سلطنة عُمان
Sultanate of Oman

هيئة تنظيم الاتصالات
Telecommunications Regulatory Authority

Development of Bottom-Up LRIC Models in the Sultanate of Oman

Methodological document on BULRIC modelling

April 2014

ص.ب: ٥٧٩، روي ١١٢ | سلطنة عمان | هاتف: ٣٠٠ ٥٧٤ ٢٤ ٩٦٨+ | فاكس: ٦٤٠ ٥٦٣ ٢٤ ٩٦٨+ | البريد الإلكتروني: traoman@tra.gov.om
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Sultanate of Oman
Telecommunications Regulatory Authority

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1. Introduction

The Telecommunications Regulatory Authority of the Sultanate of Oman ('the TRA') is empowered under The Telecommunications Regulatory Act, issued by Royal Decree No. 30/2002 (and subsequent amendments thereto), to make decisions in relation to the regulatory remedies that may be required to address the risks that arise for consumers and competition as a consequence.

Over the last few years the telecommunications market in the Sultanate of Oman has been expanding; new players have entered the market, bringing competition and new products and services for customers. The TRA works to ensure the development of competition within this sector to benefit the end customer in Oman.

In order to promote competition and ensure that dominant operators in the Sultanate of Oman treat new entrants fairly, the TRA regulates both retail and wholesale services in the telecommunication sector.

In this context, the TRA developed a Bottom-up Long Run Incremental Costing model ('BULRIC model') in 2005 to determine interconnection charges. However, significant changes in technology, networks and geographic/population coverage have taken place in the Oman telecommunications sector in the last few years and thus the methodology, which was applied in such models, is due to be reviewed. Therefore, the TRA has commissioned Axon Partners Group Consulting S.L. ('Axon Consulting') to revise this methodology and to develop new BULRIC models, accordingly.

The initial result of these works was materialised in the publication on November 6th, 2013 of a Consultation Document outlining TRA's preliminary views on a number of key issues for the development and implementation of BULRIC models for fixed and mobile networks. Stakeholders were encouraged to provide their views and comments to the methodological approaches proposed for the implementation of these Models.

After the publication of this document, three Operators (i.e. Haya, Nawras and Omantel) provided their contributions, outlining their position in each of the questions listed by the TRA[1]. The TRA appreciates the time and efforts dedicated by the

[1] The Operators' contributions and the TRA responses are described in the Position Statement.

operators, and believes these contributions are essential to improve the robustness of the present document.

This methodological document lays out the main methodological approaches that will be implemented in the BULRIC Models, considering the Public Consultation document and the contributions provided by the Operators.

2. Objectives

TRA is empowered under the Act to review and determine the charges for interconnection and access services. As per the Executive Regulations and license conditions of Class I licensees, Long Run Incremental Cost (LRIC) is to be used as a basis to estimate the interconnection charges whereas charges for access services, leased circuits, co-location etc. of dominant operator are required to be cost-based as per the Executive Regulations. In 2005, TRA developed a BULRIC model in order to determine interconnection charges for selected interconnection services. However, quite significant changes in technology, networks and geographic/population coverage have taken place in Oman telecom sector since 2005. Based on this, the need was felt to undertake fresh review of the methodologies to review and set charges for regulated fixed and mobile wholesale services.

TRA is also required to review and approve the retail tariffs of dominant telecom operators. To discharge this task effectively, TRA has to ensure that these tariffs are competitive and increase consumer welfare. This is only possible if true costs of services is known to TRA so that the services are not over or under-priced. Moreover, TRA often has to conduct investigations relating to possible anti-competitive practices by dominant operators for which knowledge of services costs is a pre-requisite. For taking better regulatory decisions, TRA also wishes to conduct various kinds of sensitivity analysis to see their impact on the outcome for which flexible models are quite helpful.

TRA views that BULRIC models, being based on efficient network and able to cost services close to their true economic costs, provide a good basis to meet different regulatory requirements.

Through BULRIC models to be developed as a result of industry consultation, TRA intends to meet following objectives:

1. Reviewing and determining charges for regulated wholesale (interconnection and access) services for both fixed and mobile networks;
2. Reviewing dominant operators' retail tariffs;
3. Conducting investigations for anti-competitive behaviour; and
4. Conducting various sensitivity analyses.

TRA intends to use BU-LRIC models as a compliment with other costing obligations on operators in order to provide better basis to TRA to take regulatory decisions on above-mentioned objectives.

3. 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 before hand the methodology that is to be considered in the BULRIC models to be developed by the TRA.

This section introduces the main methodological issues, outlining the different possible options available together with their description, and introducing the approach that will be implemented in the BULRIC Models.

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

- Methodological issues common to all BULRIC models (section 3.1)
- Issues specific to BULRIC models for a mobile network (section 3.2)
- Issues specific to BULRIC models for a fixed network (section 3.3)
- Costing of ancillary services (section 3.4)

3.1. Methodological issues common to all BULRIC models

When defining the methodology for the development of BULRIC models there are 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 in the Sultanate of Oman (one for fixed network and other for mobile network). Namely:

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

3.1.1. Cost elements to be considered

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

- Network CapEx
- Network OpEx
- Licences and frequency usage fees
- Retail costs
- G&A costs
- Royalty fees
- Cost of capital
- Working capital

The categories listed above are analysed in following subsections:

Network CapEx

Network CapEx includes the investment made by the operators for developing the network. In particular:

- Network equipment purchasing (for example, switches) , including related software
- Network infrastructure (for example, network buildings, ducts)
- 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 TRA considers 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 3.1.3 addresses the annualisation method, which is to be applied to CapEx, through which the network CapEx shall be recovered along the useful life of the asset.

Network OpEx

Network OpEx includes the recurrent costs associated to operating the network. In particular:

- 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 TRA considers that all the categories of network OpEx listed above should be considered.

Licences and spectrum fees

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

- Licences are related to the permission required to sell telecommunication services, and they can take the form of annual and/or one-off fees. Both options will 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 and/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.

Additionally, 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"*[2]

The TRA concurs with the GSMA's statement above and is of the view that:

- Licence 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 total amount in the market (separately for fixed and mobile networks) multiplied by the market share of the modelled operator.

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

- Spectrum costs are included in the model as a network resource. 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.)

The cost categories listed above are related to the provision of retail services and should not be allocated to wholesale services. Additionally, it is important to note that modelling retail costs could divert the efforts that should be dedicated to network modelling.

The TRA establishes that the retail costs should not be included in the BULRIC models as they are not relevant for wholesale services.

G&A costs

G&A costs are associated with management activities and are common for network and commercial activities. It is common practice to include G&A costs in BULRIC models based on a mark-up on top of network costs. Specifically, at least the following cost items shall be considered as part of G&A:

- Offices and related costs
- Finance department
- Regulatory department
- Human Resources department
- Legal department
- General Administration

The TRA sets that G&A costs are to be included in the BULRIC models based on a mark-up percentage on top of network costs. This percentage will be calibrated based on the data provided by the operators (see section 3.1.8).

Royalty fees

Royalty fees are applicable on the licensed operators in the Sultanate of Oman. These fees are calculated as a percentage of gross revenues, currently calculated as 7% of licensed revenue minus interconnect payments.

The TRA constitutes that, with the objective of ensuring the consistency and clarity of the calculations, the royalty fees should be added in the BULRIC Models on top of services' cost.

Cost of capital

Costing of services needs to take into account a reasonable amount of return on the invested capital an operator would be able to earn in a truly competitive market. In order to estimate this reasonable amount of return, the TRA establishes the use of **Weighted Average Cost of Capital (WACC)**, which is defined as the sum of the weighted cost of equity and debt. These weights are based on the market value of debt and equity, respectively.

The use of the WACC is the overwhelmingly preferred mechanism to reflect a reasonable regulated profit level in the telecommunications industry and is a de-facto international standard in the implementation of BULRIC models.

To set the appropriate rate of return, the TRA will apply the methodology established in the consultation[3] of the WACC for Omani operators in 2011 after taking into account valid comments from the operators on the said consultation paper. The TRA will update the inputs and calculations employed to reflect the variations in the market and the optimum financial structure of the referenced operator.

The WACC employed for the fixed BULRIC model will correspond to the mid-range point of a generic fixed operator, while the WACC employed for the mobile BULRIC model will correspond to the mid-range point of a generic mobile operator, defined as the average between the upper and lower limits of the WACC range.

Please note that section 3.1.3 addresses the annualisation method to be applied to CapEx, which incorporates the effect of the cost of capital, based on the WACC value.

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.

The TRA shall consider working capital requirements associated to network-related activities on its BULRIC Models. Working capital not related to network costs, (for example, due to the retail activities of the operator) shall not be considered in the

[3] "Determining the WACC for Omani telecommunications operators", 2011

development of the BULRIC models, consistent with the principle that retail costs will not be considered.

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. BULRIC Models to be developed by the TRA will capture this effect through the use of the planning-horizon concept[4], which avoids the need to include it in the depreciation formulas. The TRA 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. The TRA considers that, in the case Operators 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. The working capital will be calculated as a percentage of OpEx for each year, based on information provided by the operators.

3.1.2. Treatment of OpEx

Determination of Network-related Operations and Maintenance Costs

Network-related operations and maintenance costs commonly represent a significant part of operators' costs. Therefore, the precise 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 Operating Costs associated with the operation and maintenance of the network, which are outlined below:

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[4] 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.

- **Based on percentages over CapEx**: OpEx is calculated indirectly using a percentage provided by operators. Operators 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[5]).
- **Based on Bottom-up calculation** (unit cost per element): the cost is calculated directly from bottom-up modelling of the operating costs 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 operators in the market.

The international practice shows that both methodologies are valid approaches to determine Network OpEx, and reveal that a combination of both is frequently employed on a case-by-case basis. For instance, the UAE's TRA, whose approach is based on percentages over CapEx, states in its public consultation[6] that the bottom-up approach requires a detailed examination of each of the activities undertaken by the operator in question and, as a result, bottom-up models have tended to use other methodologies. On the other hand, Bahrain's TRA states in its public consultation[7] that:

> *"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 TRA'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. Nevertheless, the TRA is of the opinion that the information from top-down systems may be used to calculate of OpEx as a percentage over CapEx, provided these are reasonable, or by extracting other relevant information for applying a bottom-up approach.

The TRA believes 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 is not enough information

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

available, it would be preferred to calculate OpEx as a percentage over CapEx. The specific method to be applied will be analysed on a case-by-case basis.

Some examples of when each methodology shall be used in the development of the BULRIC Models are provided below:

- It is preferred to calculate electricity costs based on average consumption per equipment element and average price per kWh (bottom-up approach). This method is preferable because the unitary costs of the electricity are not strictly correlated to the CapEx and because this methodology allows the application of different cost trends for CapEx and electricity prices transparently.
- The costs associated to personnel in charge of maintaining the core network are expected to be calculated based on percentages over CapEx. In this case, the benefits that may be obtained from a bottom-up approach may not be worth the effort of gathering the required information (it may not be available or may be difficult to obtain). For example, average technician time dedicated to repair a failure and average failures per year. Nevertheless, in this case, the model will consider different cost trends in OpEx and CapEx to ensure the accuracy of the results.

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, Legal functions, etc.

The consideration of the G&A will be made taking into account that the two Operators in the Sultanate (Omantel and Nawras) have both fixed and mobile operations under one company. Under this consideration, the G&A expenses of the two operators will be shared between the BULRIC Models for fixed and mobile networks according to the earnings of the fixed and mobile businesses.

Additionally, it should be noted that the total G&A expenses considered should not exceed a 10% of the total cost base of the Operator. This maximum value accepted is above the values used in the BULRIC Models published by NRAs in other countries such as France[8] (5%), Belgium[9] (7%) or Sweden[10] (6%).

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 of network assets, compared to the Gross Book Value of total assets.

3.1.3. Treatment of Capital-Related Costs

Assets valuation method

The TRA identifies two main potential approaches to be used for assets valuation:

- A **static approach,** by which assets are valuated based on a static unitary price. Depending on how the unitary price is calculated there are two methodologies:
    - Historical Cost Accounting (HCA) is the average price paid historically by the company to acquire an asset, based on the operator's book
    - Current Cost Accounting (CCA) reflects the current and expected market value of the assets
- A **dynamic approach**, 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 top-down regulatory cost models and bottom-up models which only cover one year (static). For BULRIC models covering a multi-year period of time, the dynamic approach is normally preferred.

