Guide on costing modelling for the determination of mobile and fixed-line wholesale voice call termination rates

Version 5

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1 Introduction

1.1 Review of pro-competitive conditions

1.1.1 The Independent Communications Authority of South Africa ('the Authority'/'ICASA') is engaged in a review of the pro-competitive conditions imposed on licensees in terms of its Call Termination Regulations, 2014. A Findings Document was published on 28 March 2022 in which the Authority reviewed the market for wholesale voice call termination services as well as the effectiveness of competition in the telecommunications market.

1.1.2 The Authority made various determinations including the following:

1.1.2.1 Licensees must charge cost-based pricing.

1.1.2.2 Mobile termination rates will move to symmetry within a transitional period of twelve months.

1.1.2.3 New licensees will qualify for asymmetry for a limited period of three years after entry into the market.

1.1.2.4 South African licensees must charge reciprocal international termination rates for voice calls originating outside of South Africa.

1.1.3 The Authority published a notice of commencement of the cost modelling phase with respect to the review of pro-competitive conditions imposed on the relevant licensees in terms of the call termination regulations, 2014 (as amended) on 26 May 2023. The Authority stated, "*having determined that there are still competition issues in the call termination market that may require regulatory intervention in its Market Review Phase, the Authority is now embarking on the Cost Modelling Phase in order to determine the efficient cost of providing wholesale voice call termination services*".[1] The purpose of this notice was to outline the next steps and the timelines with respect to the cost modelling exercise. The bottom-up and top-down shell

[1] Government Gazette No. 48660. Page 429. Available https://www.icasa.org.za/legislation-and-regulations/call-termination-rate-review-notice.

models were published on the Authority's website together with the notice.

1.2 Stakeholder workshop, modelling guide, shell models

1.2.1 A stakeholder workshop took place on 31 May 2023, at the Authority's offices in Centurion. One-on-one meetings were held with Cell C, MTN, Telkom and Vodacom between 1 and 6 June 2023.

1.2.2 The Authority's Proposed Modelling Guide on bottom-up and top-down shell models for the determination of mobile and fixed-line wholesale voice call termination rates was published on 2 June 2023.[2] This guide also explained the methodology used to determine Pure Long Run Incremental Costs. It describes how the modelling approach is based on "*international best practices which aligns with the determinations above, while also considering South Africa's market dynamics"*. The guide further explains the cost modelling approaches available to the Authority, and recommends after an "analysis of economic efficiency, distributional effects, competitive effects, and commercial and regulatory consequences" that the Authority adopt the pure LRIC approach.

1.2.3 Stakeholders provided written comments on the notice of commencement of the cost modelling exercise on 7 June 2023, and the Authority provided written responses to those requests for clarification on 15 June 2023.

1.2.4 Stakeholders were then requested to comment on methodology aspects of the TD/BU cost models by 10 July 2023, later revised to 24 July 2023.

1.3 Decision on methodology

1.3.1 Stakeholder submissions on the Authority's methodology were considered at a Committee meeting on 10 August 2023 and at a Council

[2] See Guide on bottom-up and top-down shell models for the determination of mobile and fixed-line wholesale voice call termination rates. Published on 2 June 2023. Available https://www.icasa.org.za/legislation-and-regulations/mobile-and-fixed-termination-rates.

meeting on 22 August 2022, and the Authority made the following decisions, captured in a separate Methodology Briefing Note:

1.3.1.1 The pure LRIC approach will be used to model termination costs;

1.3.1.2 Economic depreciation will be applied to model termination costs;

1.3.1.3 Fixed termination costs will be modelled separately to mobile termination costs;

1.3.1.4 The top-down spreadsheets will be used to sense-check and calibrate bottom-up model outcomes; and

1.3.1.5 Asymmetric costs will not be modelled.

1.4 Bottom-up information collection process

1.4.1 Stakeholders were invited to submit information on BU models by 15 November 2023, in order to provide calibration information for the BU models.

1.4.2 There were one-on-one stakeholder meetings to discuss top-down information with:

1.4.2.1 MTN on 22 November 2023,

1.4.2.2 Cell C on 24 November 2023, and

1.4.2.3 Vodacom on 24 November 2023.

1.4.3 Operators also provided comments on the BU model during the course of this process.

1.4.4 After the publication of revised versions of the bottom up models, stakeholders on the 12th of December, stakeholders were invited to provide further comments on the 15th of January.

1.5 Recommendations

1.5.1 The modelled costs are as follows:

	2024	2025	2026	2027
Fixed termination costs	0.00594	0.00610	0.00627	0.00644
Mobile termination costs	0.0386	0.0390	0.0395	0.0403

1.5.2 The costs thus suggest approximately 0.6 cents per minute for termination of fixed calls, and between 3.9 and 4 cents per minute for mobile calls. These results are broadly in line with international experience, and with implicit rates per minute implied by on-net call charges in South Africa:

1.5.2.1 For instance, mobile termination rates in the European Union are set at approximately 4 cents, and fixed termination rates are set at 1.5 cents.

1.5.2.2 Large MNOs in South Africa charge implicit prices per leg of an on-net call of between R0.0415 and R0.055 per minute.[3]

1.5.3 In general, termination rates are rounded to the nearest reasonable fraction of a cent. In the present case, this suggests setting an MTR at 4 cents, and an FTR at 1 cent. This will permit smaller operators in South Africa the ability to offer retail prices per minute for off-net calls that are not loss-making.

1.5.4 In respect of a glide path, current mobile termination rates are R0.09 for large operators, and R0.13 for small operators, while fixed termination rates are R0.06 per minute. A reasonable glide path towards symmetry over 12 months, taking into account a limited reduction in the first year and also comments by stakeholders that competition will be improved through lower termination rates in the absence of asymmetry, is as follows:

	Current	**FY 2024 / 2025**	**FY 2025 / 2026**
Mobile large	9	7	4
Mobile small	13	9	4
Fixed	6	4	1

1.6 Structure of this document

1.6.1 The purpose of this document is to provide a report on the BU models.

[3] See Methodology Briefing Note Paragraph 6.7.6.

1.6.2 The remainder of this report is structured as follows. In section 2, economic depreciation and WACC are discussed. The mobile bottom-up model is explained in Section 3, and in Section 4 the top-down mobile model is explained. The fixed bottom-up and top-down models are explained in Section 5.

