard	▶ Equi-Proportional Mark-Up (EPMU)
Allocation of non-network common-costs for the LRIC+ standard	▶ Equi-Proportional Mark-Up (EPMU)
Network dimensioning optimization approach	▶ Yearly approach
Period of time modelled	▶ One-year period.
Data sources	▶ Information from C&W ▶ Information from benchmark

A.2. Specific to BULRIC Models for a mobile network

Methodological issue	Methodology used by ECTEL
Definition of reference operator	
Demand	▶ The mobile network is dimensioned to meet one-third of the entire market demand under the assumption that there are three operators in each island
Spectrum	▶ MHz of spectrum available in each band in the market (use either 850MHz/1900MHz or 900/1800MHz) (information from C&W)
Network Coverage	▶ Coverage areas (square km) ▶ Voice subscribers ▶ Data and SMS subscribers ▶ Regional Voice Subscribers
Mobile services and increments	
List of services considered in the BULRIC Model	▶ Technical Singularity ▶ Service category
Definition of the increments	▶ Based on services type: Traffic and Subscribers
Mobile network design	
Boundary between access and core networks	▶ Mobile Network – Radio ▶ Mobile Network – Transmission ▶ Mobile Network – Switching
Network topology design	▶ Scorched node

Methodological issue	Methodology used by ECTEL
Geographical modelling	▶ Traffic Distribution by land type: Splits the traffic into that carried in dense, medium and rural areas ▶ Coverage areas (square km): Splits the geographic area into dense, medium and rural ▶ Cell Sectorisation: Determines whether a cell is omni or sectorised
Technologies considered	
Radio access technologies	▶ GSM technologies
Core network technologies	▶ 3Gpp Legacy Core Network ▶ MSC and associated components such as the HLR are assumed to be located off-island and shared
Transmission technologies	▶ The mobile network is assumed not to own any fixed transmission infrastructure ▶ Uses leased line obtained at commercial rates from a fixed network operator

A.3. Specific to BULRIC models for a fixed network

Methodological issue	Methodology used by ECTEL
Definition of reference operator	
Demand	▶ The fixed network is dimensioned to meet the entire market demand
Fixed services and increments	
List of services	▶ Technical Singularity ▶ Type of service ▶ Access rental services technology
Definition of the increments	▶ Access services: PSTN Access, ISDN Access, ADSL ▶ Transmission: retail and wholesale traffic services, leased lines and data services
Fixed network design	
Boundary between access and core networks	▶ Fixed Model - Access Network ▶ Fixed Model – Transmission ▶ Fixed Model – Switching
Network topology design	▶ Scorched node
Technologies considered	
Fixed access technologies	▶ The access network is based around a copper cable infrastructure

Methodological issue	Methodology used by ECTEL
Core network technologies	▶ Media Gateway (MG) – this equipment connects to the copper access network, and provides the functionality for provision of voice and ISDN calls. ADSL services are provided via a collocated DSLAM unit. ▶ Softswitch/Multi-Service Edge and Voice Packet Gateway – this equipment collocated and route calls between MGs, and provides the link between the IP infrastructure of the OECS national network and outside networks
Transmission technologies	▶ The core transmission network is based around optical fibre cables which may be either underground in ducts or aerial, supported on poles. ▶ The transmission network is based on traditional SDH equipment, in a resilient ring configuration.

Annex B. List of services to be included in the BULRIC Model for mobile networks

B.1. Retail services

B.1.1. Access Services

Services related to the provision of access:

- Subscription

B.1.2. Data Services

Services for the transmission of data (measured in MB).

- Data traffic

B.1.3. Voice Services

Voice calls (measured in minutes) split into call direction:

- On-net voice calls
- Outgoing off-net voice calls

B.1.4. SMS Services

Short message services (measured in number of SMS) split into direction:

- On-net SMS
- Outgoing off-net SMS

B.1.5. MMS Services

Multimedia Message Services (measured in MB) split into direction:

- On-net MMS
- Outgoing off-net MMS

B.1.6. Video call Services

Video-call services (measured in minutes) split into call direction:

- On-net video calls
- Outgoing off-net video calls

B.2. Wholesale services

B.2.1. Data Services

Wholesale services for the transmission of data (measured in MB).

- Inbound Roaming data

B.2.2. Voice Services

Voice calls (measured in minutes):

- Incoming voice calls (termination)
- Origination Inbound roaming calls
- Incoming Inbound roaming calls

B.2.3. SMS Services

Short message services (measured in number of SMS):

- Incoming SMS (termination)
- Origination Inbound roaming SMS
- Incoming Inbound roaming SMS

B.2.4. MMS Services

Wholesale Multimedia Message Services (measured in MB):

- Incoming MMS (termination)
- Outgoing Inbound roaming MMS
- Incoming Inbound roaming MMS

Annex C. List of fixed services to be included in the BULRIC Model for fixed networks

C.1. Voice Services

Services enclosing voice calls (measured in minutes), disaggregated based on the segment (wholesale and retail) and call direction:

Retail

- Retail On-net
- Retail Outgoing to other fixed network (off-net)
- Retail Outgoing to a mobile network (off-net)
- Retail Outgoing to international destination (off-net)
- Retail calls to local DQ
- Retail calls to international DQ
- Retail calls to emergency services