Nevertheless, valuating the civil infrastructure of the fixed operators (for example copper access network, civil works and ducts) according to a dynamic approach may lead to an overestimation of access services' costs. It is common practice among regulators to avoid such an overestimation by valuating historic civil infrastructure according to an HCA approach. For example, the French NRA (ARCEP), regarding the

[8] ARCEP mobile LRIC Model release 5, March 2011
[9] Bottom-up fixed network cost model for BIPT version 1.0, December 2011
[10] PTS mobile LRIC model, version 2, updated in June 2013

cost methodology that should be applied in the valuation of copper access network assets stated that[11]:

> *"for copper local loop assets, the choice between building a new network ("make") or renting the existing one ("buy") is meaningless and the long-term economic signal constituted by replacement costs has no reason to exist. On the contrary, the reuse of these assets that are not bound to be replicated should be encouraged.*
>
> *Using an approach based on the operator's real investments in these assets is therefore more suitable than modelling that results in a "make or buy" type signal."*

The TRA considers the dynamic approach to be a more appropriate choice for the implementation of BULRIC models, especially taking into consideration that the BULRIC models are planned to cover a period of time extending considerably over more than one year, making the dynamic approach suitable. In the case of civil infrastructure installed before the period of time considered in the model (20011[12]), the TRA determines to use an HCA approach.

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[13], 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*

[11] Public consultation on the "Criteria for choosing an investment cost annualisation methodology and the transition from copper to fibre". March 2011.
[12] Please see section 3.1.7
[13] 'International Telecommunication Union Regulatory Accounting Guide', 2009

(and efficiencies) that an entrant/alternative operator would face, if entering into the market at a specific time."

In addition to this, the TRA considers it highly important to take into account the existing regulation and the services provided by the operators. Therefore, in the event that an asset is strictly required for provision of a service, it should not be re-valuated even though an MEA may exist.

Accordingly, the TRA establishes that two different approaches should be used depending on the nature of the asset:

- The telecommunication equipment should be generally substituted for an MEA in the case that the existing asset is not commonly installed by new entrants in the telecommunication industry. For instance, traditional switching nodes should be substituted for newer technologies, like soft-switching based network.
- The assets that are specifically required for the provision of currently regulated services should not be substituted, even though substitute modern technologies are available, unless the substitute modern technology is able to provide the same or a very similar technical functionality as the original asset. In particular the TRA is of the opinion that copper access network should not be valuated based on an MEA (i.e. fibre), as it is required for the provision of Local Loop Unbundling (LLU) services.

Annualisation method

The pattern of cost recovery over time is critically dependent on the depreciation methodology assumed. The TRA is of the opinion that, when estimating the annualised costs for assets, 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 3.1.3.

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 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.

International practice shows that the tilted annuity and the economic depreciation/adjusted tilted annuity are the most commonly used methods when implementing BULRIC models.

The TRA considers the tilted annuity approach as the preferred 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.

At the same time, the TRA acknowledges that, when pricing services provided over new networks' or networks in early stages of deployment, it is economically sensible to take into account the expected evolution of the demand in a foreseeable future. Not doing so would result in unrealistically high unitary costs during the first years of network deployment, something which, if translated into the prices, would curtail demand and thus impede the development of future economies of scale.

To avoid this phenomenon, the TRA is of the opinion that adjusted tilted annuities should be employed exclusively for the annualisation of specific assets related to networks in the early stage of deployment (for example LTE and FTTH). Nevertheless, the Models should also be able to apply a tilted annuities approach to these assets to allow a proper understanding of the impact of the annualisation methodology.

Based on the above, the TRA considers that tilted annuities should be applicable to all the assets considered in the BULRIC Models, and only in the case of assets associated to the provision of new services an adjusted tilted annuities should be employed.

The following paragraphs describe the specific formula that will be employed in the introduction of these annualisation approaches in the BULRIC Models.

Tilted annuities: The application of the tilted annuities approach to an asset will obey the formula outlined below:

$$d_i = I \cdot \frac{p_i}{\sum_{n=i_0}^{i_0+UL-1}(p_n \cdot \alpha_n)}$$

Where:

- I is the investment associated to the asset
- d_i is the annualised costs at year i (within the useful life)
- p_i is the reference price of the asset for the year i
- UL is the useful life of the asset
- i_0 is the year when the asset was purchased
- $\boldsymbol{\alpha_i}$ represents the cost of capital factor and responds to the following formula:

$$\alpha_i = (1 + WACC)^{-(i-i_0+1)}$$

Adjusted tilted annuities: The BULRIC Models will calculate the adjusted tilted annuities of an asset based on the following formula:

$$d_i = I \cdot \frac{p_i \cdot O_i}{\sum_{n=i_0}^{i_0+UL-1}(p_n \cdot O_n \cdot \alpha_n)}$$

Where O_i reflects the production factor of the asset.

3.1.4. 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)[14]:** 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.
- **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 (specifically Total-Service LRIC). Under the TSLRIC approach, several 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.

Based on the above definitions, it is clear that the choice of a pure LRIC or the LRIC+ cost standard is dependent on the intended treatment of common and joint costs, in particular on whether certain services should bear part of those costs, or not.

In the case of access wholesale services (one-way interconnection), there is no controversy, as it is widely accepted that these services must bear a fair share of common and joint costs.

[14] Some variants may be drawn on the Pure LRIC approach, depending on the definition of the increments. For instance, the Total Service LRIC (TSLRIC) approach considers a broad increment defined as the total traffic throughput, while the Total Element LRIC (TELRIC) defines each increment as an independent network unit (e.g. radio access network, core network). The TRA's preferred approach for the definition of the increments may be found in section 3.2.2 (for mobile networks) and section 3.3.2 (for fixed networks)

In the case of two-way interconnection services (such as voice termination), a relevant academic and regulatory debate has taken place in recent years about whether it is appropriate to allocate common and joint costs to these services. Following a recommendation of the European Commission for the determination of voice interconnection costs[15], a number of European NRAs have recently determined that voice termination should not bear common or joint costs, such as spectrum fees or coverage costs. Outside of the EU, however, most NRAs, including those in the GCC countries, have favoured the view that termination services should also bear a fair share of common and joint costs.

The TRA is of the view that currently there is not strong evidence that pure LRIC levels may be appropriate for the Omani market. Thus, the TRA establishes the adoption of LRIC+ cost method for all services.

This costing standard shall be based on a TSLRIC (Total Service LRIC) approach, which is supported by most of the regulators in the GCC and European countries.

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

As indicated above, the LRIC+ cost standard incorporates a fair share of common and joint costs. Thus, a methodology needs to be defined to establish the criteria that shall be employed for cost allocation to services, in other words, to define what 'fair share' of these costs each specific service should bear.

The TRA has identified a number of potential methodologies to be used for the allocation of common costs:

- **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.

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

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. NRAs are not known to have adopted this approach in practice.

Alternatively, the EPMU approach is commonly employed as a considerably more workable solution. While the EPMU approach has the advantage of simplicity, it may also present severe 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:

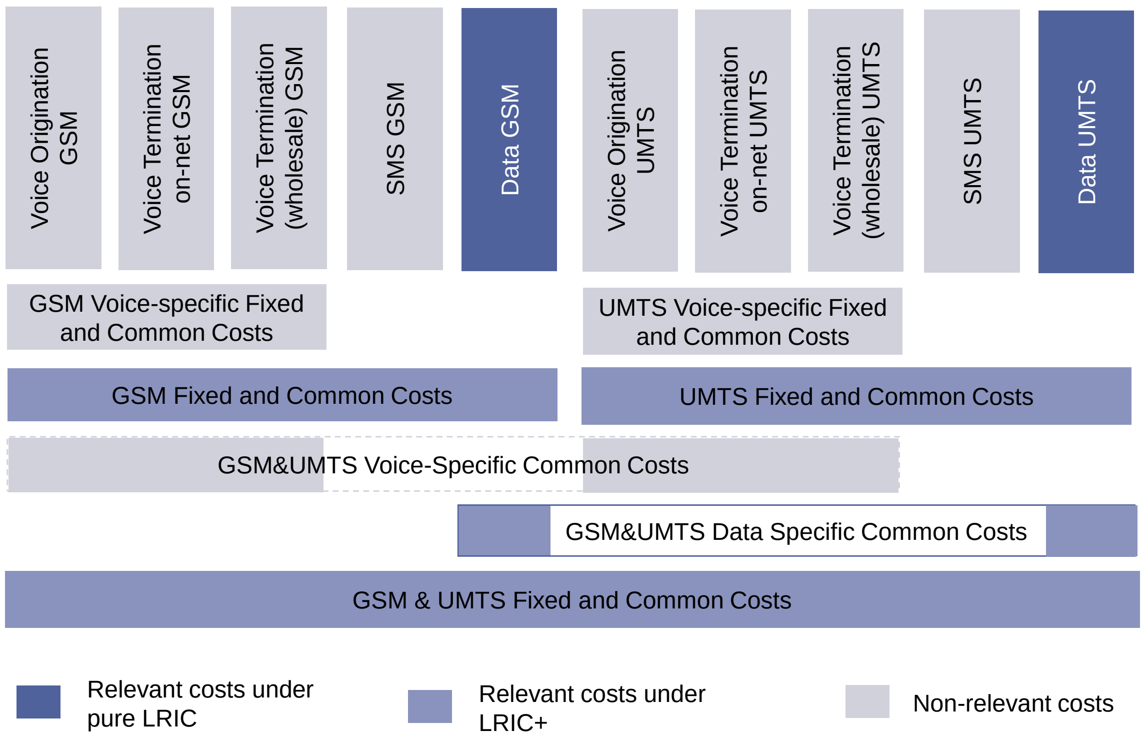

Exhibit 1: Example of relevant incremental costs under both the pure LRIC and LRIC+ standards of mobile voice termination. [Source: Axon Consulting]

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.

Based on the above, the TRA believes 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. The TRA also considers that the use of this approach would allow a better recognition of the common costs that should be assigned to services provided over early stage networks, such as the 4G and FTTH services.

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

As indicated in section 3.1.1, the TRA expects 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 TRA thus establishes to employ an EPMU to allocate G&A common costs to services under the LRIC+ standard.

3.1.5. Network dimensioning optimisation approach

In BULRIC models, two different approaches are generally identified in 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 TRA is of the opinion that the yearly approach is 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.

Additionally, the TRA envisages the introduction of a forward looking filtering tool that will ensure that in the event that there is a sharp decline in traffic demand in a specific year, which is expected to recover in a foreseeable future (i.e. within 3-4 years), the number resources will be preserved. That is, the BULRIC models to be developed will avoid the dismantling and subsequent deployment of network resources after a dip in demand.

3.1.6. Use of gradients

Gradients are sometimes used to weight the cost allocation to certain services with the objective of characterising cost differences depending on a variety of factors, including:

- peak and off peak calls
- different bitrates
- different levels of quality of service

For instance, a NRA may set different prices for peak and off-peak interconnection services making use of gradients. In that case, the NRA may calculate the peak and off-peak wholesale charges in two steps:

- Step 1: the average cost per minute is calculated with the BULRIC model (for example, 2.00 USD cents)
- Step 2: the gradients are applied to the average unit cost to obtain the unitary prices for peak and off-peak traffic, ensuring the total costs are recovered. For example, in the case that 70% of the traffic is in peak-time and that a price of 1.20 USD cents is set for off-peak time, the peak time price would be:

$$Peak\ Time\ Price = \frac{2.00\ USDcents - 1.20\ USDcents * 30\%}{70\%} = 2.34\ USDcents$$

It is the opinion of the TRA that cost differences among services should be represented through accurate network modelling and cost allocation. However, the TRA acknowledges that sometimes this price differentiation may be difficult to capture with BULRIC models. In those cases, gradients may represent an acceptable simplification.

Therefore, the TRA considers using gradients to represent cost differences among services, in the event that it is not feasible through network modelling algorithms.

3.1.7. Period of time modelled

Given that the unit costs of services are calculated depending on the demand at a specific point in time, the period of time modelled will be crucial in the scope of the possible analyses of the model’s results.

Fixed and mobile networks have been well established in the Sultanate of Oman for many years, covering the vast majority of the population. In order to take into consideration the historical rollout of fixed and mobile networks, and to be able to calibrate the models, it is deemed necessary that the time frame considered begins in the past. Nevertheless, the TRA does not consider it essential to go back to the take-up stages of mobile and fixed networks, as it would add complexity to the modelling process.

The TRA considers that a time frame starting in the year 2011 would gather sufficient information to ensure a proper calibration of the model in past years.

With regards to the final year of the time frame, it is the intention of the TRA to define the wholesale rates for the next five years (ending in 2018).

Therefore, the TRA sets that BULRIC models cover a 2-year historic period and a 5-year future period. Accordingly, the BULRIC models are determined to cover from 2011 to 2018.

3.1.8. 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 the Omani market. Data required includes, inter alia: information about traffic volumes, traffic statistics and patterns, network coverage, number of network elements, location of network sites, network dimensioning rules, CapEx and OpEx unit costs.