2 Economic depreciation and WACC

2.1 Economic depreciation

2.1.1 As explained above, the Authority decided to follow the economic depreciation approach, rather than the tilted annuity method used in 2018, for the reasons explained in the Methodology Briefing Note. Applying economic depreciation results in outcomes we would observe in a competitive market. This involves applying modern equivalent asset values and considering the lifetime of a business rather than a narrow timeframe. This is the approach suggested by the GSMA[4], for example (noting that there are informational difficulties that may argue for the use of a simpler approach), and applied by regulators such as Comreg[5] and Ofcom[6].

2.1.2 The approach applied in the current version of the model departs from previous models in that there is no terminal volume to the production volume when calculating the asset unit cost (and thus no uplift to accommodate this), and the model also considers a business life of 20 years, rather than 50 years, for example. While the present model is shorter in duration, it is important to take into account the much higher cost of capital in South Africa, linked in part to greater uncertainty here, which means that volumes and costs far into the future, after being discounted to the present day, are lower here than in developed countries.

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[4] See: https://www.gsma.com/mobilefordevelopment/resources/the-setting-of-mobile-termination-rates-best-practice-in-cost-modelling/

[5] See: https://www.comreg.ie/media/dlm_uploads/2019/05/ComReg-1948b.pdf

[6] See, for example, https://www.ofcom.org.uk/consultations-and-statements/category-2/2021-26-wholesale-voice-markets-review

2.1.3 Applying the economic depreciation approach, each asset is purchased in the year in which it is needed, applying a cost for the asset based on a specific price trend for it. All of the capital and operating expenditure associated is added in each year and discounted to the beginning of the period using the WACC.

2.1.4 The call termination volumes produced by each asset group are also discounted to the present day using the WACC. The unit costs for each asset group are then calculated by dividing the total discounted costs by the total discounted termination volumes to arrive at a unit price. The volumes and resulting unit costs are trended by the price index applicable to each cost element in order to more closely replicate outcomes in competitive markets.

2.1.5 A business period of 2018 – 2037 is considered, which balances the need to have realistic values of assets, costs and volumes, with the need to have a long enough life of business.

Stakeholder comments

2.1.6 A stakeholder commented that price trends ought not be incorporated in the calculation of economic depreciation, since volumes are increasing and prices trend downwards in telecommunications services. Furthermore, the stakeholder raised concerns that price increases would not be accounted for in the next MTR update. According to the stakeholder, previous models produced by Ofcom and for the Eurorate process did not take into account upward price trends. This concern is mitigated in the model by adjustments to the maximum capacities of radio equipment and 4G equipment costs, which have resulted in lower 4G termination rates, and thus lower blended termination rates over time as 4G traffic grows as a proportion of all traffic.

2.1.7 Another stakeholder had previously commented that in a competitive market, prices over time would reflect price trends, and this was indeed modelled by previous regulators.

2.1.8 Incorporating price trends more accurately reflects prices over time in a competitive market. There is little risk of under-recovery of the costs of termination, since even if rates were set at zero, this would have a negligible impact on operators. As explained in the Authority's Methodology Briefing Note applied in the present process, the termination rates are paid and received by operators, and the net revenues involved are negligible as a proportion of overall revenues. Previous regulators, including Ofcom in 2021, have indeed modelled price trends over time when computing economic depreciation. For all these reasons, the current model applies this approach.

2.2 Weighted average costs of capital

2.2.1 A weighted average cost of capital (WACC) for telecommunications networks in South Africa is needed in order to provide a return on assets including when applying the economic depreciation methodology, so as to identify the annualised costs of capital (sometimes referred to as CAPEX), as follows:[7]

$$CAPEX = (Gross\ value - cumulated\ depreciation) * WACC$$

The WACC, in turn, can be represented as follows:

$$WACC = \left[Ke \times \frac{E}{D+E}\right] + \left[Kd \times (1-t) \times \frac{D}{D+E}\right]$$

where:

Ke is the cost of equity, typically determined using the Capital Asset Pricing Method (CAPM) model, explained below

Kd is the cost of debt, which sometimes uses the firms' actual cost of debt, which includes a premium over the risk-free rate applied to debt (often government treasury bonds)

E is the proportion of equity in the firms' capital structure (or the market value of equity)

D is the proportion of debt in the firms' capital structure (or the market value of debt)

t is the rate of tax

2.2.2 The CAPM model, in turn, defined as follows:

$$\mathrm{Ke} = \mathrm{rf} + \beta \times (\mathrm{Em} - \mathrm{rf})$$

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[7] See, in this regard, the International Telecommunications Union (ITU), 2009, Regulatory Accounting Guide, available at: https://www.itu.int/ITU-D/finance/Studies/Regulatory_accounting_guide-final1.1.pdf

where:

rf is the risk-free rate applied to debt (often government treasury bonds)

β is the risk of the company relative to the market (the levered beta)

$Em - rf$ is the market risk premium (the premium over risk-free returns

2.2.3 The pre-tax nominal WACC per annum is based on data contained in stakeholder submissions. The WACC formula has been corrected to use the levered beta rather than the unlevered beta. Furthermore, a risk-free rate for South Africa has been used, which will to some degree capture the impact of power cuts and the risks inherent in the broader economy.

2.2.4 The WACC applied in the model is 21.18% in 2023.

Table 1: WACC assumptions

Major inputs	**Assumptions**	**Source**
% debt that is capital	27.5%	Stakeholder submissions
Asset beta (unlevered beta)	0.81-1.19	Stakeholder submissions
Equity beta (levered beta)	1.02-1.51	Stakeholder submissions
Debt premium	1.3%-2%	Stakeholder submissions
Equity risk premium	5%-5.8%	Stakeholder submissions
Company tax rate	2018-2021: 28% 2022-2037: 27%	Orbitax
Risk-free rate (10-year government bond)	2018-2022: 8.3% - 10.2% 2023-2037: 10.3%	World Government Bonds

3 Bottom up mobile network

3.1 Overall approach

3.1.1 There are several costing approaches to BU-LRIC models:

3.1.1.1 Scorched earth: a model is built from the ground up (i.e. no existing network topologies are taken into account);

3.1.1.2 Scorched node: existing network topologies are used, and network elements not related to voice traffic are removed;

3.1.1.3 Modified scorched node: an efficient network is constructed, based on existing network topologies.

3.1.2 The modified scorched node approach, which takes into account existing networks and allows for efficiencies to be introduced in the network model, is often applied in practice. The main idea in respect of developing the BU-LRIC model for termination is to use network traffic demand to dimension a reasonable, representative network for South Africa, typically based on the number of operators.