Wholesale

- Call Termination
- Call transit
- Wholesale Incoming traffic from national (termination)
- Wholesale Incoming traffic from international (termination)
- Wholesale local DQ access service
- Wholesale international DQ access service
- Wholesale emergency services access service
- Wholesale Transit
- Wholesale international call origination

C.2. Other services

- Broadband traffic (measured as throughput in Gbps in the busy hour)
- TV Channels (measured as throughput required to be delivered to the access nodes)
- Leased lines and Corporate Data services capacity (measured in Gbps)

Annex D. List of resources to be included in the BULRIC Model for mobile networks

The following table shows a list of resources to be included in the model:

Category	Name	Unit
Site	Tower-Rural	# of sites
Site	Rooftop-Rural	# of sites
Site	Tower-Suburban	# of sites
Site	Rooftop-Suburban	# of sites
Site	Tower-Urban	# of sites
Site	Rooftop-Urban	# of sites
Site	Electricity	Kw/h
Site	Fuel	Litres
Site	Generator	#of generators
Site	Air Conditioning	# of air conditioners
2G site equipment	GSM BTS	# of BTS
2G site equipment	GSM BTS - SW	# of BTS-SW
2G site equipment	GSM TRX	# of TRXs
2G BSC	Base Station Controller (BSC) Unit	# of BSCs
2G BSC	Base Station Controller (BSC) Unit - Software	# of BSCs-SW
3G site equipment	UMTS NodeB	# of NodeBs
3G site equipment	UMTS NodeB - SW	# of NodeBs-SW
3G site equipment	UMTS cell-carrier	# of carriers
3G RNC	Radio Network Controller (RNC) Unit	# of RNCs
3G RNC	Radio Network Controller (RNC) Unit - SW	# of RNCs-SW
4G site equipment	LTE eNodeB	# of eNodeBs
4G site equipment	LTE eNodeB-SW	# of eNodeBs-SW
4G site equipment	LTE cell-carrier	# of carriers
4G Switch	LTE Switch Unit	# of Switches
4G Switch	LTE Switch Unit-SW	# of Switches-SW
Backhaul MW	PDH Up to 34Mbps	# of links
Backhaul MW	SDH Up to 155 Mbps	# of links
Backhaul MW	ETH Up to 500 Mbps	# of links
Backhaul MW	ETH Up to 1000 Mbps	# of links
Backhaul LL	LL 2 Mbit/s (E1)	# of lines
Backhaul LL	LL 2 Mbit/s (E1)	km
Backhaul LL	LL 34 Mbit/s (E3)	# of lines
Backhaul LL	LL 34 Mbit/s (E3)	km
Backhaul LL	LL 155 Mbit/s (STM-1)	# of lines
Backhaul LL	LL 155 Mbit/s (STM-1	km
Backhaul LL	LL 1Gbps (Gigabit Eth)	# of lines
Backhaul LL	LL 1Gbps (Gigabit Eth)	km
Backbone LL	LL 34 Mbit/s (E3)	# of lines
Backbone LL	LL 34 Mbit/s (E3)	km
Backbone LL	LL 155 Mbit/s (STM-1)	# of lines
Backbone LL	LL 155 Mbit/s (STM-1)	km
Backbone LL	LL 622 Mbit/s (STM-4)	# of lines
Backbone LL	LL 622 Mbit/s (STM-4)	km

Category	Name	Unit
Backbone LL	LL 1Gbps	# of lines
Backbone LL	LL 1Gbps	km
Backbone LL	LL 10Gbps	# of lines
Backbone LL	LL 10Gbps	km
Backbone MW	SDH Up to 155 Mbps	# of links
Backbone MW	SDH Up to 622 Mbps	# of links
Backbone MW	ETH Up to 1000 Mbps	# of links
Backbone MW	Repeater Up to 155 Mbps	# of links
Backbone MW	Repeater Up to 622 Mbps	# of links
Backbone MW	Repeater Up to 1000 Mbps	# of links
Backbone LL	Submarine LL 34 Mbit/s (E3)	# of lines
Backbone LL	Submarine LL 34 Mbit/s (E3)	km
Backbone LL	Submarine LL 155 Mbit/s (STM-1)	# of lines
Backbone LL	Submarine LL 155 Mbit/s (STM-1)	km
Backbone LL	Submarine LL 622 Mbit/s (STM-4)	# of lines
Backbone LL	Submarine LL 622 Mbit/s (STM-4)	km
Backbone LL	Submarine LL 1Gbps	# of lines
Backbone LL	Submarine LL 1Gbps	km
Backbone LL	Submarine LL 10Gbps	# of lines
Backbone LL	Submarine LL 10Gbps	km
Core	Core Site	# of sites
Core	Media Gateway (MGW) Unit	# of MGW
Core	Media Gateway (MGW) Unit-SW	# of MGW
Core	Mobile Switching Center Server (MSCS) Unit	# of MSCSs
Core	Mobile Switching Center Server (MSCS) Unit-SW	# of MSCSs
Core	Serving GPRS Support Node (SGSN)	# of SGSN
Core	Serving GPRS Support Node (SGSN)-SW	# of SGSN
Core	Gateway GPRS Support Node (GGSN)	# of GGSN
Core	Gateway GPRS Support Node (GGSN)-SW	# of GGSN
Core	Home Location Register (HLR)	# of HLR
Core	Home Location Register (HLR)-SW	# of HLR
Core	Billing Centre (BC)	# of BC
Core	Billing Centre (BC)-SW	# of BC
Core	Short Message Service Centre (SMSC)	# of SMSC
Core	Short Message Service Centre (SMSC)-SW	# of SMSC
Core	Multimedia Messaging Service Centre (MMSC)	# of MMSC
Core	Multimedia Messaging Service Centre (MMSC)-SW	# of MMSC
Core	Voicemail System (VMS)	# of VMS
Core	Voicemail System (VMS)-SW	# of VMS
Core	Mobile Management Entity (MME)	# of MME
Core	Mobile Management Entity (MME)-SW	# of MME
Core	Serving Gateway (SGW)	# of SGW
Core	Serving Gateway (SGW)-SW	# of SGW
Core	Packet Data Network Gateway (PGW)	# of PGW
Core	Packet Data Network Gateway (PGW)-SW	# of PGW
Core	Policy and Charging Rules Function (PCRF)	# of PCRF
Core	Policy and Charging Rules Function (PCRF)-SW	# of PCRF
Core	Home Subscriber Server (HSS)	# of HSS
Core	Home Subscriber Server (HSS)-SW	# of HSS
Core	Call Session Control Function (CSCF)	# of CSCF
Core	Call Session Control Function (CSCF)-SW	# of CSCF
Core	Session Border Controller (SBC)	# of SBC
Core	Session Border Controller (SBC)-SW	# of SBC
LIC	SPECTRUM 800MHz	MHz
LIC	SPECTRUM 850/900MHz	MHz
LIC	SPECTRUM 1800MHz	MHz
LIC	SPECTRUM 1900MHz	MHz
LIC	SPECTRUM 2600MHz	MHz
LIC	MW Spectrum	MHz