The TRA 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 TRA shall issue one or more data requests and will engage with the operators to facilitate the exchange of information. The TRA expects swift and close co-operation by all operators concerned to ensure the completeness and accuracy of the gathered data.

Data provided by operators in this process shall be regarded as confidential unless otherwise stated, and appropriately justified, by the TRA. 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 TRA shall resort to the use of international benchmarks as preferred alternative data source.

In the case that a particular piece of data provided by the operators is not considered to be sufficiently reliable by the TRA (for instance, in the case of a material deviation versus the international norm) the TRA will convene the operator to justify 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 TRA may resort to the use of international benchmarks as preferred alternative data source.

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

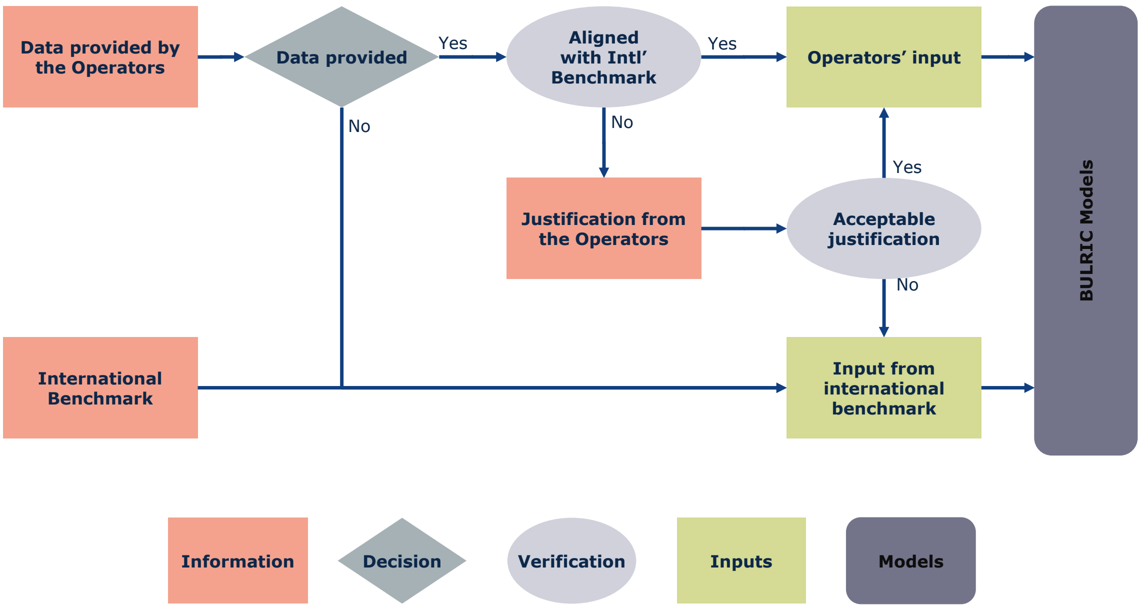

Exhibit 2 Diagram of data revision process. [Source: Axon Consulting]

Additionally, the BULRIC models are planned to cover up to 2018 (see section 3.1.7) and, therefore, forecasts are required, especially for traffic demand. In the opinion of the TRA, 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 TRA to ensure they are aligned with recent and expected market trends. In case the forecasts provided are considered as non-reliable, the TRA will use its own knowledge of the Omani market to estimate a reasonable level of demand for future years.

Therefore, the TRA establishes to rely on the forecasts developed by the operators as primary and preferential source for the development of BULRIC models.

3.2. Issues specific to BULRIC models for a mobile network

This chapter describes a number of issues that are specific to a BULRIC model for a mobile network. This is because the differences between fixed and mobile networks (for example, structure, technologies and operations) and because of the differences between both markets (different services, different number of players, etc.). The following sections will describe the issues listed below:

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

3.2.1. Definition of the Reference Operator

One of the most important methodological issue to be defined for the development of BULRIC models is the kind of operator that will be modelled, the so-called reference operator. One of the following options can be followed:

- Developing one BULRIC model for each 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 wholesale charges are required.
- Developing a BULRIC model for a generic reference operator representing a hypothetical existing 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 wholesale charges.
- Developing a BULRIC model for a hypothetical new entrant, meaning a generic reference operator which would be presumed to 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.

In the opinion of the TRA, the Omani mobile market is sufficiently developed, with two MNOs of sufficiently similar size and a few resellers. Additionally, the TRA notes that the development of a model for each MNO is generally intended when asymmetric levels in the MTRs are defined. However, the TRA is of the view that MTRs in the Sultanate should continue to be symmetrical. In that context, the TRA determines that one single BULRIC mobile model should be developed, representing a generic reference operator.

The TRA sees reduced merit in modelling a new entrant, especially given that this approach would have to rely on a large number of subjective assumptions that could affect the accuracy of results. Therefore, the TRA shall define the generic reference operator as a hypothetical existing operator, i.e. one possessing the most salient features of mobile operators present in the Omani market, yet one that is not expected to match the characteristics of any particular individual operator.

In this context, it is required to define the characteristics of the modelled reference operator. The following topics in particular are described in the following subsections:

- Demand
- Spectrum
- Coverage

Demand

The demand is the volume of services provided by the 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 defined based on its market share. The following two approaches are commonly used to calculate the modelled operator's market share:

- **Average operator:** According to this approach, the market share is defined as 1/n; "n" being the number of mobile network operators. This option is the most commonly used, especially when no new entrants are expected in the foreseeable future.
- **New entrant with minimum efficient scale:** According to this approach, a minimum market share is defined for an operator with a minimum efficient scale. 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"[16].

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

The current mobile telecoms market in Oman presents two MNOs (Class I[17] operators; i.e. Oman Mobile and Nawras) both with a market share above 40%[18], that account for the total mobile traffic in the Sultanate. Based on this, the TRA believes that the approach of modelling an average operator is more suitable for the Omani market. In particular, the modelled operator is suggested to have a 50% market share (n=2) throughout the whole time frame modelled.

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 following exhibit shows the current allocation of spectrum for mobile operators in the Sultanate of Oman.

[16] European Commission – Explanatory note on the recommendations of TR - 2009
[17] Class I operators defined as operators with owned network, excluding resellers.
[18] According to the Telecom Market Indicators Report Q1, 2013, during this period Omantel represented the 49% of the market while Nawras represented the 41% in terms of suscribers.

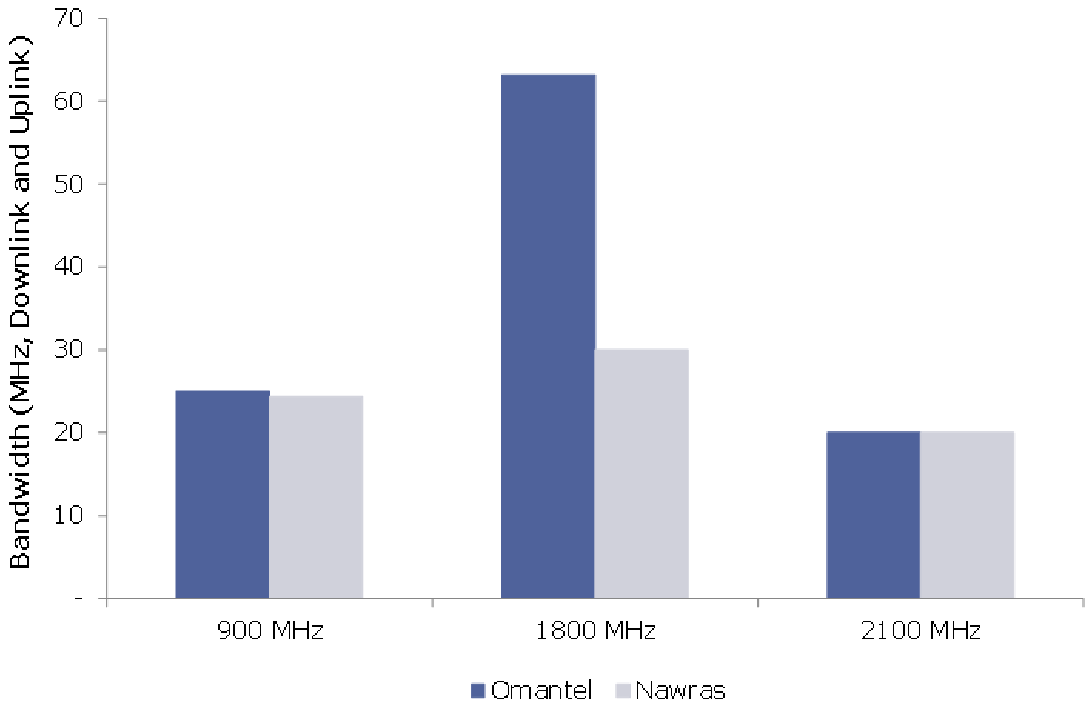

Exhibit 3: Spectrum allocation between Omantel and Nawras as of Q3, 2013. [Source: Axon Consulting, based on TRA data]

Therefore, the TRA sets that the modelled operator should have 50% of the spectrum available in each band in the Omani market. At the same time, the spectrum fees considered would be the average value per MHz in the Sultanate.

With regards to the spectrum that will be available in the future, the TRA is currently aiming to award two portions of spectrum (2x20 MHz) in the 2.6 GHz band and one portion (2x10 MHz) in the 800 MHz band, which will need to be considered. Therefore, the TRA determines to consider the spectrum currently available, plus the expected amount of spectrum to be auctioned.

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 TRA shall use the population coverage as a fundamental metric, in order to determine the extension of the network. Coverage will vary 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).

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 licence obligations.

3.2.2. Mobile services and increments

List of services considered in the BULRIC Model

The BULRIC model should include the network services provided by MNOs in the Sultanate of Oman 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, the disaggregation of services shall be based on their materiality, ensuring that services representing a significant number of connections or amount of traffic are incorporated in the model.

According to this rationale, a first differentiation in the services would be according to their category. The BULRIC mobile model shall 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) should 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)

In the case of data services, the TRA is of the opinion that differentiation between generic services (browsing, e-mail, etc.) and video related services would be useful.

Finally, an additional disaggregation of the services shall be introduced based on the radio access technology employed for their provision. Although this disaggregation will mostly be implemented internally in the Model (with the objective of properly model the networks), some of the services will also be explicitly disaggregated when they are perceived differently by the customers based on their technology (for example, data services may be disaggregated into narrowband, broadband and ultra broadband).

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

Definition of the increments

The definition of increments is required when using a LRIC or LRIC+ cost standard. As per the chosen methodology, increments in the BULRIC model shall be defined as groups of services.

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. For example, the SMS-Centre will be only associated with SMS services, regardless of technology.
- **Based on a wholesale-retail distinction**: increments are defined as groups of retail or wholesale services. This is, for instance, the approach proposed by the European Commission[19], which specifies that voice interconnection services be defined as the relevant increment for the determination of pure incremental costs.

The TRA is of the view that 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, the TRA believes that 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

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

considered time period. Based on the above, the TRA plans to define separate increments for voice and data services.

Finally, the TRA recognises 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, the TRA also believes that, for regulatory purposes, mobile wholesale services should not be regulated on the basis of the underlying technology. Based on the above, the TRA does not expect to define increments on the basis of technology; unless such distinction is justified, given the intrinsic differences in the services provided. In particular, the TRA will assess whether it is economically justifiable to differentiate between narrowband and broadband data services.

Based on the above, the TRA establishes to define the following increments:

- Voice services
- Data services, potentially separating between narrowband and broadband data services

3.2.3. Mobile Network Design

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

- Boundary between access and core networks
- Network topology design
- Geographical modelling
- Technologies considered
- Network Sharing

Boundary between access and core networks

Mobile networks can be separated mainly into two blocks: access network and core network. The TRA is of the opinion that the definition of the boundary between both parts of the network is required to make way for further methodological issues to be described in this document.

The TRA determines to define the following separation between access and core networks:

- Access network would include radio access sites and support infrastructure, radio access equipment (for example BTS, Nodes B,) and a transmission link between the radio access node and the controller (for example, BSC, RNC, etc.).
- Core network would include the equipment and supporting infrastructure above, including the radio network controllers. This includes the backbone transmission, switching equipment and other platforms.

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. 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.

In the view of the TRA, different considerations may be made depending on the network block:

- **Access network**: in the case of the access network, the number of nodes is relatively high and its exact position is not relevant (number of nodes and average installed equipment is sufficient).

  The TRA considers that the number of nodes in the mobile network modelled should closely reflect the actual number of nodes in the Operators' networks. Hence, the TRA envisages the implementation of a Modified Scorched Node 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 additional radio equipment required per technology and geotype, in order to ensure enough capacity to satisfy the demand.
3. The resulting amount of radio equipment will be contrasted against radio equipment units provided by operators for a reference year (i.e. 2012), to ensure the methodology followed is consistent with the modified scorched node approach.
4. In case clearly detectable inefficiencies arise throughout this process which suggests that the number of nodes employed by mobile operators is not efficient, they will not be considered in the model.