<u>Market shares and asymmetry</u>

3.1.3 Stakeholders commented that the hypothetical operator modelled needs to have a reasonable market share and network coverage, as well as reasonable network assignments. While there were five mobile network operators in South Africa in 2018, there are even more licensees that have access to IMT spectrum. At the same time, there is extensive network sharing in South Africa. Taking these comments into account, the model considers as the default an operator market share of 33%. While five mobile operators were modelled for radio frequency spectrum caps for instance in ICASA's recent spectrum auction, for present purposes for establishing the pure LRIC of mobile call termination, it is more appropriate to model a hypothetical operator that has a market share of 33%, taking into account:

3.1.3.1 The fact that only two mobile operators have close to full-coverage networks.

3.1.3.2 Remaining MNOs have varying levels of network coverage and typically rely to a substantial extent on network sharing.

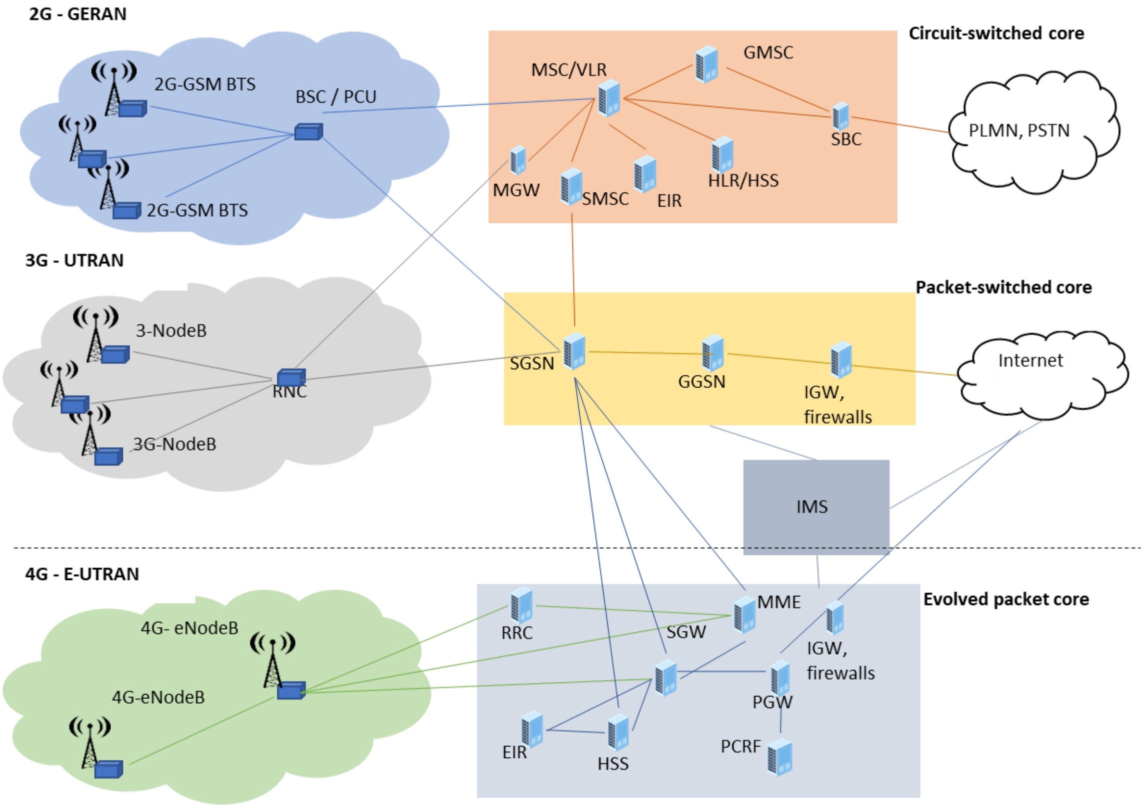
3.1.4 Stakeholders raised concerns about the number of mobile network operator scenarios in version 4 of the model, and in particular why market shares below 33% would be modelled since the Authority has decided not to model asymmetries in costs, as explained in Paragraph 1.3.1.5 above. However, market shares have been a flexible input into the model since the beginning of the process, and this is because it aids in assessing its overall reasonableness and responsiveness. Indeed, stakeholders have used this input in order to test its veracity. In version 5 of the model, the smaller market share scenarios have been removed in order to simplify it and to make it clear that the model is not intended to model asymmetry.

3.1.5 Stakeholders raised concerns that the levels of coverage appear to be high. The levels of coverage have now been adjusted to broadly reflect the levels of coverage reported by licensees in public disclosures. While licensees have different levels of coverage, the hypothetical operator modelled is considered to be competitive and efficient, and is thus modelled to have the highest levels of coverage in South Africa reported by licensees.