Table 1: Illustrative example of resources to be considered in the BULRIC model for mobile networks. [Source: Axon Consulting]

Annex E. List of resources to be included in the BULRIC Model for fixed networks

The following table shows a list of resources to be included in the model:

Category	Name	Unit
Site	For core node	#
Site	Diesel Generator	#
Site	Electricity	KWH
Site	Fuel	litres
Trunk fibre	Fibre link[15]	km
Microwave Transmission	Ethernet Mw link	#
Microwave Transmission	Mw Tower	#
Fibre Transmission	Ethernet chassis	#
Fibre Transmission	DWDM Chassis	#
Fibre Transmission	DWDM lambda inserter	#
Edge Routers	Edge routers chassis	#
Edge Routers	Fast card	#
Edge Routers	Gigabit card	#
Edge Routers	10 Gigabit card	#
Distribution routers	Distribution routers chassis	#
Distribution routers	Fast card	#
Distribution routers	Gigabit card	#
Distribution routers	10 Gigabit card	#
Core routers	Core routers chassis	#
Core routers	Fast card	#
Core routers	Gigabit card	#
Core routers	10 Gigabit card	#
Converters	TDM to IP converter chassis	
Converters	DS1 Card	
Converters	OC1 Card	
Converters	OC3 Card	
Converters	OC12 Card	
Converters	OC48 Card	
Converters	OC192 Card	
Converters	Fast Ethernet card	
Converters	Gigabit Ethernet card	
Converters	10 Gigabit Ethernet card	

[15] Fibre elements including supporting infrastructure resources such as trenches, poles and ducts.

Category	Name	Unit
Core Network	Call Session Control Function (CSCF) hardware	#
Core Network	Call Session Control Function (CSCF) software	#
Core Network	Access Gateway Control Function (AGCF) hardware	#
Core Network	Access Gateway Control Function (AGCF) software	#
Core Network	Softswitch hardware	#
Core Network	Softswitch software	#
Core Network	Application server (AS) hardware	#
Core Network	Application server (AS) software	#
Core Network	Charging Gateway (CG) hardware	#
Core Network	Charging Gateway (CG) software	#
Core Network	Packet Switched Server (PSS) hardware	#
Core Network	Packet Switched Server (PSS) software	#
Core Network	Media Gateway Controller Function (MGCF) hardware	#
Core Network	Media Gateway Controller (MGCF) software	#
Supporting platforms	Network Management System (NMS) hardware	#
Supporting platforms	Network Management System (NMS) software	#
Supporting platforms	Home Subscriber Server (HSS) hardware	#
Supporting platforms	Home Subscriber Server (HSS) software	#
Supporting platforms	Voice Mail Server (VMS) hardware	#
Supporting platforms	Voice Mail Server (VMS) software	#
Supporting platforms	VAS, IN hardware	#
Supporting platforms	VAS, IN software	#
Supporting platforms	Billing system hardware	#
Supporting platforms	Billing system software	#

Table 2: Illustrative example of resources to be considered in the BULRIC model for fixed networks. [Source: Axon Consulting]

Annex F. Summary of questions

Question 1: Do you agree that Network CapEx, Network OpEx, License and spectrum fees, G&A Expenses and cost of capital should be included in the cost base of the BULRIC Models in the manner indicated in this section?

Question 2: Do you agree with the ECTEL's proposal on the treatment of OpEx in the BULRIC Models?

Question 3: Do you agree with the ECTEL's view in how assets should be valued and the proposed application of the modern equivalent assets?

Question 4: Do you agree with the ECTEL's view to implement tilted annuities in the BULRIC cost models? In the case that you have a different view, please support it with rationale.

Question 5: Do you agree with the ECTEL with the proposed approach for the consideration of working capital?

Question 6: Do you agree with the use of LRIC+ standard?