- **Core network**: in this case the position of the nodes is relevant (especially for the dimensioning of the backbone links) and may depend on political, economic, demographic and geographic issues. Nevertheless, the position of the nodes should ensure the efficiency of the network. Therefore, the modified scorched node approach is perceived as the best alternative to dimension the core network. This means that the number and location of the core nodes will be based on operators' existing nodes. These locations may be modified in the case any inefficiency is identified.

According to the previous considerations, the TRA establishes that both access and core mobile networks are designed based on a modified scorched node approach.

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 into the model, a geographical analysis of the Sultanate will be performed, 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 within 5 km of a population centre)

Apart from that, an additional geotype will be disaggregated in order to take into consideration the sites deployed for road coverage.

Accordingly, the TRA expects to define 9 geotypes, 8 of which will be constituted by municipalities sharing a set of relevant characteristics and the other will be used to reflect road coverage. In particular, the aggregation of municipalities into geotypes will respond to the scheme presented in the exhibit below:

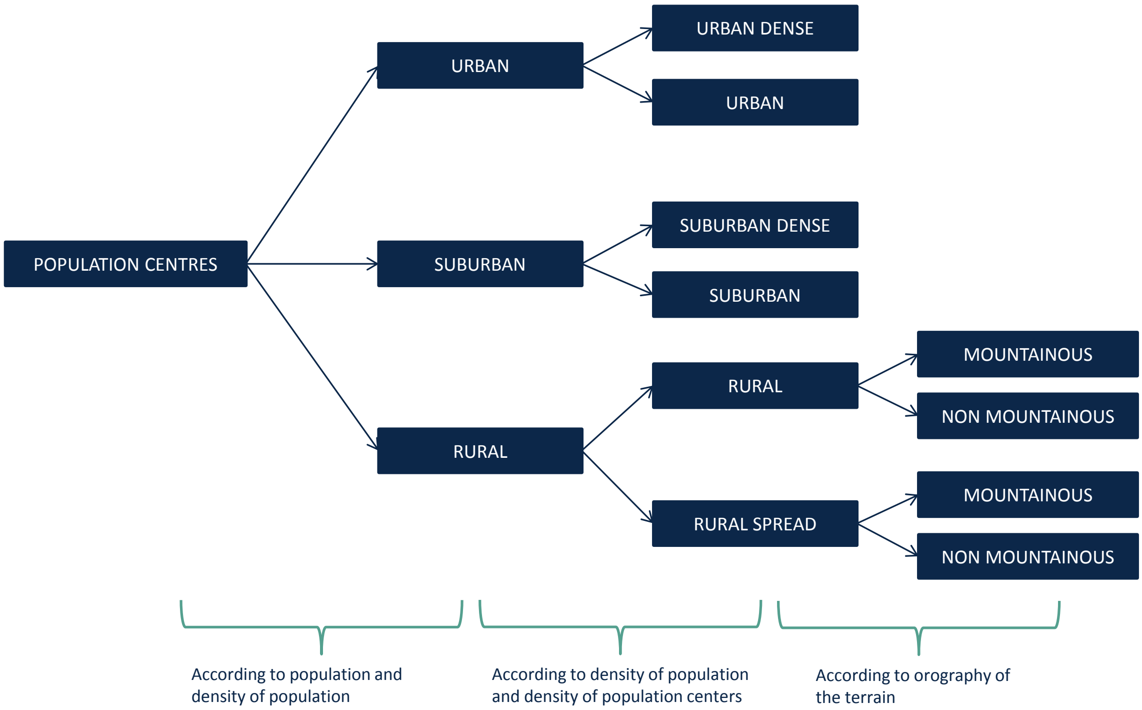

Exhibit 4: Classification of municipalities into geotypes. [Source: Axon Consulting]

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 Sultanate.

As a result of this highly-intensive data analysis, the TRA expects to obtain a proper classification of the municipalities in Oman, in order to allow a proper consideration of the operating conditions faced by Omantel and Nawras. For illustrative purposes, the exhibit below provides a preliminary overview of how the Sultanate would be divided among the different geotypes aggregating municipalities:

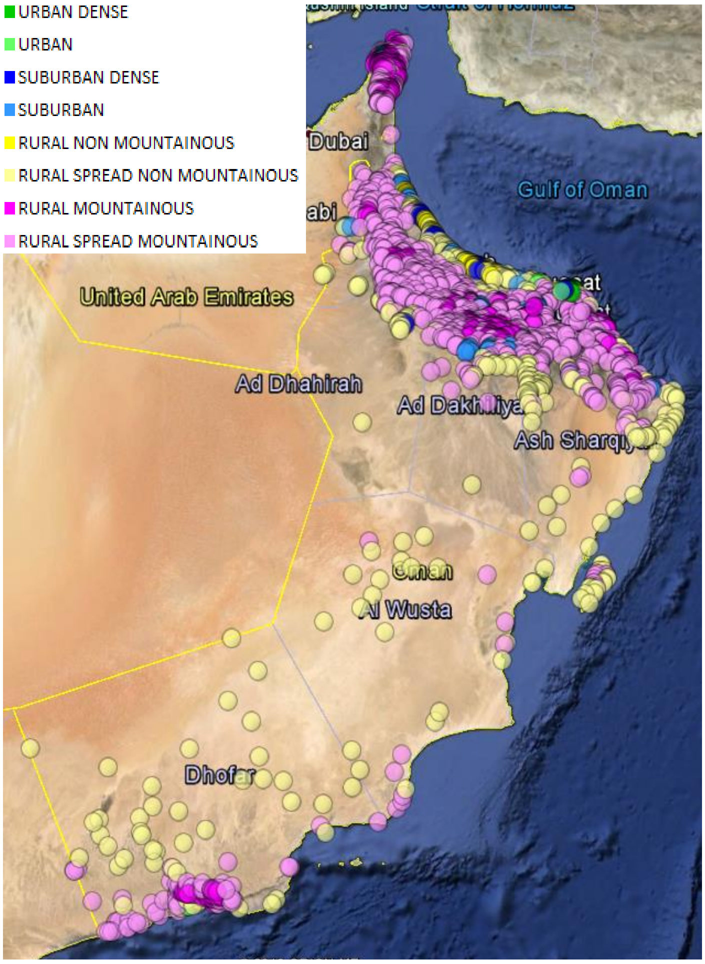

Exhibit 5: Illustrative overview of the classification of population centres into geotypes.

The definition of these geotypes will also take into consideration unpopulated areas surrounding the populated centers and will allow a precise modelling of the geographical characteristics faced in Oman, being able to represent differences in coverage cell radii, type of sites (tower or rooftop), demand density, etc.

Technologies to be modelled

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

This section describes the technologies 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

Currently, both MNOs in the Omani market have developed the following radio access technologies:

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

With the objective of accurately representing the existing mobile networks in the Sultanate of Oman, the TRA dictates to include GSM, UMTS and LTE radio access networks in the BULRIC model.

Each of these technologies will be dimensioned separately, each one based on its 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 in the same radio sites.

Core network technologies

There are two different technologies currently coexisting in typical 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:

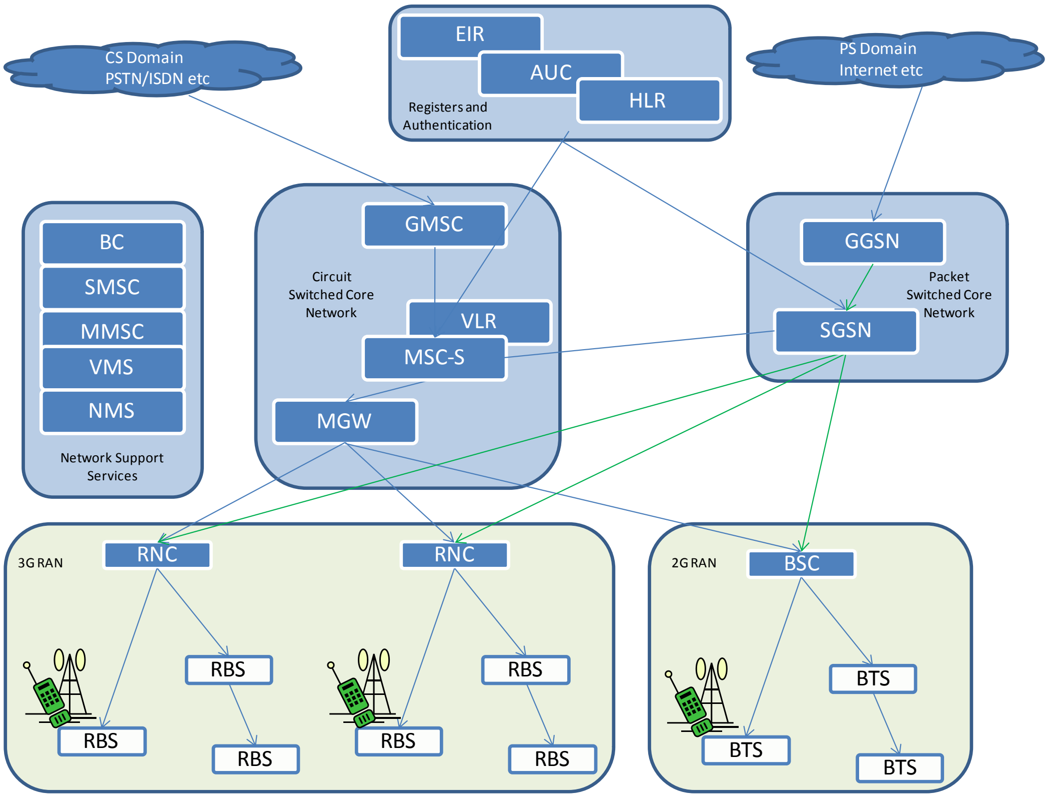

Exhibit 6: Illustrative structure of a mobile network based on 3Gpp legacy core technology. [Source: Axon Consulting]

- **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:

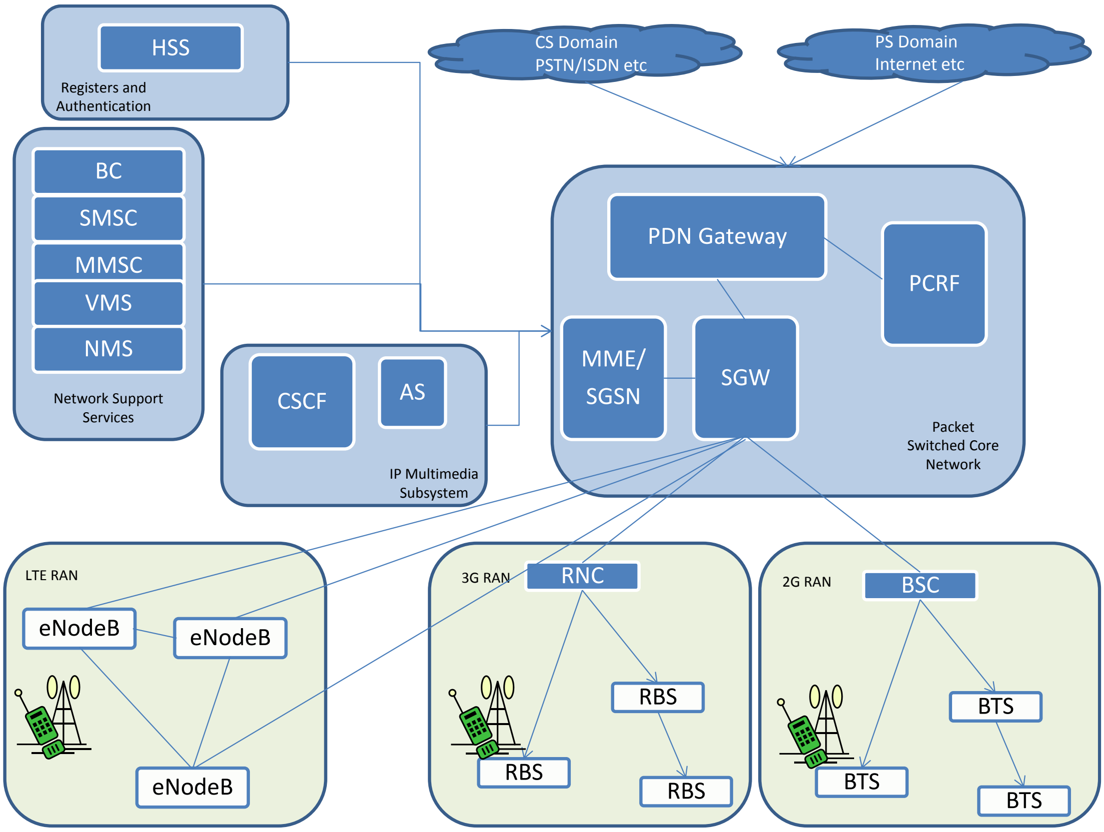

Exhibit 7: Illustrative structure of a mobile network based on Evolved Core Network technology. [Source: Axon Consulting]

Although it is likely that mobile networks are totally based on the Evolved Core in the mid-term, the TRA expects that both networks are going to coexist within the period to be modelled (i.e. until 2018). Therefore, the TRA determines 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 C 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
- Satellite. Although this technology is not frequent, it may be required for covering isolated areas

With regard to the use of leased lines, in order to ensure consistency between both BULRIC models and actual cost orientation, the unit cost of leased lines considered in the BULRIC model for mobile networks will be set equal to the unit cost of leased lines extracted from the BULRIC Model for fixed networks for each of the years modelled (2011-2018).