Network topology

3.1.6 A generic network topology is considered for the model, as shown on Figure 1 (see list of acronyms in Appendix A).

Figure 1: Network topology

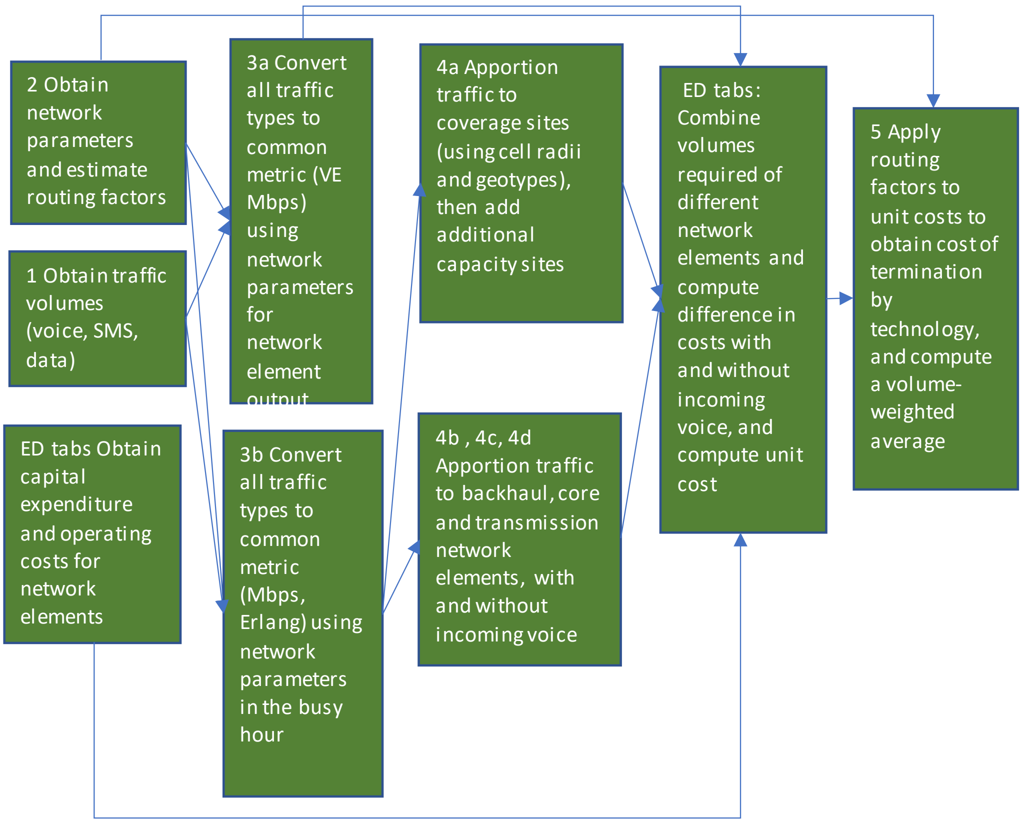


Sources: Acacia analysis adapted from: https://telecominfraproject.com/naas-playbook-post-launch/ and Haryadi, S. (2018). The Concept of Telecommunication Network Performance and Quality of Service., available at: https://osf.io/mukqb/

3.1.7 There is a balance to be struck between (i) developing a model for South Africa that is sufficiently granular to reasonably estimate the LRIC of termination costs, and (ii) developing a model that is so information intensive as to unduly burden licensees that have to provide that information. This is explained in the Authority's Methodology Briefing Note. Models including the ICASA 2018 model, the model used in Kenya by the Communications Authority of Kenya, the Eurorate model developed for the European Union, and the Ofcom model developed for the United Kingdom, were considered in order to arrive at a balanced approach.

3.1.8 In the following sections, the details of the model are explained, for each of the tabs in the model. The overall plan for the model is shown below in Figure 2.

Figure 2: BU Plan



Approach to benchmarking inputs

3.1.9 Stakeholders provided a range of often divergent information on network design parameters and unit costs. This information was compared with information used in previous models, and best estimates of parameters and costs applied by a hypothetical efficient operator were used in the model.

Possible model limitations

3.1.10 A stakeholder raised a concern that an over-estimated MTR is not benign since this harms competition, as explained in the Authority' Methodology Briefing Note, and the model should sufficiently ensure that it is not under-estimated nor over-estimated.

3.1.11 Another stakeholder commented that the proposes that the model does not overestimate MTRs, in two respects:

3.1.12 **Terminal volumes and investments:** A stakeholder commented that the production volume and asset terminal value beyond 2037 may not impact on the termination rate substantially. Similarly, the terminal date of the model does not result in substantially different termination rates. In these respects, the termination rate is not biased either upwards or downwards.

3.1.13 **Technology mix beyond 2030:** A stakeholder commented that it is not clear that fixing the technology mix beyond 2030, the approach used in previous models in the UK and EU, will result in an overestimated termination rate, since:

3.1.13.1 Data volumes might grow substantially, which may mean that a greater proportion of the network overall will vary with traffic,

3.1.13.2 If 5G is deployed extensively and the bulk of data traffic were handed over to 5G, then voice traffic might account for a greater proportion of network traffic on 2G, 3G and 4G network elements.

3.1.14 It is important to note that there are two reasons to consider that the model may overestimate pure LRIC:

3.1.14.1 Backhaul networks in South Africa in dense urban and urban areas are almost certainly built by mobile operators for additional services, including fibre to the premises. The likelihood of backhaul links being disconnected in at least these areas is thus likely overstated in the model, as explained in paragraph 3.8.3 below.

3.1.14.2 The model does not take into account 5G, as explained above in Paragraph 3.2.6. It is likely that the coverage network for 5G, built for data services, would be denser and thus more extensive than that for 2G-4G. The number of sites avoided as a result of eliminating inbound calls may therefore be lower than estimated in the model.

3.1.15 Where relevant, and to mitigate the risk of over-estimated termination rates raised above, the model takes into account benchmarked cost inputs and parameters where information provided by stakeholders suggests that their costs of terminating inbound calls are significantly higher than an efficient hypothetical operator in a competitive market would incur.

3.1.16 This approach is a balanced approach, resulting in a model that neither over or under-estimates the costs of call termination. It is important to note that the risks of over and under-estimation are not equal. As explained in the Methodology Briefing Note, a high termination rate harms competition, because this prevents smaller operators from competing with on-net discounts implemented by large operators. At the same time, a low termination rate carries few risks, since (i) these have a negligible impact on net revenues, (ii) substantially lower termination rates in South Africa have not led to lower investment and clearly improved outcomes for consumers, and (iii) a number of countries have set MTRs at zero. It is thus important to ensure that termination rates do not have an upward bias.

3.2 Summary tab

3.2.1 The summary tab shows the estimated LRIC termination cost per minute from the BU model for 2018-2037. It enables users to see how LRIC termination costs change by changing key assumptions.

Spectrum

3.2.2 In relation to spectrum assignments, the model reflects changing spectrum assignments over time due to the Authority's spectrum auction in 2022 (made available in the model in 2023 due to delays with digital migration etc.), the upcoming auction to be held in 2024, and reduced total spectrum availability to account for 5G use, which falls outside of the model. In order to calculate available spectrum:

3.2.2.1 First, total available spectrum in each band for each period has been calculated. This has been conservatively estimated, excluding additional TDD assignments in the 1800MHz and 2100MHz bands throughout the period.

3.2.2.2 Second, total available spectrum in each band is multiplied by the market share, and then rounded down according to the maximum carrier bandwidth for each band.

3.2.2.3 There are some adjustments depending on the scenario, following stakeholder proposals:

3.2.2.3.1 Carrier bandwidth size for LTE in the 900MHz band is 2x3MHz.

3.2.2.3.2 Carrier bandwidth size for 3G in the 900MHz is 2x3.8MHz, to make more efficient use of spectrum given the assumed volumes.

3.2.2.3.3 2x70MHz is assumed available in the 900MHz band from 2018.