Question 6: Do you agree with the suggested treatment of common cost under the LRIC+ standard in the BULRIC Models?

Question 8: Do you agree with the use of a yearly approach for network optimisation?

Question 6: Do you agree with the time period defined (i.e. from 2015 to 2020)?

Question 6: Do you agree with treatment of data sources described in this section?

Question 7: Do you agree with the reference operator and its characteristics (e.g. demand, spectrum, coverage) described above?

Question 8: Do you agree with the proposed list of services and the grouping of services into increments for the BULRIC model for mobile networks?

Question 9: Do you agree with the ECTEL's approach for Mobile Network Modelling?

Question 10: Do you agree with the ECTEL that the BULRIC model for fixed networks should consider a reference operator with the characteristics described above?

Question 11: Do you agree with the proposed list of services and increments for the BULRIC model for fixed networks?

Question 12: Do you agree with the ECTEL's approach for Fixed Network Modelling?

Annex G. International Benchmark on selected methodological issues

As part of the decision process of determining the best alternatives for each of the methodological approaches described in this document, the ECTEL has reviewed the alternatives adopted by a number of other NRAs, an exercise which is summarized in this annex.

Even though the ECTEL has taken into account the international best practice[16], the methodology described in the public consultation has been carefully designed to reflect the reality and specificities of the market in the ECTEL member states and to serve the ECTEL's regulatory objectives. Therefore, participants in the public consultation are advised that they should not aim to establish a direct relationship between the proposed methodology and this benchmark exercise or any other benchmark or international references which may be additionally provided.

The countries covered in the benchmark have been included so as to have a sufficient representation of the methodologies applied to BULRIC Models that have been published by other NRAs in the Caribbean, Latin America, Europe, Middle East and Africa. The table below shows the list of countries that have been used for this analysis, detailing which type of BULRIC Models, or public consultations (mobile or fixed), have been made publicly available by each NRA.

[16] The ECTEL has not only analysed on the number of countries adopting one option, but has also taken into account the trend followed the NRAs that have developed the most recent models (for instance, although the majority of NRAs have not modelled NGN networks in their BULRIC models for fixed networks, the most recent models tend to consider them).

REGION	COUNTRY	MOBILE	FIXED
CARIBBEAN AND LATIN AMERICA	BRAZIL	√	√
	CAYMAN ISLANDS	√	√
	JAMAICA	√	√
	COLOMBIA	√	√
	EL SALVADOR	√	√
EUROPE	BELGIUM	×	√
	SPAIN	√	√
	FRANCE	√	√
	NORWAY	√	√
	SWEDEN	√	√
	UK	√	√
MIDDLE EAST	OMAN	√	√
	BAHRAIN	√	√
	UAE	√	√
	SAUDI ARABIA	√	√
	JORDAN	√	√
AFRICA	ZIMBABWE	√	√
TOTAL		**16**	**17**

Table 3: List of countries included in the benchmark [Source: Axon Consulting]

The table below describes the specific sources (models, models' documentation or public consultation documents) that have been employed in each case:

Country	Networks considered	Document	Date released
Brazil	Mobile & Fixed	Documento com a abordagem conceitual para os modelos bottom-up de rede móvel e fixa	September 2013
Cayman Islands	Mobile & Fixed	Decision for the Costing Manual Consultation (CD 2005-1)	July 2008
Jamaica	Fixed	Cost Model for Fixed Termination Rates - Principles and Methodology	July 2015
	Mobile	Cost Model for Mobile Termination Rates - Determination Notice	July 2012
Colombia	Fixed	Informe Modelo Convergente NGN	December 2011
	Mobile	Manual del Modelo IP	August 2012
		Modelo Costos Roaming	August 2012
El Salvador	Mobile & Fixed	Descripción del modelo diseñado para la estimación de los costes asociados a los distintos servicios contemplados en el Decreto 295	September 2010

Country	Networks considered	Document	Date released
Belgium (BIPT)	Fixed	Consultation document for the draft NGN/NGA models	December 2011
		Bottom-up fixed network cost model for BIPT (version 1.0)	December 2011
Spain (CMT)	Mobile	Public Consultation document on the LRIC Model for mobile networks	October 2011
		20111021_Modelo_costes	October 2011
	Fixed	Public consultation document for the LRIC Model for interconnection costs in fixed networks	December 2012
		LRIC Model for interconnection costs in fixed networks	December 2012
France (ARCEP)	Mobile	Bottom-up mobile LRIC model for ARCEP (Release 5): Model Documentation	March 2011
		model-cout-tamobile-230311	March 2011
	Fixed	Model documentation: Modèle technico-économique des coûts de la terminaison d'appel fixe en France	July 2013
		Modèle technico-économique des coûts de la terminaison d'appel fixe en France	July 2013
Norway (NPT)	Mobile	Model documentation for the Norwegian Post and Telecommunications Authority: Mobile cost model version 8 final	May 2013
		NPT v8F Generic	May 2013
	Fixed	NPT's fixed long-run incremental cost model: Final access model documentation	September 2012
		LRIC-modell aksessnett versjon 1.7	September 2012
Sweden (PTS)	Mobile	New mobile long-run incremental cost (LRIC) model: Documentation for the final cost model	May 2011
		PTS mLRIC model 2013 by PTS	May 2011[17]
	Fixed	Hybrid Model Documentation v7.1	November 2009
		Hybrid model v7.1	November 2009
UK (Ofcom)	Mobile	Mobile LRIC model version 1	April 2010
	Fixed	Ofcom Narrowband Charge Control model	February 2013
Oman	Mobile & Fixed	Development of Bottom-Up LRIC Models in the Sultanate of Oman – Position Statement	April 2014
Bahrain (TRA)	Mobile & Fixed	Draft Position Paper on the "Development, implementation and use of bottom-up fixed and mobile network cost models in the Kingdom of Bahrain"	May 2011
UAE (TRA)	Mobile & Fixed	Consultation document on "The Development of Bottom-Up LRIC Models	July 2012