Additionally, the BULRIC model shall 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 will be dimensioned separately for each geotype. The availability per geotype of each of the transmission technologies considered will 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 two 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 TRA will consider the current backbone links in the MNOs networks, including their distance, the technology employed and the percentage of 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 the NRAs.

- **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.

In the view of the TRA, 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 TRA also recognises that the extent of site sharing, which may be required, varies from one market to another and in particular may be of less importance when, as is the case in Oman, MNOs have sufficient scale on their own.

On the other hand, the TRA is of the view that 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 TRA will include site sharing in the BULRIC model, based on the extent to which site sharing is actually employed by MNOs in the Omani market. The TRA will not consider RAN sharing on its BULRIC model.

3.3. 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

3.3.1. 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 each fixed operator in the market
- Developing a BULRIC model that represents a hypothetical generic existing operator
- Developing a BULRIC model representing a hypothetical generic new entrant

Unlike in the case of mobile networks, however, it is often difficult to define a generic 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."*[20]

Accordingly, the most common international practice is for BULRIC models to represent a fixed operator with a demand and a national coverage similar to the incumbents.

In the case of Oman, there is one main fixed-line player with national coverage at present, Omantel. National coverage is achieved through a copper-based access network.

On the other hand, the optical-fibre-based next-generation access network, of much greater capacity, is in its early stages of deployment. The two fixed operators, Omantel and Nawras, are developing their own networks; additionally, the National Broadband Company (NBC) has also initiated the deployment of a GPON NGA network. However it is uncertain, at the current time, the pace at which demand for these services will grow and the rhythm at which these operators will deploy the coverage of their NGA access networks.

On the basis of this reality, and in agreement with international practice, the TRA establishes to model a reference operator which, regarding the copper-based access network, will have similar characteristics to the incumbent, Omantel. In particular,

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

the reference operator will be presumed to have the same demand and the same coverage for copper-based access network as Omantel.

The modelling of the NGA network will be determined based on the rollout plans of Omantel, Nawras and the NBC. Specifically, the TRA will presume that the reference operator has a rollout plan for the NGA network, which will be equivalent to the most ambitious rollout plan of the three, as measured by population coverage and number of connections.

3.3.2. Fixed services and increments

List of services

The BULRIC model for fixed networks should include the services provided, or those that shall be provided in the foreseeable future, by the operators in the Sultanate of Oman 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 should 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 this, the TRA determines that a first categorisation should be made based on the type of service, namely:

- Access rental services
- Voice traffic
- Broadband
- Leased Lines and Data Capacity
- Access to passive infrastructure

Regarding access rental services the TRA sets that they are to be separated based on the technology used (PSTN, ISDN2, ISDN30, xDSL and FTTH) and specific services should be included for wholesale access services (LLU, Shared LLU, WLR and Bitstream access services).

In the case of voice services, the TRA establishes that they should be split into the following destinations:

- On-net

- Outgoing to other network (off-net), separating by destination
- Incoming traffic (termination)
- Transit

In the case of broadband services, the TRA determines to differentiate between retail and wholesale (bitstream) services. Moreover, broadband services are planned to be further split by bitrate.

Leased lines and Data Capacity services are expected to be split by bitrate and technology.

Finally, the TRA will incorporate the following passive infrastructure services into the BULRIC model:

- Co-location services
- Dark fibre rental
- Duct rental
- Sub-duct rental
- Pole rental
- Access to landing stations

Please find in Annex B a detailed list of the services determined by the TRA 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 3.2.2, increments in the fixed BULRIC model shall also 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. Based on this first-level separation, it is possible to introduce further disaggregation.

With regard to the access increment, TRA is of the view that the strong inter-dependencies between fibre and copper access services, and between these and the access to passive infrastructure makes it highly relevant to identify accurately the common costs shared among these services. Therefore, in order to improve the identification of the incremental costs related to each of these service classes, the TRA establishes that the access increment should be further divided based on the access technology used to provide the service to the end-user.

With regard to the conveyance increment, TRA believes that – in a fixed network based on NGN architecture (see section 3.3.3) – 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. TRA does not see particular merit in drawing such a distinction for the purpose of wholesale tariff setting.

Therefore, the increments to be considered in the BULRIC model for fixed networks will be defined as follows:

- Access Services, further subdivided into
  - Copper access services
  - Fibre access services
  - Third party access to infrastructure (i.e. poles, ducts)
- Conveyance

3.3.3. Fixed Network Design

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

- Boundary between access and core networks
- Network topology design
- Geographical modelling
- Technologies considered

Boundary between access and core networks

As with the mobile networks, fixed networks can be separated mainly into two main blocks: access network and core network. In the view of the TRA, the definition of the boundary between both parts of the network is required to make way for further methodological issues to be described in this document.

The TRA establishes to define the following separation between access and core networks:

- **Access network** would include the equipment and infrastructure that is mainly subscriber-dependent. More specifically, access network would include the assets between the customer's premise and the line card (included).

- **Core network** would include the equipment above the line card, mostly capacity-driven. In particular core network would include switching equipment, platforms, backbone and supporting infrastructure, etc.

Network topology design

As described in section 3.2.3, 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 the incumbent operator, it is standard practice to take the incumbent's existing geographical distribution of the main network access nodes as a given in the network design process. By main network access nodes, the TRA refers to those facilities where wire-line connection is terminated (for example, location of the Main Distribution Frame in the case of traditional copper access networks).

Maintaining the existing main access nodes does not mean that potential inefficiencies cannot, or should not, be addressed. For instance, the ERG[21], 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 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."*[22]

A review of international practice shows how the use of this modified scorched node approach is, in fact, the most widespread methodological choice for network topology design.

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[21] ERG was the predecessor to the Body of European Regulators for Electronic Communications (BEREC)
[22] ERG - Recommendation on how to implement the commission recommendation C(2005) 3480 - 2005

The TRA determines that a modified scorched node approach is the most adequate methodological choice for the implementation of a fixed BULRIC model in Oman. By adopting a modified scorched node approach, the TRA shall make the following methodological assumptions:

- The existing geographical locations of the main access nodes (for example, MDFs) of Omantel will be taken as starting point for the reference operator's fixed network design.
- The geographical locations of the main access nodes of the reference operator may be altered, only in cases where clearly identified inefficiencies are detected. The nature of the changes introduced would depend on the type of inefficiency detected.
- The particular geographical location and number of network nodes and network elements below the level of the main access node will not be taken as a given or used as an input in the dimensioning process. This includes the location of nodes, such as cabinets, manholes or poles routes, followed by network elements such as ducts or cables. As a result, the TRA does not envisage that the number and characteristics of these elements will necessarily coincide with Omantel's network. Nevertheless, the TRA shall gather relevant data about such network elements from operators for calibration purposes, and to identify relevant variations between the BULRIC model's results and Omantel's actual network.

Geographical Modelling

The investment required for covering a certain area with a fixed access network depends highly on the density of premises and on the type of buildings (for example, tall buildings with a number of premises compared with single-family houses). Additionally, the network will strongly depend on the proximity of the premises (i.e. it is not the same to cover an area of scattered houses, as it is an area with a number of small villages).

With the objective of representing these issues precisely, and to accurately model the reality of the network in the Sultanate of Oman, the TRA establishes to aggregate populated areas with similar characteristics into geo types. This approach is, in fact, the standard in BULRIC modelling.

According to international practice, the process of identifying similar geo types is highly dependent on the information available. Thus, geographical analyses will be conducted taking into consideration the level of detail available so as to ensure that it sufficiently captures the geographical characteristics of the Sultanate.

Initially, the TRA expects to split the relevant geotypes for the fixed networks BULRIC Model according to the following key parameters:

- Population served
- Density of population
- Density of premises

In addition to the parameters above, information about the type of buildings (for example, between single family houses, flat residences and business buildings) shall be used to the extent that such information is available.

Based on this set of variables, a total of 6 geotypes would be differentiated, as illustrated in the exhibit below:

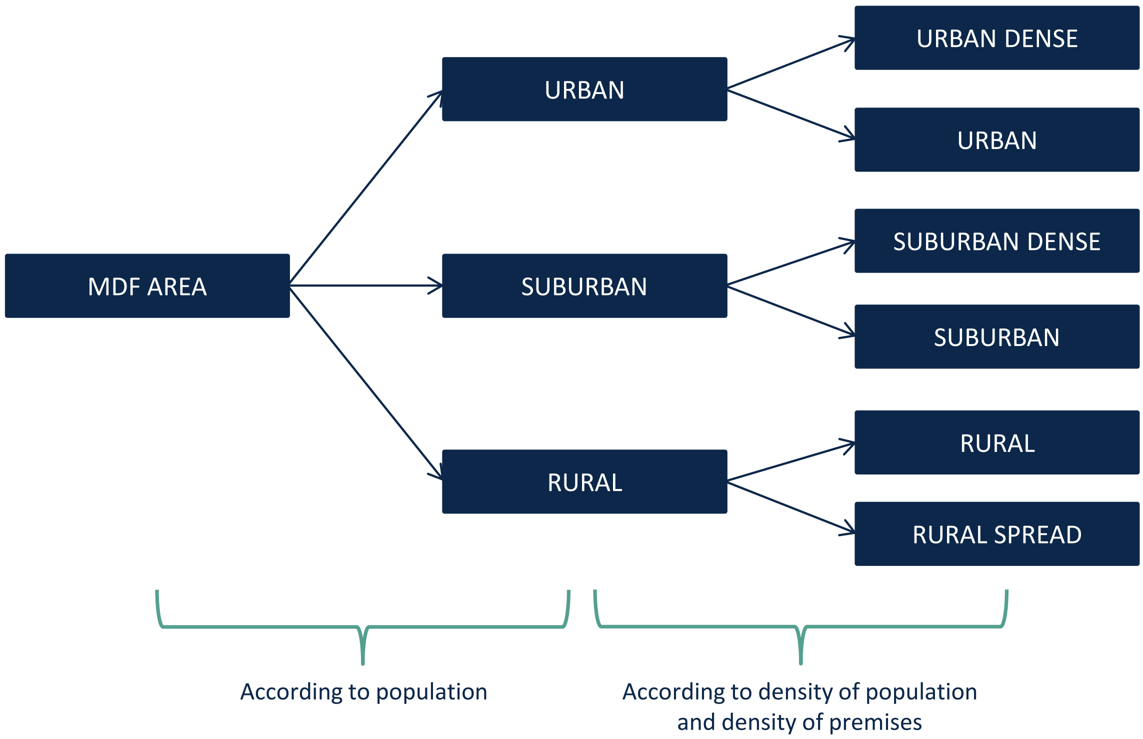

Exhibit 8: Classification of MDF areas into geotypes. [Source: Axon Consulting]

Detailed geographical analyses will be performed on samples of the MDF areas based on operators' information, in order to characterise them and to obtain the required parameters for the dimensioning of the fixed access network. In particular, the TRA envisages the implementation of a detailed GIS analysis at street and premises level for sample MDF areas. This analysis will be used to characterize important parameters such as average road distances, number of premises, households and businesses per street, etc. The figure below illustrates this GIS modelling employed for fixed access network modelling:

Exhibit 9: Illustrative example of the process to be followed for the dimensioning of the fixed access network. [Source: Axon Consulting]

The level of detail achieved through this GIS analysis, as well as the number of samples analysed, will be highly dependent on the quality and amount of information available. Nevertheless, the TRA will ensure that a sufficient number of samples for each geotype will be analysed, retaining a level of detail for each of them that will guarantee that the fixed access network model correctly represents the geographical characteristics of the Sultanate.

Technologies to be modelled

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

- Fixed access technologies
- Core network technologies
- Transmission technologies

Fixed access technologies

The following fixed access technologies are mostly used in the Sultanate of Oman:

- **Copper pairs**: Traditional access technology owned by the incumbent, based on copper pairs. In the case of copper access networks, they are commonly based on a point-to-point topology, between the line cards and the subscriber's premise.