3.2.2.4 Spectrum is then apportioned to technologies in tab 2a, following stakeholder submissions. The latter assumptions are reasonable given the conservative overall estimate of available total spectrum explained above. An overall check is provided in the summary tab to ensure that the total spectrum applied in the model does not exceed actual total spectrum, subject to the comments above.

3.2.3 A stakeholder commented that sub-1GHz spectrum holders had only 76MHz of spectrum before the auction in 2022, and that there is a spectrum cap of 187MHz per operator overall, and 2x21MHz in sub-1GHz bands, currently. However, in South Africa, the effect of multiple-operator core network (MOCN) and roaming arrangements mean that large operators, MTN and Vodacom, installing and rolling out networks for smaller rivals (Cell C, Liquid Telecom, and Rain) using the latter's radio frequency spectrum assignments to do so, mean that effective access to spectrum far exceeds the spectrum caps applicable to spectrum assignments to MTN and Vodacom. It would be unreasonable to consider only the 76MHz or 187MHz available to the latter entities when modelling the hypothetical efficient operator for the purposes of modelling the costs of call termination.

3.2.4 A stakeholder commented that TDD spectrum cannot be used for voice services in South Africa. However, this runs counter to industry experience, no other stakeholder suggested this, and the models produced by other regulators do not apply this assumption. This assumption has thus not been used in the model.

Coverage

3.2.5 Coverage levels assumed in the model reflect levels of coverage available across networks in South Africa. While some stakeholders commented that coverage levels appear to be high, it must be recalled that coverage levels are intended to reflect

Impact of 5G

3.2.6 It seems highly likely that the rollout of 5G will take place in higher frequency spectrum bands, requiring substantial site densification,[8] and thus fewer sites that are sensitive to inbound call volumes. However, a stakeholder commented that since 5G is outside of the scope of the current modelling process, it would be difficult to consider how 5G might impact on MTRs. The model therefore does not make any adjustments for the rollout of 5G.

Model behaviour as scale changes

3.2.7 The model results in lower inbound call costs per unit as scale increases. A stakeholder commented that in their experience, pure LRIC models give rise to lower rates for smaller operators, since a greater proportion

[8] See ICASA, 2021, '5G ANNUAL REPORT - 2021', available at: https://www.icasa.org.za/uploads/files/ICASA-2021-5G-Annual-Report.pdf

of volumes are served by coverage networks. In the model, the market share of the licensee is linked not only to volumes, but also to spectrum and coverage levels, with larger market shares associated with higher levels of coverage and spectrum. The greater the spectrum

3.3 Tab 1 Volumes

3.3.1 The "1 Volumes" tab captures volume data for 2018-2037 for three different growth scenarios. The volume data used was largely extracted from the ICASA 2018 model. Although MMS traffic was included in the 2018 model, it has been excluded from the current model as it is not a widely used service in South Africa.

3.3.1.1 Geotype technology splits for 2017-2022 have been adjusted based on stakeholder submissions, the ICASA 2018 model, and overall subscriber technology splits. Since only one stakeholder provided detailed information on this, and given that another stakeholder requested that the 2018 model data ought to be used, a reasonable proportion of the latter stakeholder's information was used in combination with subscriber technology splits and ICASA 2018 data.

3.3.2 While a stakeholder commented that its own data ought to be used for the model, a more balanced approach is to use this information in combination with other information, including the ICASA 2018 model, to arrive at a reasonable approach to modelling. Note that subscriber growth and technology split for the 2031-2037 period have been made static to match 2030's values, which means that the volumes do not adjust for changes in technology beyond 2030. This assumption is based on stakeholder comments that previous models, including the Ofcom 2021 model, applies static volumes beyond a reasonable forecast period. This means that the volumes of 2G voice services, including 2G voice, are almost certainly overstated in later years, which mitigates any possible understatement in earlier years.

3.4 Tab 2a Network parameters

3.4.1 This tab shows general parameters, network parameters (GSM, UMTS, LTE), core network dimensioning parameters, and conversion factors (units in the busy hour converted to megabits per second).

Non-homogeneity factor

3.4.2 Two stakeholders submitted that there are differences in traffic load between different sites in a single geography, and between sectors on sites, and that the previous version of the model does not satisfactorily model non-homogeneity. There is a debate as to how to model such a non-homogeneity factor. One stakeholder suggested:

3.4.2.1 Modelling a single-sector site, and apply the proportion of the busiest sector average traffic to busy hour traffic, and

3.4.2.2 Increasing the resulting single sector busy hour traffic by the average proportion by which busy sites carry additional traffic.

3.4.3 However, carrying out this approach results in a very high number of sites overall, that bears no relationship to even the largest networks in South Africa. Ultimately, the number of network elements built in the model should be broadly reflective of actual networks with comparable market shares in South Africa.

3.4.4 This approach to non-homogeneity has thus been changed to the approach in Ofcom 2021, which reduced sector capacity by half a carrier per sector for macrocells for 2G and 3G networks. The percentage of total carriers post 2012/13 in that model was then applied in the present model. The Eurorate model does not appear to have applied a non-homogeneity factor.

Maximum utilisation

3.4.5 A stakeholder commented that network capacity in the model should reflect efficiency differences when comparing 2G, 3G and 4G networks. Sector capacity from 4G networks ought to be substantially higher than 3G and 2G networks. This should in turn flow through to termination costs for 2G, 3G and 4G services, with 4G termination costs reflecting the lowest costs. The stakeholder further commented that the Eurorate model had been prepared to be robust to networks across very diverse European Union countries, from densely populated Belgium and the Netherlands to sparsely populated Finland and Norway.

3.4.6 The maximum utilisation factors have thus been adjusted to reflect the maximum utilisation factors used in the Eurorate model. This has two effects:

3.4.6.1 It reproduces the outcomes mentioned above, in that the differences between 2G, 3G and 4G sector capacity are significant,

3.4.6.2 The termination costs reflect the differences in efficiency for 2G, 3G, and 4G services.

3.4.7 While a stakeholder suggested changing the routing factors to reflect the apportionment of shared costs to individual technologies, the above approach mitigates the concern raised by the stakeholder, which is to ensure that the relative efficiencies of the different technologies are correctly reflected in the model.