[17] The PTS updated the inputs employed in the LRIC model for mobile networks in June 2013

Country	Networks considered	Document	Date released
		of Telecommunications Networks in the UAE”	
Saudi Arabia (CITC)	Mobile & Fixed	LRIC Model Guidelines for the Kingdom of Saudi Arabia	March 2008
Jordan (TRC)	Mobile & Fixed	Notice requesting comments on the construction of TSLRIC+ models for the costs of interconnection services	June 2009
Zimbabwe (POTRAZ)	Mobile & Fixed	Consultation paper on telecommunications network cost analysis and modelling	November 2012

Table 4: Description of the sources considered in the benchmark. [Source: Axon Consulting]

Please note that a number of regulators have developed separate models for access and transmission fixed network. In these cases, both models have been analysed jointly in the benchmark. In the event that methodological differences exist between them, these will be outlined in the benchmark.

The results of the benchmark conducted are outlined below (where information is not available, cells have been left blank). They have been structured according to the same criteria employed in the main body of this document:

- Common features for mobile and fixed BULRIC Models
- Specific features of the BULRIC Model for a mobile network
- Specific features of the BULRIC Model for a fixed network

Common features for mobile and fixed BULRIC Models

This section presents the results of the benchmark for those issues that are treated jointly for the BULRIC Models for fixed and mobile networks.

Given that, especially within European countries, the methodological issues treated in this section may have been treated differently for the BULRIC Models for mobile or fixed networks, the benchmarks included below will provide the methodological approaches followed by the NRAs, separately for mobile and fixed networks.

Cost elements to be considered

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
MOBILE NETWORKS	**Network CapEx**	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	**16 / 16**
	Network OpEx	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	**16 / 16**
	Spectrum fees	√						x	√	√	√	√	√	√	√		√	√	**10 / 11**
	Retail Costs	x	√		x	x		x	x	x	x	x	x	√	x	x	x	x	**2 / 15**
	G&A Costs	√	√					√	√	√	√	x	√	√	√	√	√	√	**12 / 13**
FIXED NETWORKS	**Network CapEx**	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**17 / 17**
	Network OpEx	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**17 / 17**
	Retail Costs	x	√	√	x	x	x	x	x	x	x	x	x	√	x	x	x	x	**3 / 17**
	G&A Costs	√	√	√			√	x	x	√	√	x	√	√	√	√	√	√	**12 / 15**

Table 5: Benchmark: Costs elements to be considered. [Source: Axon Consulting]

Cost of Capital

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
MOBILE NETWORKS	**Weighted Average Cost of Capital (WACC)**	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	**16 / 16**
	Return of Turnover (RoT)	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	**0 / 16**
FIXED NETWORKS	**Weighted Average Cost of Capital (WACC)**	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**17 / 17**
	Return of Turnover (RoT)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	**0 / 17**

Table 6: Benchmark: Costs of capital. [Source: Axon Consulting]

Treatment of OpEx

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Based on percentages over CapEx**	√	√	√	√			x	√	√	√	x	x	x	√	√	√	√	**11/15**
	Based on Bottom-up calculation	x	x	x	x			√	x	x	x	√	√	√	x	x	x	x	**4/15**
FIXED NETWORKS	**Based on percentages over CapEx**	√	x	x	√		x	x	√	√	x	√	x	x	√	√	√	√	**9/16**
	Based on Bottom-up calculation	x	√	√	x		√	√	x	x	√	x	√	√	x	x	x	x	**7/16**

Table 7: Benchmark: Treatment of OpEx. [Source: Axon Consulting]

Assets valuation method

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Static approach - HCA**	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	**0/16**
	Static approach - CCA	x	√	√	x	√		x	x	x	x	x	x	√	x	x	x	x	**4/16**
	Dynamic approach (Cash-flow)	√	x	x	√	x		√	√	√	√	√	√	x	√	√	√	√	**12/16**
FIXED NETWORKS	**Static approach - HCA**	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	**0/17**
	Static approach - CCA	x	√	√	x	√	x	x	x	x	x	x	x	√	x	x	x	x	**4/17**
	Dynamic approach (Cash-flow)	√	x	x	√	x	√	√	√	√	√	√	√	x	√	√	√	√	**13/17**

Table 8: Benchmark: Assets valuation method. [Source: Axon Consulting]