- **NGA**: Next Generation Access networks are mostly based on Passive Optical Network (PON) technology. These networks do not require electrically powered equipment through the use of passive optical splitters. They distribute the signal to multiple customers (point-to-multipoint topology).

Although the NGA network is likely to be the Modern Equivalent Asset of the copper network (see section 3.1.3), one of the most important outcomes of the BULRIC model for fixed networks is expected to be the cost of the Local Loop Unbundled (LLU) services. With the objective of estimating the cost of the LLU services, it is required that the point-to-point copper network is incorporated in the BULRIC model.

With regards to the network topology implemented for NGA networks, the TRA is of the view that point-to-multipoint (P2M) PON technology should be implemented, given the preference displayed by international operators for this solution.

Additionally, it is important to take into account the existence of infrastructure providers in the Omani market developing open access networks that are able to provide both point-to-point (P2P) and P2M wholesale services.

Therefore, the TRA establishes that point-to-point copper and both point-to-point and point-to-multipoint fibre access networks are modelled in the BULRIC model for fixed networks. Both copper and fibre schemes will coexist in the network of the reference operator, to better reflect the real status of the fixed networks of Omani Operators.

With regards to the supporting infrastructure (ducts, poles, etc.), the TRA does not expect that the operators deploy specific infrastructure for the NGA network, but the infrastructure developed for the copper network is to be reused. Therefore, the TRA determines that the reference operator employs the same civil works infrastructure for both the copper-based access and the NGA.

Core network technologies

The following core technologies are currently 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.

In the opinion of the TRA, the NGN core network represents the MEA of the traditional fixed networks. In that context, NGN core network is able to provide all retail and wholesale services currently being offered by operators. Therefore, the TRA establishes to 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:

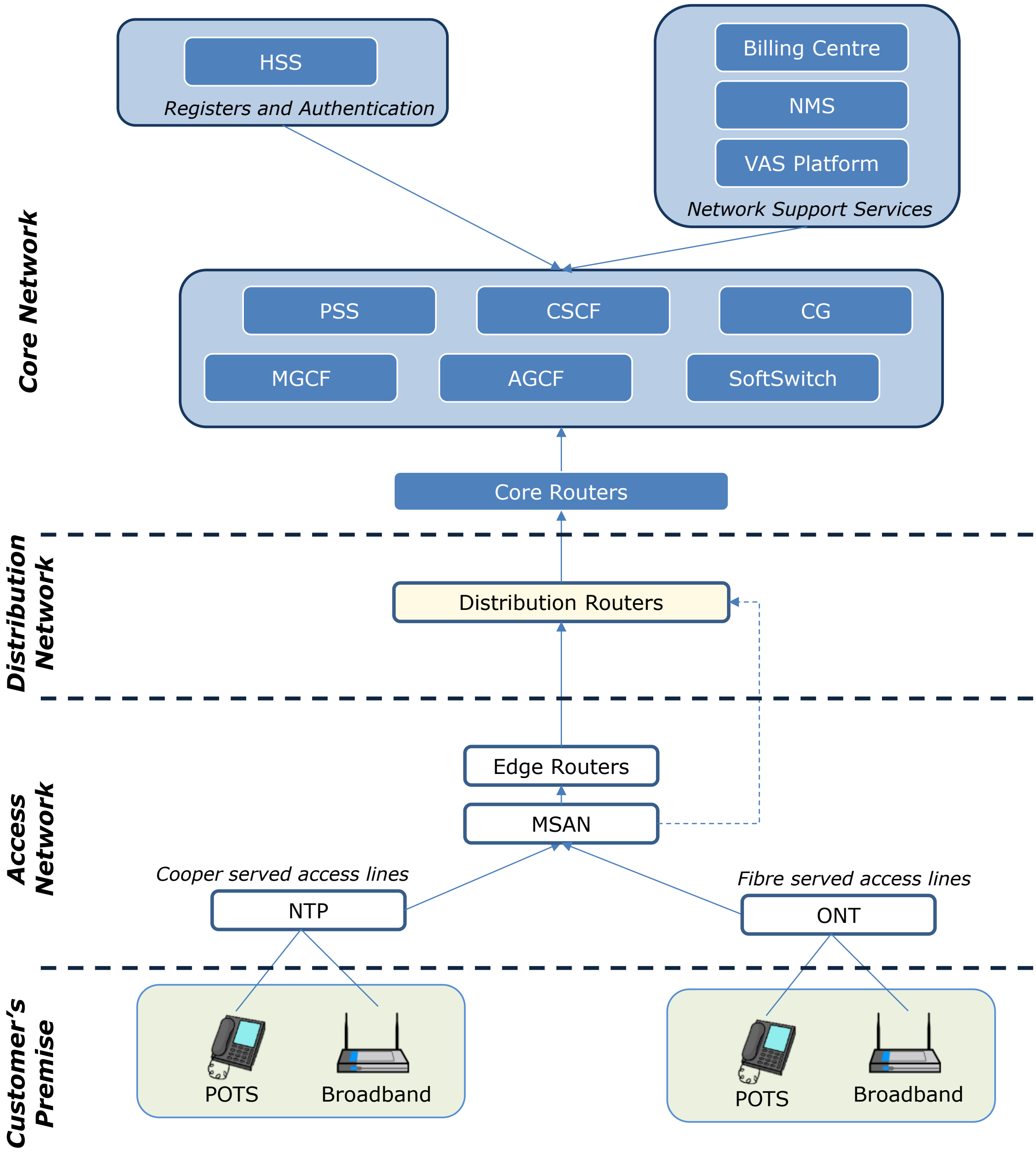

Exhibit 10: Illustrative structure of a fixed network based on NGN technology. [Source: Axon Consulting]

On the basis of the selection of technologies presented above, Annex D 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.

Regarding the different technologies available, the TRA considers that, even though SDH transmission has been and is still commonly used by fixed operators, this technology is being largely substituted by native Ethernet transmission.

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

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

3.4. Costing of ancillary, one-off and reduced materiality services

The TRA notes that there is a number of services included (or which may be included) in the wholesale reference offers, that are not appropriate to be included in the fixed or mobile BULRIC models. Services which shall not be incorporated in the main BULRIC models are those that meet one or more of the following conditions:

- Services which do not make use of network equipment, in particular services related to one-off interventions or ancillary services.
- Services of reduced materiality.

With the objective of setting appropriate wholesale tariffs for such services, the TRA determines to develop a separate and simpler costing module, which will not be linked to the BULRIC models described in the above sections.

The calculation of the costs of these services will separate the main components that are required for their provision. In particular, the following cost components will be considered in the calculation:

- Cost of own personnel, inclusive of a mark-up associated to personnel management, structure, etc.
- Cost of materials and specific equipment.

- Other costs associated to works subcontracted to third parties (for example, civil works or call centres)

These costs will be calculated based on a P*Q modelling approach. This means that the units of each component required for the provision of the service will be multiplied by a unitary cost.

In the case of personnel costs, the average time (i.e. hours) required for the provision of the service will be multiplied by the unitary cost per hour of the personnel (inclusive of the mark-up described above). The material and subcontracted costs will be calculated based on the average costs required per service unit.

These inputs are planned to be collected from the operators as well as from existing Top-Down models. The reasonability of the gathered figures will be checked by using the same approach as described in section 3.1.8.

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

A.1. Retail services

A.1.1. Access Services

Services related to the provision of access:

- Subscribers

A.1.2. Data Services

Services for the transmission of data (measured in MB) split into technology, and their inherent quality of service.

GPRS/EDGE

- Data traffic (mail, browsing or similar) through GPRS/EDGE technologies
- Data traffic (mail, browsing or similar) through GPRS/EDGE technologies

UMTS/HSPA

- Data traffic (mail, browsing or similar) through UMTS/HSPA technologies
- Data traffic (mail, browsing or similar) through UMTS/HSPA technologies

LTE

- Data traffic (mail, browsing or similar) through LTE technology
- Data traffic (video streaming and similar) through LTE technology

A.1.3. Voice Services

Voice calls (measured in minutes) split into direction and end segment:

- On-net voice calls
- Outgoing off-net voice calls to other mobile networks
- Outgoing off-net voice calls to fixed networks
- Outgoing off-net voice calls to international networks

- Outgoing on-net voice calls to voicemail
- Outgoing on-net voice calls to directory assistance
- Outgoing on-net voice calls to customer services
- Outgoing on-net voice calls to emergency services

A.1.4. SMS Services

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

- On-net SMS
- Outgoing off-net SMS

A.1.5. MMS Services

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

- On-net MMS
- Outgoing off-net MMS

A.1.6. Video call Services

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

- On-net video calls
- Outgoing off-net video calls originated in UMTS network

A.2. Wholesale services

A.2.1. Data Services

Wholesale services for the transmission of data (measured in MB) split into technology, inherent quality of service and segment.

GPRS/EDGE

- National Roaming Origination data traffic (mail, browsing or similar) through GPRS/EDGE technologies
- National Roaming Origination data traffic (video streaming and similar) through GPRS/EDGE technologies

- International Roaming Origination data traffic (mail, browsing or similar) through GPRS/EDGE technologies
- International Roaming Origination data traffic (video streaming and similar) through GPRS/EDGE technologies

UMTS/HSPA

- National Roaming Origination data traffic (mail, browsing or similar) through UMTS/HSPA technologies
- National Roaming Origination data traffic (video streaming and similar) through UMTS/HSPA technologies
- International Roaming Origination data traffic (mail, browsing or similar) through UMTS/HSPA technology
- International Roaming Origination data traffic (video streaming and similar) through UMTS/HSPA technology

LTE

- National Roaming Origination data traffic (mail, browsing or similar) through LTE technology
- National Roaming Origination data traffic (video streaming and similar) through LTE technology
- International Roaming Origination data traffic (mail, browsing or similar) through LTE technology
- International Roaming Origination data traffic (video streaming and similar) through LTE technology

A.2.2. Voice Services

Voice calls (measured in minutes) split into segment:

- Incoming voice calls from national networks
- Incoming voice calls from international networks
- Call origination service
- Origination National Roaming calls
- Origination International roaming calls
- Incoming National Roaming calls
- Incoming International roaming calls

A.2.3. SMS Services

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

- Incoming SMS from national networks
- Incoming SMS from international networks
- Origination National Roaming SMS
- Origination International roaming SMS
- Incoming National Roaming SMS
- Incoming International roaming SMS

A.2.4. MMS Services

Wholesale Multimedia Message Services (measured in MB) split into segment:

- Incoming MMS from national networks
- Incoming MMS from international networks
- Outgoing National Roaming MMS
- Outgoing International roaming MMS
- Incoming National Roaming MMS
- Incoming International roaming MMS

A.2.5. Video call Services

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

- Incoming video traffic
- Origination National Roaming video calls
- Origination International roaming video calls
- Incoming National Roaming video calls
- Incoming International roaming video calls

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

B.1. Access Services

Fixed access rental services (measured in number of lines) split into technologies and differentiating between retail and wholesale services:

- PSTN rental Rentals
- ISDN2 Rentals
- ISDN30 Rentals
- ADSL Rentals
- FTTH Rentals
- Wholesale copper line rentals
- Wholesale FTTH P2M line rentals
- Wholesale FTTH P2P line rentals
- Local Loop Unbundled (LLU)
- Shared LLU
- Bitstream rentals

B.2. Leased Lines

Retail services

- E1 Retail National Leased Line
- E3 Retail National Leased Line
- STM1 Retail National Leased Line
- STM4 Retail National Leased Line
- STM16 Retail National Leased Line
- E1 Retail International Leased Line (national segment)
- E3 Retail International Leased Line (national segment)
- STM1 Retail International Leased Line (national segment)
- STM4 Retail International Leased Line (national segment)
- STM16 Retail International Leased Line (national segment)
- Fast Ethernet Retail port
- Gigabit Ethernet Retail port

- Ethernet national traffic per Mbps
- Ethernet international traffic per Mbps
- MPLS/IP connection service

Wholesale terminating services

- E1 Terminating Leased Line
- E3 Terminating Leased Line
- STM1 Terminating Leased Line
- STM4 Terminating Leased Line
- STM16 Terminating Leased Line
- Fast Ethernet Terminating Leased Line
- Gigabit Ethernet Terminating Leased Line

Wholesale trunk services

- E1 Wholesale National trunk Leased Line
- E3 Wholesale National trunk Leased Line
- STM1 Wholesale National trunk Leased Line
- STM4 Wholesale National trunk Leased Line
- STM16 Wholesale National trunk Leased Line
- E1 Wholesale International trunk Leased Line (National segment)
- E3 Wholesale International trunk Leased Line (National segment)
- STM1 Wholesale International trunk Leased Line (National segment)
- STM4 Wholesale International trunk Leased Line (National segment)
- STM16 Wholesale International trunk Leased Line (National segment)
- Fast Ethernet Wholesale port
- Gigabit Ethernet Wholesale port
- Ethernet National trunk traffic per Mbps
- Ethernet International trunk traffic per Mbps