Site sharing

3.4.7.1 Site sharing data provided by one stakeholder reflected a very high proportion of non-shared sites, which contradicted information on the extend of site sharing in South Africa particularly given the recent sales of towers to tower companies. While the proportion of sites that are shared have been updated in the model, the hypothetical efficient operator would choose between the least cost option of renting versus owning sites, and the site rental option is thus the default scenario in the model. The site-ownership scenario (setting sites rented to 'No') should be used with caution, and likely results in an over-estimate of the cost of pure LRIC call termination services.

Core network elements

3.4.7.2 The assumed asset lives of core network items are based on the ICASA 2018 model and in the case of the SBC and IMS (call server hardware), for which there are no parameters in the ICASA 2018 model, the Ofcom 2021 model's assumptions have been used.

3.4.7.3 One stakeholder commented that the asset lives of core network items have been overstated and that ICASA ought to use shorter asset lives, which is more consistent with the EC's 2019 model and its asset register. Furthermore, as more core elements are moving towards cloud-based solutions, a greater proportion of the network elements are software elements which has a shorter asset life of around 6 years. Using the ICASA 2018 for most core network items puts ICASA's 2023 numbers at between the asset life assumptions of Axon 2019 and Ofcom 2021, and thus provide reasonable assumptions for a reasonably efficient operator.

3.5 Tab 2b Routing factors

3.5.1 This process involves several steps:

3.5.1.1 First, a set of basic services is selected, including incoming voice, based on previous models. The ICASA 2018 model further broke down services by geotype in the routing factors but this is not necessary for the computation of pure LRIC (traffic by geotype and site type is taken into account when calculating network demand).

3.5.1.2 Second, a basic routing factor for each service type is implemented through each cost element.

3.5.1.3 Third, final routing factors are computed, transforming all types of traffic into voice-equivalent megabits per second.

3.6 Tab 3 Volumes for network demand (3a) and output (3b) – Mbps, Erlang

3.6.1 Here, the routing factors from tab 2b are applied to the traffic volumes from tab 1 to compute volumes in the busy hour used for asset demand (tab 3a) and asset component output for each asset group (tab 3b).

3.6.2 A stakeholder commented that tab 3b could be deleted since (i) the increment is all incoming voice, not incoming voice split by technology, and (ii) there is an element of 'cost allocation' between technologies. However, a standard approach to computing pure LRIC termination rates, such as that applied by Ofcom in 2021, computes output per network element group, some of which are only applicable to specific technologies (2G, 3G, and 4G). In the absence of computing pure LRIC per cost element in the ED tabs using output volumes from 3b, it would not be possible to use individual cost trends for individual cost elements, and thus outcomes in competitive markets would not be as accurately reflected in the model. It is thus reasonable to compute pure LRIC termination rates for each cost element, and then compute a blended rate. Nonetheless, a single pure LRIC termination rate has also been computed in the calibration tab on LRIC revenues, costs, for comparison purposes.

3.7 Tab 4a Network– sites, RAN

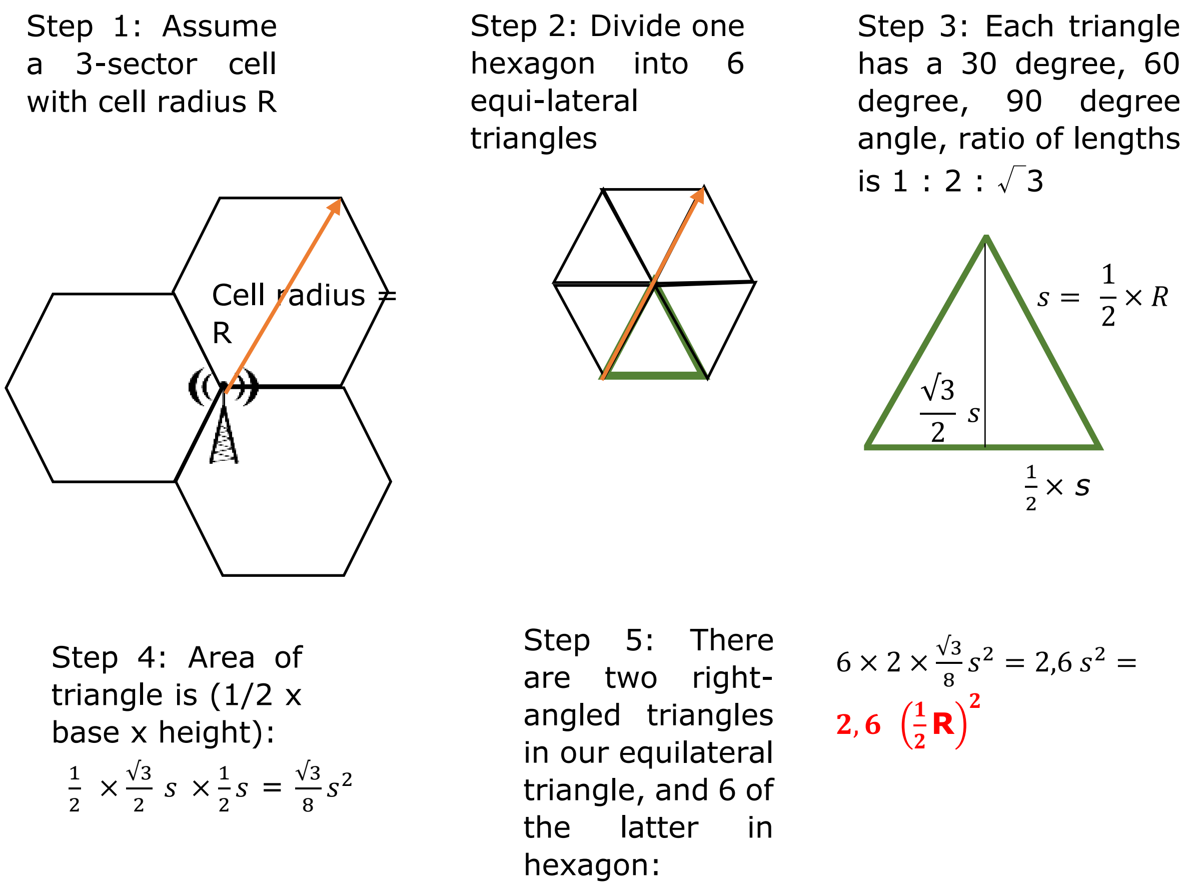
3.7.1 In this tab, the network elements needed for the various services are apportioned into different geographic areas (dense urban, urban, towns and semi-dense, rural).