Annualisation criteria

		Brazil	Cayman Islands	Jamaica	Colombia[18]	El Salvador	Belgium	Spain	France	Norway[19]	Sweden	UK	Oman	Bahrain[20]	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	Straight line depreciation	x	x	x	√			x	x	X	x	x	x	x	x	x	x	x	1 / 15
	Standard Annuity	x	√	x	x			x	x	x	x	x	x	x	x	x	x	x	1 / 15
	Tilted Annuity	x	x	x	x			x	√	x	x	x	√	√	√	√	√	√	7 / 15
	Economic depreciation (Adjusted Tilted annuities)	√	x	√	x			√	x	√	√	√	√	√	x	x	x	x	8 / 15
FIXED NETWORKS	Straight line depreciation	x	x	x	√		x	x	x	x	x	x	x	x	x	x	x	x	1 / 16
	Standard Annuity	x	√	x	x		x	x	x	x	x	x	x	x	x	x	x	x	1 / 16
	Tilted Annuity	x	x	√	x		x	x	√	√	√	x	√	√	√	√	√	√	10 / 16
	Economic depreciation (Adjusted Tilted annuities)	√	x	x	x		√	√	x	√	x	√	√	√	x	x	x	x	7 / 16

Table 9: Benchmark: Annualisation criteria. [Source: Axon Consulting]

[18] In addition, the model used in Colombia includes the accelerated and geometric depreciation methods.
[19] The NRA in Norway defines two different annualisation methodologies to be employed in the LRIC model for fixed network depending on the level of the network. That is, it uses tilted annuities for core network equipment, whereas for the access network equipment it uses tilted annuities and economic depreciation (depending on the specific asset)
[20] The TRA in Bahrain proposed to implement tilted annuities and adjusted tilted annuities in the LRIC models

Working Capital

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	Associated to Network CapEx	x	√	√	√	x		x	x	x	x	x	x	√	√	√		√	7 / 15
	Associated to Network OpEx	√	√	√	√	x		x	x	√	√	x	√	x	x	√		√	9 / 15
FIXED NETWORKS	Associated to Network CapEx	x	√	√	√	x	x	x	x	x	x	x	x	√	√	√		√	7 / 16
	Associated to Network OpEx	√	√	√	√	x	√	√	x	√	x	x	√	x	x	√		√	10 / 16

Table 10: Benchmark: Treatment of Working Capital. [Source: Axon Consulting]

Cost standard

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	Fully Allocated Costs (FAC)	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	0 / 15
	Pure Long Run Incremental Costs (Pure LRIC)[21]	x	x	√		x		√	√	x	x	√	√	x	x	x	x	x	5 / 15
	Long Run Incremental Costs plus Common Costs (LRIC+)	√	√	√		√		√	√	√	√	√	√	√	√	√	√	√	15 / 15
FIXED NETWORKS	Fully Allocated Costs (FAC)	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	0 / 16
	Pure Long Run Incremental Costs (Pure LRIC)	x	x	√		x	x	x	x	x	x	x	√	x	x	x	x	x	2 / 16
	Long Run Incremental Costs plus Common Costs (LRIC+)	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	√	16 / 16

Table 11: Benchmark: Cost standard. [Source: Axon Consulting]

[21] The use of the Pure LRIC approach by the NRAs in Spain, France and UK is limited to the calculation of Mobile Termination Rates (MTRs)

Allocation of common and joint network costs

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	Equi-Proportional Mark-Up (EPMU)	√	x	X		√		√	√	√	√	√	x	x	√	√	√	√	11/15
	Effective Capacity	x	√	x		x		x	x	x	x	x	√	√	x	x	x	x	3/15
	Shapley-Shubik	x	x	√		x		x	x	x	x	x	x	√	x	x	x	x	2/15
	Ramsey Pricing	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	0/15
FIXED NETWORKS	Equi-Proportional Mark-Up (EPMU)	√	x	X		√	√	√	√	√	√	√	x	x	√	√	√	√	12/16
	Effective Capacity	x	√	x		x	x	x	x	x	x	x	√	√	x	x	x	x	3/16
	Shapley-Shubik	x	x	√		x	x	x	x	x	x	x	x	√	x	x	x	x	2/16
	Ramsey Pricing	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	0/16

Table 12: Benchmark: Allocation of common and joint network costs. [Source: Axon Consulting]

Network Optimisation Approach

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	Yearly approach	√	√	√		√		x	√	√		√	√	√					9/10
	Historical approach	x	x	x		x		√	x	x		x	x	x					1/10
FIXED NETWORKS	Yearly approach	√	√	√		√	√	√	√	√		√	√	√					11/11
	Historical approach	x	x	x		x	x	x	x	x		x	x	x					0/11

Table 13: Benchmark: Network dimensioning approach. [Source: Axon Consulting]

Period of time modelled

		Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
MOBILE NETWORKS	**Static (1 year)**	x	√	X		√		x	x	x	x	x	x	x	x		x		**2 / 13**
	Dynamic (several years)	√	x	√		x		√	√	√	√	√	√	√	√		√		**11 / 13**
	Period of time modelled (years)		*1*	*5*		*1*		*30*	*25*	*50*	*50*	*30*	*11*	*4-5*	*5*		*5*		
FIXED NETWORKS	**Static (1 year)**	x	√	X		√	x	x	x	x	x	x	x	x	x		x		**2 / 14**
	Dynamic (several years)	√	x	√		x	√	√	√	√	√	√	√	√	√		√		**12 / 14**
	Period of time modelled (years)		*1*	*8*		*1*	*50*	*50*	*15*	*60*	*40*	*40*	*11*	*4-5*	*5*		*5*		

Table 14: Benchmark: Period of time modelled. [Source: Axon Consulting]

Specific features of the BULRIC Model for a mobile network

Operator to be modelled

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Each MNO in the market	x	x	x	x	x	√	x	x	x	x	x	x	√	x	√	√	**4 / 16**
Generic Mobile Operator	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	x	**15 / 16**