B.3. Voice Services

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

Retail

- On-net voice calls
- Retail outgoing off-net voice calls to national fixed
- Retail outgoing off-net voice calls to national mobile
- Retail outgoing off-net voice calls to international
- Retail outgoing off-net voice calls to satellite
- Retail outgoing on-net voice calls to voicemail

- Retail outgoing on-net voice calls to directory assistance
- Retail outgoing on-net voice calls to customer services
- Retail outgoing on-net voice calls to emergency services

Wholesale

- Call Termination Single Segment
- Call Termination Double Segment
- Call Termination Long Segment
- Call transit service domestic
- Call transit service international
- Call origination service

B.4. Broadband Services

Broadband internet services split into bitrate and technology. Differentiation between retail and wholesale (bitstream) is also done:

Retail broadband services

- 1Mbps or less ADSL line
- 2Mbps ADSL line
- 4Mbps ADSL line
- 5Mbps ADSL line
- 6Mbps ADSL line
- 12Mbps ADSL line
- 40Mbps FTTH line
- 100Mbps FTTH line

Wholesale broadband services

- 1Mbps or less bitstream line
- 2Mbps bitstream line
- 4Mbps bitstream line
- 5Mbps bitstream line
- 6Mbps bitstream line
- 12Mbps bitstream line
- 40Mbps bitstream line
- 100Mbps bitstream line

B.5. Other Wholesale Services

- Duct rental (measured in Km)

- Sub-duct rental (measured in Km)
- Pole rental (measured in number of poles)
- Dark fibre (measured in Km)
- Point of Interconnection
- International IP bandwidth
- Access to landing stations
- Collocation services:
    - At access provider land
    - At access seeker's premises
    - Collocation of a container shelter, etc. at access provider land
    - Collocation of the access seeker equipment within the access provider premises
    - Collocation of the access seeker antennas in access provider towers
    - Collocation of the access seeker pole on the roof of an access provider building
    - Electrical power

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

The following table shows a list of the most material resources the TRA intends to incorporate in its BULRIC Model for mobile networks:

Category	Name	Unit
Site	Tower-Rural	# of sites
Site	Rooftop-Rural	# of sites
Site	Micro-Rural	# of sites
Site	Tower-Suburban	# of sites
Site	Rooftop-Suburban	# of sites
Site	Micro-Suburban	# of sites
Site	Tower-Urban	# of sites
Site	Rooftop-Urban	# of sites
Site	Micro-Urban	# of sites
Site	Batteries	# of batteries
Site	Electricity	Kw/h
Site	Fuel	Litres
Site	Generator	#of generators
Site	Air Conditioning	# of air conditioners
Site	Security services	# of sites
Site	Antenna 900	# of antennas
Site	Antenna 1800	# of antennas
Site	Antenna 2100	# of antennas
Site	Antenna Biband	# of antennas
Site	Antenna Triband	# of antennas
Site	Antenna MIMO4x4	# of antennas
Site	Antenna Micro	# of antennas
2G site equipment	GSM BTS	# of BTS
2G site equipment	GSM BTS - SW	# of BTS-SW
2G site equipment	GSM900 TRX	# of TRXs
2G site equipment	GSM1800 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	UMTS900 carrier	# of carriers
3G site equipment	UMTS2100 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	LTE800 carrier	# of carriers
4G site equipment	LTE900 carrier	# of carriers
4G site equipment	LTE1800 carrier	# of carriers
4G site equipment	LTE2100 carrier	# of carriers
4G site equipment	LTE2600 carrier	# of carriers
4G Switch	LTE Switch Unit	# of Swtiches

Category	Name	Unit
4G Switch	LTE Switch Unit-SW	# of Swtiches-SW
Backhaul MW	PDH Up to 34Mbps	# of links
Backhaul MW	SHD 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
Backhaul SAT	Satellite	# of lines
Backhaul SAT	Satellite	Mbps
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
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 MGWs
Core	Media Gateway (MGW) Unit-SW	# of MGWs
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

Category	Name	Unit
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	GSM SPEC 800MHz	MHz
LIC	GSM SPEC 900MHz	MHz
LIC	GSM SPEC 1800MHz	MHz
LIC	GSM SPEC 2100MHz	MHz
LIC	GSM SPEC 2600MHz	MHz
LIC	UMTS SPEC 800MHz	MHz
LIC	UMTS SPEC 900MHz	MHz
LIC	UMTS SPEC 1800MHz	MHz
LIC	UMTS SPEC 2100MHz	MHz
LIC	UMTS SPEC 2600MHz	MHz
LIC	LTE SPEC 800MHz	MHz
LIC	LTE SPEC 900MHz	MHz
LIC	LTE SPEC 1800MHz	MHz
LIC	LTE SPEC 2100MHz	MHz
LIC	LTE SPEC 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 D. List of resources to be included in the BULRIC Model for fixed networks

The following table shows an illustrative example of the resources considered in BULRIC models for fixed networks:

Category	Name	Unit
Site	Site Rural	m2
Site	Site Suburban	m2
Site	Site Urban	m2
Site	Diesel Generator	#
Site	Electricity	KWH
Site	Fuel	litres
Access Copper	Copper cable 1 pair	km
Access Copper	Copper cable 2 pair	km
Access Copper	Copper cable 5 pair	km
Access Copper	Copper cable 10 pair	km
Access Copper	Copper cable 20 pair	km
Access Copper	Copper cable 30 pair	km
Access Copper	Copper cable 50 pair	km
Access Copper	Copper cable 100 pair	km
Access Copper	Copper cable 200 pair	km
Access Copper	Copper cable 250 pair	km
Access Copper	Copper cable 400 pair	km
Access Copper	Copper cable 600 pair	km
Access Copper	Copper cable 800 pair	km
Access Copper	Copper cable 1000 pair	km
Access fibre	Fibre cable 2 strand	km
Access fibre	Fibre cable 8 strand	km
Access fibre	Fibre cable 12 strand	km
Access fibre	Fibre cable 24 strand	km
Access fibre	Fibre cable 48 strand	km
Access fibre	Fibre cable 72 strand	km
Access infrastructure	Duct urban	km
Access infrastructure	Duct suburban	km
Access infrastructure	Duct rural	km
Access infrastructure	3-subduct	km
Access infrastructure	Flexible duct	km
Access infrastructure	Manhole class 1	#
Access infrastructure	Manhole class 2	#
Access infrastructure	Manhole class 3	#
Access infrastructure	Manhole class 4	#
Access infrastructure	Trench urban	km
Access infrastructure	Trench suburban	km
Access infrastructure	Trench rural	km
Access infrastructure	Poles concrete	#
Access infrastructure	Poles wood	#
Access infrastructure	Connection box class 1	#
Access infrastructure	Connection box class 2	#
Access infrastructure	Connection box class 3	#
Access infrastructure	Connection box class 4	#

Category	Name	Unit
Access nodes	MDF class1	#
Access nodes	MDF class2	#
Access nodes	MDF class3	#
Access nodes	MDF class4	#
Access nodes	MDF class5	#
Access nodes	MSAN chassis medium	#
Access nodes	MSAN chassis large	#
Access nodes	PSTN line card	#
Access nodes	ISDN line card	#
Access nodes	ADSL/PSTN line card	#
Access nodes	ADSL/ISDN line card	#
Access nodes	FTTH line card	#
Access nodes	Splitter rack class1	#
Access nodes	Splitter rack class2	#
Access nodes	Spliter card	#
Trunk fibre	Fibre Cable 2 strand	km
Trunk fibre	Fibre Cable 8 strand	km
Trunk fibre	Fibre Cable 12 strand	km
Trunk fibre	Fibre Cable 24 strand	km
Trunk fibre	Fibre Cable 48 strand	km
Trunk fibre	Fibre Cable 72 strand	km
Trunk fibre	Fibre Cable 96 strand	km
Trunk fibre	Fibre Cable 192 strand	km
Trunk fibre	Submarine Fibre Cable 2 strand	km
Trunk fibre	Submarine Fibre Cable 8 strand	km
Trunk fibre	Submarine Fibre Cable 12 strand	km
Trunk fibre	Submarine Fibre Cable 24 strand	km
Trunk fibre	Submarine Fibre Cable 48 strand	km
Trunk fibre	Submarine Fibre Cable 72 strand	km
Trunk fibre	Submarine Fibre Cable 96 strand	km
Trunk fibre	Submarine Fibre Cable 192 strand	km
Microwave Transmission	Ethernet Mw link	#
Fibre Transmission	DWDM Chassis	#
Fibre Transmission	DWDM amplifier	#
Fibre Transmission	DWDM lambda inserter	#
Edge Routers	Edge routers chassis	#
Edge Routers	Gigabit card	#
Edge Routers	10 Gigabit card	#
Distribution routers	Distribution routers chassis	#
Distribution routers	Gigabit card	#
Distribution routers	10 Gigabit card	#
Core routers	Core routers chassis	#
Core routers	Gigabit card	#
Core routers	10 Gigabit card	#
Converters	TDM to packed converter chassis	
Converters	E1 Card	
Converters	E3 Card	
Converters	STM 1 Card	
Converters	STM 4 Card	
Converters	STM 16 Card	
Converters	Gigabit Ethernet card	
Converters	10 Gigabit Ethernet card	
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	#

Category	Name	Unit
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	#
Supporting platforms	National internet connectivity	Mbps
Supporting platforms	International internet connectivity	Mbps

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

Annex E. 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
GCC	Gulf Cooperation Council
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
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
TRA	Telecommunications Regulatory Authority
UAE	United Arab Emirates
UMTS	Universal Mobile Telecommunications System
VAS	Value Added Services
VoIP	Voice over IP. Voice over Internet Protocol

سلطنة عُمان
Sultanate of Oman

هيئة تنظيم الاتصالات
Telecommunications Regulatory Authority

Development of Bottom-Up LRIC Models in the Sultanate of Oman

Supporting Annex

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Supporting Annex: 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 TRA has reviewed the alternatives adopted by a number of other NRAs, an exercise which is summarized in this supporting annex.

Even though the TRA has taken into account the international best practice[23], the methodology described in the methodological document has been carefully designed to reflect the reality and specificities of the Telecom Market in the Sultanate of Oman and to serve the TRA's regulatory objectives. Therefore, no direct relationships should be established s between the 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 relevant geographical regions for Oman and countries considered best practice (covering the GCC, Middle East, European and African Countries). 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.

[23] The TRA 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
GCC AND MIDDLE EAST	BAHRAIN	√	√
	UAE	√	√
	SAUDI ARABIA	√	√
	JORDAN	√	√
EUROPE	BELGIUM	×	√
	SPAIN	√	√
	FRANCE	√	√
	NORWAY	√	√
	SWEDEN	√	√
	UK	√	√
AFRICA	ZIMBABWE	√	√
TOTAL		**10**	**11**

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
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 BULRIC Model for mobile networks	October 2011
		20111021_Modelo_costes	October 2011
	Fixed	Public consultation document for the BULRIC Model for interconnection costs in fixed networks	December 2012
		BULRIC 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

Country	Networks considered	Document	Date released
		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[24]
	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
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 of Telecommunications Networks in the UAE"	July 2012
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 the public consultation 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

[24] The PTS updated the inputs employed in the BULRIC model for mobile networks in June 2013

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

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Network CapEx**		√	√	√	√	√	√	√	√	√	√	**10/10**
	Network OpEx		√	√	√	√	√	√	√	√	√	√	**10/10**
	Spectrum fees		x	√	√	√	√	√	√		√	√	**8/9**
	Retail Costs		x	x	x	x	x	√	x	x	x	x	**1/10**
	G&A Costs		√	√	√	√	x	√	√	√	√	√	**9/10**
	Royalty fees		x	x	x	x	x	x	x	x	√	x	**1/10**
FIXED NETWORKS	**Network CapEx**	√	√	√	√	√	√	√	√	√	√	√	**11/11**
	Network OpEx	√	√	√	√	√	√	√	√	√	√	√	**11/11**
	Retail Costs	x	x	x	x	x	x	√	x	x	x	x	**1/11**
	G&A Costs	√	x	x	√	√	x	√	√	√	√	√	**8/11**
	Royalty fees	x	x	x	x	x	x	x	x	x	√	x	**1/11**