<u>Coverage network</u>

3.7.2 The model begins with site coverage radii and the geography of South Africa. First, a coverage network is built to a specified population coverage, and this coverage network provides for a basic layer of radio access network capacity using coverage spectrum. Next, traffic demand is used to assess the total capacity requirements, and first apportion traffic demand to coverage spectrum on coverage sites. Once the latter has absorbed capacity, then overlays to coverage sites absorb additional demand, and additional sites are added, until all demand is absorbed.

3.7.3 The network is dimensioned based on cell radii and a standard model of cell coverage, assuming a mobile site that has three sectors. In order to calculate site coverage, a hexagon shape for a cell sector is assumed, and this is divided into 6 triangles (described on Figure 3). There are 3 sectors per site with a hexagon factor of 2.6. The hexagon's coverage is then 2.6 * (1/2 X radius)^2.

Figure 3: Cell coverage area



3.7.4 A coverage network is then constructed reaching, for example, 99% of the population in South Africa using low frequency spectrum, e.g. the 900MHz band for 2G and 3G and the 800MHz band for 4G. This approach to coverage sites follows the approach set out by the European Commission in 2009, as follows:[9]

"Coverage can be best described as the capability or option to make a single call from any point in the network at a point in time, and capacity represents the additional network costs which are necessary to carry increasing levels of traffic. The need to provide such coverage to subscribers will cause non-traffic-related costs to be incurred which should not be attributed to the wholesale call termination increment."

3.7.5 Coverage networks are required for 2G, 3G and 4G services, which will cause non-traffic-related costs to be incurred, and which are not

[9] See: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009H0396

attributed to the wholesale call termination increment. This is because coverage networks would be required for all three technologies to offer mobile services, including voice, SMS and data, regardless of whether inbound calls were available or not.

3.7.6 The properties of the coverage network provide for standard network dimensions to achieve a basic level of network coverage, and not merely an abstract bare minimum set of infrastructure needed to produce one 2G voice call. The purpose of analysing the coverage network in a pure LRIC cost model is to identify costs that would be incurred whether inbound calls are offered or not, i.e. costs that would not be avoided if call termination was not offered. MNOs build extensive network infrastructure for coverage purposes that would be available regardless of whether inbound calls are offered or not. This is a standard approach to modelling pure LRIC.

3.7.7 One stakeholder commented that the coverage network should provide for only 1 2G transceiver per site for coverage purposes. However, the previous models reviewed to prepare the current model, including the ICASA 2018 model, the Eurorate model and the Ofcom model, modelled standard coverage networks for 2G, 3G and 4G networks using standard network parameters. The same approach is thus followed here.

3.7.8 A stakeholder commented that the cell radii from the ICASA 2018 model implied greater coverage than what is shown in the current model, and so the coverage area should be increased. Another stakeholder suggested that the cell radii used in the ICASA 2018 model had no bearing on pure LRIC termination rates since the model was a LRAIC model. However, the cell radii in the ICASA 2018 model are in fact greater than or equal to cell radii in the Eurorate model, for example, and so if anything overstate levels of coverage from coverage sites. Furthermore, the ICASA 2018 model had an estimate of Pure-LRIC embedded in it.

3.7.9 Stakeholders also provided cell radii far in excess of the ICASA 2018 model. However, the number of sites to build a coverage network applying these assumptions is so small as to be implausible. The radii used in the ICASA 2018 model applied using the formula explained above for coverage, which reduces the area covered in the current model, are a reasonable approximation in the context of previous pure LRIC models.

Geotypes

3.7.10 In order to construct the coverage network, a dataset from Statistics South Africa was used. This contains Census 2011 data on populations and geographic areas in the 21 588 sub-places[10] within South Africa sorted by population density, and add up the geographic area, by geotype.

3.7.11 Stakeholders suggested considering the Authority's previous 2018 geotypes. In addition, the World Bank definition of three degrees of urbanisation were also considered:[11]

"1. Cities, which have a population of at least 50,000 inhabitants in contiguous dense grid cells (>1,500 inhabitants per km^2);

2. Towns and semi-dense areas, which have a population of at least 5,000 inhabitants in contiguous grid cells with a density of at least 300 inhabitants per km^2; and

*3. Rural areas, which consist mostly of low-density grid cells.") until 99% of the population is covered (**Error! Reference source not found.**)."*

3.7.12 In South Africa, a substantial proportion of the population lives in cities, using the above definition. Given the fact that stakeholders typically consider additional geotypes for metropolitan areas and cities, and given that the Authority modelled 4 geotypes in 2018, a fourth category has been added to the above, that for dense urban areas. However, a definition of dense urban above 2 400-6 500 people per km^2, the approach in the 2018 process, does not correspond to the World Bank definition for towns and semi-dense areas, the delineation for which is 1,500 inhabitants per km^2). Furthermore, splitting urban and dense

[10] One sub-place (Kwareyathlose SP) was removed as it did not have an area figure.

[11] See: https://blogs.worldbank.org/sustainablecities/how-do-we-define-cities-towns-and-rural-areas

urban using the latter demarcation results in a comparable split in the population. As a result, the definition of urban changes from 2 400-6 500 people per km^2 in the 2018 model to 1 500-6 499 people per km^2. Towns and semi dense areas and rural follow the World Bank's definition above, with the former category being less dense (300-1 499 people per km^2) than in the previous model (330-2 400 people per km^2).

3.7.13 The population density (not the minimum populations) are applied to sub-places in South Africa when computing data for the geotypes. Census 2011 population data from Statssa data and updated data from DataFirst at the University of Cape Town[12] were overlaid in R, with square kilometres calculated in R and the population densities calculated within the excel cost model.

3.7.14 The area and population figures for the four geotypes were built from South Africa's sub-place areas to provide better granularity of the network modelling of the geotypes, as requested by stakeholders. The final sub-place data set used in the bottom-up mobile cost model analysis was constructed by processing three separate data sets. The first is the "enumeration-area-type" data set from DataFirst, which contains population figures by enumeration area, which was used to create the small area layer and district level population figures for 2011. The second data set, "District projections by sex and age", from Statssa contained population figures for 2020 by district, which together with the first data set, was overlayed onto the map boundary data set, also from Statssa, to calculate the small area layer populations for 2020 (See

3.7.15

3.7.16 Equation **1**).

3.7.17 This was used to calculate the 2020 sub-place area populations which was then used to categorise the data into the four geotypes. The final data set was transferred to the cost model where sub-places were arranged from most to least dense areas before calculating the area (square kms) and population figures for the four geotypes (see **Error!**

[12] See: https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/517/get_microdata

Reference source not found.). The same process was followed when constructing 3G and 4G population coverage.