Table 15: Benchmark: Operator to be modelled. [Source: Axon Consulting]

Consideration of modern equivalent assets – Access Network

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered		x				x	x	x	x	x	x	x	x	x	x	x	**0 / 12**
Modern Equivalent Assets not considered		√				√	√	√	√	√	√	√	√	√	√	√	**12 / 12**

Table 16: Benchmark: Consideration of modern equivalent assets in the mobile access network. [Source: Axon Consulting]

Consideration of modern equivalent assets – Core Network

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered		x				√	x	x	√	x	√	√	x	x	x	x	**4 / 12**
Modern Equivalent Assets not considered		√				x	√	√	x	√	x	x	√	√	√	√	**8 / 12**

Table 17: Benchmark: Consideration of modern equivalent assets in the mobile core network. [Source: Axon Consulting]

Technologies to be modelled - Radio access technologies

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain[22]	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
2G (GSM)	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	**15/15**
3G (UMTS)	√	x	√	√		√	√	√	√	√	√	√	√	x	x	√	**12/15**
4G (LTE)	√	x	x	√		√	x	x	x	x	√	x	x	x	x	x	**4/15**

Table 18: Benchmark: Technologies to be modelled - Radio access technologies. [Source: Axon Consulting]

Technologies to be modelled – Core network technologies

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia[23]	Jordan[24]	Zimbabwe	TOTAL
3Gpp Legacy Core Network	√	√		√		√	√	√	√	√	√	√	√	√	√	√	**14/14**
Evolved Core Network	√	x		√		√	x	x	√	x	√	√	x	x	x	x	**6/14**

Table 19: Benchmark: Technologies to be modelled - Core network technologies. [Source: Axon Consulting]

[22] The regulator in Bahrain intends to develop both operator-specific and a generic model. In the first one, the mix of technologies of each operator is used. In the generic one, the regulator assumes use of 2G and 3G.

[23] Saudi Arabia specifies in the public consultation document in 2007 that "Ideally, the mobile model should be based on the least cost MEA technology that is currently available and widely deployed" and that "The CITC intends to consider using 2G costs for the model". At the time, operators were already undertaking the roll out of 3G. The ECTEL considers that thus CITC has set a pre-defined set of technologies.

[24] Jordan has developed models considering exclusively GSM technology, which was at the time the only technology in the market. The ECTEL considers that, even though this represents the operators' actual mix of technologies, this country is not relevant for benchmarking this particular issue.

Technologies to be modelled – Transmission network technologies

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Microwave links	√	x	√	√		√	√	√	√	√	√	√	√	√	√	√	**14/15**
Leased Lines	√	√	x	√		√	√	√	√	√	√	√	√	√	√	√	**14/15**
Optical Fibre	√	x	√	√		√	√	√	√	√					x	√	**9/11**
Satellite links	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	**0/15**

Table 20: Benchmark: Technologies to be modelled - Transmission network technologies. [Source: Axon Consulting]

Network Topology Design – Access Network

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Scorched node	x	x	x	x	x	x	x	x	x	x	x	x	x	x	√	x	**1/16**
Modified scorched node	√	√	√	√	√	x	x	x	x	x	√	√	√	√	x	√	**10/16**
Scorched earth	x	x	x	x	x	√	√	√	√	√	x	x	x	x	x	x	**5/16**

Table 21: Benchmark: Network Topology Design – Access Network. [Source: Axon Consulting]

Network Topology Design – Core Network

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Scorched node	√	x	x	x	x	x	x	x	x	x	x	x	x	√	√	√	**4/16**
Modified scorched node	x	√	√	√	√	√	√	√	√	√	√	√	√	x	x	x	**12/16**
Scorched earth	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	**0/16**

Table 22: Benchmark: Network Topology Design – Core Network. [Source: Axon Consulting]

Network Sharing

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Site Sharing		√	√			√	x	x	x	√	√	x	√	√	x	√	**8 / 13**
Radio-Access Network (RAN) Sharing		x	x			√	x	x	x	x	x	x	x	x	x	x	**1 / 13**

Table 23: Benchmark: Network Sharing. [Source: Axon Consulting]

Definition of the increments

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Based on services type	√	√				√	√	√	x	√	√	x	x	x	x	x	**7 / 13**
Based on technology	x	x				x	x	x	√	x	x	x	x	x	x	x	**1 / 13**
Open criteria	x	x				x	x	x	x	x	x	√	√	√	√	√	**5 / 13**

Table 24: Benchmark: Definition of the increments. [Source: Axon Consulting]

Specific features of the BULRIC Model for a fixed network

Operator to be modelled

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Each Operator in the market	x	x	x	x	x	x	x	x	x	√	x	x	x	x	x	√	√	**3 / 17**
Generic Operator (based on incumbent)	√	√	√	√	√	√	√	√	√	x	√	√	√	√	√	√	x	**15 / 17**

Table 25: Benchmark: Operator to be modelled. [Source: Axon Consulting]

Consideration of modern equivalent assets – Access Network

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered[25]		√	√			√	√	√	√	√	√	√	√	√				**11/11**
Modern Equivalent Assets not considered		x	x			x	x	x	x	x	x	x	x	x				**0/11**

Table 26: Benchmark: Consideration of modern equivalent assets in the fixed access network. [Source: Axon Consulting]