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

Cost of Capital

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Weighted Average Cost of Capital (WACC)**		√	√	√	√	√	√	√	√	√	√	**10/10**
	Return of Turnover (RoT)		x	x	x	x	x	x	x	x	x	x	**0/10**
FIXED NETWORKS	**Weighted Average Cost of Capital (WACC)**	√	√	√	√	√	√	√	√	√	√	√	**11/11**
	Return of Turnover (RoT)	x	x	x	x	x	x	x	x	x	x	x	**0/11**

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

Treatment of OpEx

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Based on percentages over CapEx**		x	√	√	√	x	x	√	√	√	√	**7/10**
	Based on Bottom-up calculation		√	x	x	x	√	√	x	x	x	x	**3/10**
FIXED NETWORKS	**Based on percentages over CapEx**	x	x	√	√	x	√	x	√	√	√	√	**7/11**
	Based on Bottom-up calculation	√	√	x	x	√	x	√	x	x	x	x	**4/11**

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

Assets valuation method

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Static approach - HCA**		x	x	x	x	x	x	x	x	x	x	**0/10**
	Static approach - CCA		x	x	x	x	x	√	x	x	x	x	**1/10**
	Dynamic approach (Cash-flow)		√	√	√	√	√	x	√	√	√	√	**9/10**
FIXED NETWORKS	**Static approach - HCA**	x	x	x	x	x	x	x	x	x	x	x	**0/11**
	Static approach - CCA	x	x	x	x	x	x	√	x	x	x	x	**1/11**
	Dynamic approach (Cash-flow)	√	√	√	√	√	√	x	√	√	√	√	**10/11**

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

Annualisation criteria

		Belgium	Spain	France	Norway[25]	Sweden	UK	Bahrain[26]	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Straight line depreciation**		x	x	X	x	x	x	x	x	x	x	**0/10**
	Standard Annuity		x	x	x	x	x	x	x	x	x	x	**0/10**
	Tilted Annuity		x	√	x	x	x	√	√	√	√	√	**6/10**
	Economic depreciation (Adjusted Tilted annuities)		√	x	√	√	√	√	x	x	x	x	**5/10**
FIXED NETWORKS	**Straight line depreciation**	x	x	x	x	x	x	x	x	x	x	x	**0/11**
	Standard Annuity	x	x	x	x	x	x	x	x	x	x	x	**0/11**
	Tilted Annuity	x	x	√	√	√	x	√	√	√	√	√	**8/11**
	Economic depreciation (Adjusted Tilted annuities)	√	√	x	√	x	√	√	x	x	x	x	**5/11**

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

Working Capital

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Associated to Network CapEx**		x	x	x	x	x	√	√	√		√	**4/9**
	Associated to Network OpEx		x	x	√	√	x	x	x	√		√	**4/9**
FIXED NETWORKS	**Associated to Network CapEx**	x	x	x	x	x	x	√	√	√		√	**4/10**
	Associated to Network OpEx	√	√	x	√	x	x	x	x	√		√	**5/10**

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

[25] The NRA in Norway defines two different annualisation methodologies to be employed in the BULRIC 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)

[26] The TRA in Bahrain proposed to implement tilted annuities and adjusted tilted annuities in the BULRIC models

Cost standard

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Fully Allocated Costs (FAC)**		x	x	x	x	x	x	x	x	x	x	**0/10**
	Pure Long Run Incremental Costs (Pure LRIC)[27]		√	√	x	x	√	x	x	x	x	x	**3/10**
	Long Run Incremental Costs plus Common Costs (LRIC+)		√	√	√	√	√	√	√	√	√	√	**10/10**
FIXED NETWORKS	**Fully Allocated Costs (FAC)**	x	x	x	x	x	x	x	x	x	x	x	**0/11**
	Pure Long Run Incremental Costs (Pure LRIC)	x	x	x	x	x	x	x	x	x	x	x	**0/11**
	Long Run Incremental Costs plus Common Costs (LRIC+)	√	√	√	√	√	√	√	√	√	√	√	**11/11**

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

Allocation of common and joint network costs

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Equi-Proportional Mark-Up (EPMU)**		√	√	√	√	√	x	√	√	√	√	**9/10**
	Effective Capacity		x	x	x	x	x	√	x	x	x	x	**1/10**
	Shapley-Shubik		x	x	x	x	x	√	x	x	x	x	**1/10**
	Ramsey Pricing		x	x	x	x	x	x	x	x	x	x	**0/10**
FIXED NETWORKS	**Equi-Proportional Mark-Up (EPMU)**	√	√	√	√	√	√	x	√	√	√	√	**10/11**
	Effective Capacity	x	x	x	x	x	x	√	x	x	x	x	**1/11**
	Shapley-Shubik	x	x	x	x	x	x	√	x	x	x	x	**1/11**
	Ramsey Pricing	x	x	x	x	x	x	x	x	x	x	x	**0/11**

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

[27] 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)

Network Optimisation Approach

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Yearly approach**		x	√	√		√	√					**4/5**
	Historical approach		√	x	x		x	x					**1/5**
FIXED NETWORKS	**Yearly approach**	√	√	√	√		√	√					**6/6**
	Historical approach	x	x	x	x		x	x					**0/6**

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

Period of time modelled

		Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
MOBILE NETWORKS	**Static (1 year)**		x	x	x	x	x	x	x		x		**0/8**
	Dynamic (several years)		√	√	√	√	√	√	√		√		**8/8**
	Period of time modelled (years)		*30*	*25*	*50*	*50*	*30*	*4-5*	*5*		*5*		
FIXED NETWORKS	**Static (1 year)**	x	x	x	x	x	x	x	x		x		**0/9**
	Dynamic (several years)	√	√	√	√	√	√	√	√		√		**9/9**
	Period of time modelled (years)	*50*	*50*	*15*	*60*	*40*	*40*	*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

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Each MNO in the market	√	x	x	x	x	x	√	x	√	√	**4/10**
Generic Mobile Operator	√	√	√	√	√	√	√	√	√	x	**9/10**

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

Boundary between access and core networks

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Access network up to the controller (not included)[28]	x		√	√				√			**3/4**
Access network up to the controller (included)	√		x	x				x			**1/4**

Table 16: Benchmark: Boundary between access and core networks. [Source: Axon Consulting]

[28] The models developed by the NRAs in France and UK do not make a formal distinction between access and core networks. Bahrain, UAE, Jordan and Zimbabwe have not established a boundary delimiting access and core networks in their public consultation documents.

Consideration of modern equivalent assets – Access Network

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered	x	x	x	x	x	x	x	x	x	x	**0/10**
Modern Equivalent Assets not considered	√	√	√	√	√	√	√	√	√	√	**10/10**

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

Consideration of modern equivalent assets – Core Network

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered	√	x	x	√	x	√	x	x	x	x	**3/10**
Modern Equivalent Assets not considered	x	√	√	x	√	x	√	√	√	√	**7/10**

Table 18: Benchmark: Consideration of modern equivalent assets in the mobile core network. [Source: Axon Consulting]

Technologies to be modelled - Radio access technologies

	Spain	France	Norway	Sweden	UK	Bahrain[29]	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
2G (GSM)	√	√	√	√	√	√	√	√	√	√	**10/10**
3G (UMTS)	√	√	√	√	√	√	√	x	x	√	**8/10**
4G (LTE)	√	x	x	x	x	x	x	x	x	x	**1/10**

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

Technologies to be modelled – Core network technologies

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia[30]	Jordan[31]	Zimbabwe	**TOTAL**
3Gpp Legacy Core Network	√	√	√	√	√	√	√	√	√	√	**10/10**
Evolved Core Network	√	x	x	√	x	√	x	x	x	x	**3/10**

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

[29] 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.

[30] 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. We consider that thus CITC has set a pre-defined set of technologies.

[31] Jordan has developed models considering exclusively GSM technology, which was at the time the only technology in the market. We consider 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

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Microwave links	√	√	√	√	√	√	√	√	√	√	**10/10**
Leased Lines	√	√	√	√	√	√	√	√	√	√	**10/10**
Optical Fibre	√	√	√	√	√				x	√	**6/7**
Satellite links	x	x	x	x	x	x	x	x	x	x	**0/10**

Table 21: Benchmark: Technologies to be modelled - Transmission network technologies. [Source: Axon Consulting]

Network Topology Design – Access Network

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Scorched node	x	x	x	x	x	x	x	x	√	x	**1/10**
Modified scorched node	x	x	x	x	x	√	√	√	x	√	**4/10**
Scorched earth	√	√	√	√	√	x	x	x	x	x	**5/10**

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

Network Topology Design – Core Network

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Scorched node	x	x	x	x	x	x	x	√	√	√	**3/10**
Modified scorched node	√	√	√	√	√	√	√	x	x	x	**7/10**
Scorched earth	x	x	x	x	x	x	x	x	x	x	**0/10**

Table 23: Benchmark: Network Topology Design – Core Network. [Source: Axon Consulting]

Network Sharing

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Site Sharing	√	x	x	x	√	x	√	√	x	√	**5/10**
Radio-Access Network (RAN) Sharing	√	x	x	x	x	x	x	x	x	x	**1/10**

Table 24: Benchmark: Network Sharing. [Source: Axon Consulting]

Definition of the increments

	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Based on services type	√	√	√	x	√	x	x	x	x	x	**4/10**
Based on technology	x	x	x	√	x	x	x	x	x	x	**1/10**
Open criteria	x	x	x	x	x	√	√	√	√	√	**5/10**

Table 25: Benchmark: Definition of the increments. [Source: Axon Consulting]

Specific features of the BULRIC Model for a fixed network

Operator to be modelled

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Each Operator in the market	x	x	x	x	√	x	x	x	x	√	√	**3/11**
Generic Operator (based on incumbent)	√	√	√	√	x	√	√	√	√	√	x	**9/11**

Table 26: Benchmark: Operator to be modelled. [Source: Axon Consulting]

Boundary between access and core networks[32]

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Access network up to the line cards (not included)	√	√	√	√	√	√	√					**7/7**
Other boundaries	x	x	x	x	x	x	x					**0/7**

Table 27: Benchmark: Boundary between access and core networks. [Source: Axon Consulting]

Consideration of modern equivalent assets – Access Network

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered[33]	√	√	√	√	√	√	√	√				**8/8**
Modern Equivalent Assets not considered	x	x	x	x	x	x	x	x				**0/8**

Table 28: Benchmark: Consideration of modern equivalent assets in the fixed access network. [Source: Axon Consulting]

Consideration of modern equivalent assets – Core Network

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	TOTAL
Modern Equivalent Assets considered	√	√	√	√	√	√	√	√	√	√	√	**11/11**
Modern Equivalent Assets not considered	x	x	x	x	x	x	x	x	x	x	x	**0/11**

Table 29: Benchmark: Consideration of modern equivalent assets in the fixed core network. [Source: Axon Consulting]

[32] NRAs in UAE, Saudi Arabia, Jordan and Zimbabwe have not established a specific boundary delimiting access and core networks in their public consultation documents

[33] 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 BULRIC models

Technologies to be modelled - Fixed access technologies

	Belgium	Spain	France	Norway	Sweden[34]	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
Copper pairs	√	√	√	√	√	√	√	x	√	√	√	10/11
NGA – Active Optical Networks	x	x	x	x		x	√	x				1/7
NGA – Passive Optical Networks	x	√	√	√		√	x	√				5/7

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

Technologies to be modelled – Core network technologies

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
Legacy TDM network	x	x	√	√	x	√	x	x	√	√	√	**6/11**
NGN Core network	√	√	√	√	√	√	√	√	√	√	√	**11/11**

Table 31: Benchmark: Technologies to be modelled - Core network technologies. [Source: Axon Consulting]

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

Technologies to be modelled - Transmission technologies

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
Microwave links	x	x	x	x	√	x	x	x	x			**1/9**
SDH Fibre transmission	x	x	x	√					√			**2/5**
Native Ethernet Fibre Transmission	x	x	x	x								**0/4**
WDM Fibre Transmission	√	√	√	√								**4/4**

Table 32: Benchmark: Technologies to be modelled - Transmission technologies. [Source: Axon Consulting]

Network topology

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
Scorched node	x	x	x	x	x	x	x	x	x	x	x	**0/11**
Modified scorched node	√	√	√	√	√	√	√	√	√	√	√	**11/11**
Scorched earth	x	x	x	x	x	x	x	x	x	x	x	**0/11**

Table 33: Benchmark: Network topology. [Source: Axon Consulting]

Definition of the increments[35]

	Belgium	Spain	France	Norway	Sweden	UK	Bahrain	UAE	Saudi Arabia	Jordan	Zimbabwe	**TOTAL**
Split between Access and Conveyance	√	√		√					√	√		**5/5**
Split between Access and Conveyance separating conveyance for Wholesale termination and other conveyance services	x	√		√					x	x		**2/5**

Table 34: Benchmark: Definition of the increments. [Source: Axon Consulting]

35 The BULRIC 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