Consideration of modern equivalent assets – Core Network

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered	√	√	√			√	√	√	√	√	√	√	√	√	√	√	√	**15/15**
Modern Equivalent Assets not considered	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	**0/15**

Table 27: Benchmark: Consideration of modern equivalent assets in the fixed core network. [Source: Axon Consulting]

Technologies to be modelled - Fixed access technologies

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden[26]	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Copper pairs						√	√	√	√	√	√	√	√	x	√	√	√	11/12
NGA – Active Optical Networks						x	x	x	x		x	x	√	x				1/8
NGA – Passive Optical Networks						x	√	√	√		√	√	x	√				6/8

Table 28: Benchmark: Technologies to be modelled - Fixed access technologies. [Source: Axon Consulting]

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[25] Although most of the countries for which information is available have considered fibre NGA networks as being the modern equivalent assets for the access network, all of them except from the UAE have also included copper-based access networks in their LRIC models

[26] Although it is known that the Swedish NRA included an NGA network in its LRIC model for fixed networks, it is not clear whether it is based on a passive or active structure.

Technologies to be modelled – Core network technologies

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Legacy TDM network	√	x	√	x		x	x	√	√	x	√	x	x	x	√	√	√	**8 / 16**
NGN Core network	√	√	√	√		√	√	√	√	√	√	√	√	√	√	√	√	**16 / 16**

Table 29: Benchmark: Technologies to be modelled - Core network technologies. [Source: Axon Consulting]

Technologies to be modelled - Transmission technologies

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Microwave links	√	x	√			x	x	x	x	√	x	√	x	x	x			**4 / 13**
SDH Fibre transmission	√	√	√			x	x	x	√			x			√			**5 / 9**
Native Ethernet Fibre Transmission	√	x	√			x	x	x	x			√						**3 / 8**
WDM Fibre Transmission	√	x	√			√	√	√	√			√						**7 / 8**

Table 30: Benchmark: Technologies to be modelled - Transmission technologies. [Source: Axon Consulting]

Network topology

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Scorched node	x	√	x	x		x	x	x	x	x	x	x	x	x	x	x	x	**1 / 16**
Modified scorched node	√	x	√	√		√	√	√	√	√	√	√	√	√	√	√	√	**15 / 16**
Scorched earth	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	**0 / 16**

Table 31: Benchmark: Network topology. [Source: Axon Consulting]

Definition of the increments[27]

	Brazil	Cayman Islands	Jamaica	Colombia	El Salvador	Belgium	Spain	France	Norway	Sweden	UK	Oman	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
Split between Access and Conveyance						√	√		√			√			√	√		**6 / 6**
Split between Access and Conveyance separating conveyance for Wholesale termination and other conveyance services						x	√		√			x			x	x		**2 / 6**

Table 32: Benchmark: Definition of the increments. [Source: Axon Consulting]

[27] The LRIC models developed by the NRAs in Spain and Norway allow the possibility to calculate the LRIC costs considering the conveyance increment as a whole or further divided between termination and other services. The regulators in France, Sweden, Bahrain, UAE and Zimbabwe have not specified the increments in their public consultation documents

Annex H. Glossary

2G	Second generation mobile telecommunications technology (GSM)
3G	Third generation of mobile telecommunications technology (UMTS)
4G	Fourth generation of mobile telecommunications technology (LTE)
AGCF	Access Gateway Control Function
BC	Billing Center (also referred to as Billing System)
BIPT	Belgian Institute for Postal Services and Telecommunications (National Regulatory Agency)
BTS	Base Transceiver Station: establishes the radio-connection between the user termination (mobile phone) and the mobile network according to the GSM Standard
BULRIC model	Bottom-up Long Run Incremental Costing model
Busy Hour	Period of 60 minutes during which occurs the maximum traffic load in a period of 24 hours
CapEx	Capital Expenditure
CCA	Current Cost Accounting
CG	Charging Gateway
ComReg	Commission for Communications Regulation (Irish National Regulatory Agency)
CSCF	Call Session Control Function

DSLAM	Digital Subscriber Line Access Multiplexer: equipment in charge of the connection of multiple subscriber line interfaces into a high-speed channel using multiplexing techniques
EDGE	Enhanced Data Rates for GSM Evolution
EPMU	Equi Proportional Mark-Up
ERG	European Regulators Group. ERG was the predecessor to the Body of European Regulators for Electronic Communications (BEREC)
FAC	Fully Allocated Costs
GSM	Global System for Mobile Communications
GSMA	The GSM Association (GSMA) is an association of mobile operators and related companies devoted to supporting the standardising, deployment and promotion of the GSM mobile telephone system.
HCA	Historic Cost Accounting
HSS	Home Subscriber Server
IRG	Independent Regulators Group
ITU	International Telecommunication Union
Line Card	Printed circuit board that interfaces with a telecommunications access network
LRIC	Long Run Incremental Cost
LTE	Long Term Evolution

MEA	Modern Equivalent Asset
MGCF	Media Gateway Controller Function
MNO	Mobile Network Operator
MSAN	Multi-Service Access Node
MVNO	Mobile Virtual Network Operator
NGA	Next Generation Access
NGN	New Generation Network
NRA	National Regulatory Agency
NMS	Network Management System
OpEx	Operational Expenditure
PSS	Packet Switched Server
SMS	Short Message Service
UMTS	Universal Mobile Telecommunications System
VAS	Value Added Services
VoIP	Voice over IP. Voice over Internet Protocol