Equation 1: Estimating the 2020 small area layer population[13]

$$SAL\ 2020\ pop = \frac{SAL\ 2011\ pop\ \times DC\ 2020\ pop}{DC\ 2011\ pop}$$

3.7.18 Based on assumptions about cell radii for each type of site (GSM, UMTS and LTE) in each of the four different geotypes, the site coverage in square kilometres can be estimated. The total kilometres per area divided by the site coverage provides an estimate of the sites needed for coverage across the country.

RAN dimensioning

3.7.19 Network demand is then computed based on converted volumes per geography.

3.7.19.1 First, this involves calculating how much network capacity is available from the coverage network since these costs are excluded in the voice and SMS termination rate calculation.

3.7.19.2 Total network demand for the baseline and no incoming voice is then calculated.

3.7.19.3 Overprovisioning factors for maximum capacity, soft handover, and the like, are accounted for, following the approach in the Eurorate model. As a result, there is a consolidated carrier and cell utilisation factor, which results in higher capacities than those reflect by stakeholder submissions, which resulted in implausible ratios of costs between 2G, 3G and 4G, as explained above in Paragraphs 3.4.5-3.4.6.

3.7.19.4 Additional volumes are absorbed by applying capacity spectrum to coverage sites.

[13] SAL 2020 pop, SAL 2011 pop, DC 2011 pop and DS 2020 pop refers to the estimated 2020 small area layer population, 2011 small area layer population, 2011 district populations and the 2020 district population, respectively.

3.7.19.5 Next, the model determines the active capacity sites required in addition to coverage sites to meet the quantity demanded in terms of capacity spectrum under both scenarios. Note that these are required capacity sites.

3.7.20 No capacity sites, once included in the network, are later removed when demand declines (such as for 3G data etc), since industry practice is only to remove equipment and sites once fully depreciated.

3.7.21 Six passive site types are considered: Shared towers, exclusive towers, rooftops, lampposts, in-building solutions, and microsites, which is the same number of site types used in the Authority's 2018 model.

3.7.22 Three active site types are implemented in the model, the same as those ultimately used in the Authority's 2018 model: Macrocells, microcells, and in-building solutions.

Number of transceivers and carriers

3.7.23 The number of transceivers/carriers demanded has been calculated by first calculating total demand per sector by technology, and then adjusting for maximum transceiver/carrier utilisation. Average demand is then multiplied by the number of sectors to compute the number of transceivers and carriers.

Number of spectrum bands activated per site

3.7.24 The number of cells activated in each spectrum band is computed as the maximum number of 2G, 3G and 4G cells used for coverage and capacity respectively for each spectrum band. This reflects spectrum band activation per site rather than per cell, in line with cost information provided by a stakeholder.

3.7.25 A stakeholder commented that when computing the number of spectrum bands activated on a site per band, the number of bands should be added across technologies. However, unit costs have been provided on bands activated per site and not per technology for the spectrum bands calculations, and so the maximum rather than the sum has been used.

Economic life of assets

3.7.26 Active equipment on passive sites depreciate over 8 years, while passive sites depreciate over 17 years.

3.8 Tab 4b Network – backhaul

3.8.1 The approach to calculating backhaul links is as follows:

3.8.1.1 First, average demand per site by technology (2G, 3G and 4G) is calculated.

3.8.1.2 Second, the number of single-technology and shared-technology sites is computed.

3.8.1.3 Third, average demand for per site is calculated, for each geotype and site type.

3.8.1.4 Next, the number of 2mbps links is calculated per site type and geotype, for shared and single-technology sites, based on whether it would in fact be more economical to upgrade to one 30mbps link rather than multiple 2mbps links.

3.8.1.5 The average demand for 30mbps backhaul links, 100mbps backhaul links and 500mbps backhaul links is then calculated following a similar process.

3.8.1.6 Finally, average demand per site is multiplied by the number of sites for each geotype and site type for shared sites and single technology sites, and then aggregated.

3.8.2 Not all technologies are available at each site. This is accommodated by first computing backhaul links for single-technology sites, and then shared-technology sites.

3.8.3 Stakeholders provided submissions that showed substantial own-build and dark-fibre rentals, particularly in dense urban and urban areas, but at the same time provided leased line pricing for 30mbps, 100mbps, and 500mbps links that make own-build uneconomical purely for the purposes of backhaul. Stakeholders are thus likely using their self-build networks for other purposes, such as fibre to the premises, in addition to backhaul. While a stakeholder suggested that the hypothetical efficient operator should not be assumed to operate fixed and mobile networks, at least three large MNOs in South Africa offer extensive fibre to the premises (FTTP) and mobile offerings, and so in fact the hypothetical efficient operator in South Africa would indeed offer FTTP and MNO services. This means that the backhaul costs avoided in the absence of incoming calls are likely overstated. The lowest cost backhaul alternative was used in the model.

3.8.4 Stakeholders commented that further detailed modelling of backhaul links be undertaken, to separate out the effects of modelling coverage and capacity sites, and also so that the calculation of backhaul links avoided in the absence of inbound calls are not distributed nationally but on a more granular basis. However, providing detailed site by site modelling for backhaul links is reasonable, for the following reasons:

3.8.4.1 The total number of backhaul links meets or exceeds the number of sites, which follows stakeholder suggestions on this.

3.8.4.2 The purpose of the model is to estimate the avoided costs of inbound calls, which the model achieves in respect of backhaul costs. If anything, the costs of backhaul may be over-estimated for the reasons explained in Paragraph 3.1.14.1.

3.8.5 A further comment was that a non-homogeneity factor should be added for backhaul, the maximum utilisation factor should be increased, links should follow the number of actual sites, not demand for sites, and an additional factor for microwave hops ought to be added. However:

3.8.5.1 The maximum utilisation factor for backhaul links ought to adequately accommodate non-homogeneity and additional hops for microwave backhaul, particularly given that if anything, backhaul costs are likely over estimated as explained above. There is therefore little justification to reduce the maximum utilisation factor.

3.8.5.2 It is likely that, as demand falls, fewer links would be required at sites, even those that are decommissioned, particularly for those sites that are connected to leased lines, which can typically be upgraded or downgraded. To the extent that there is little flexibility in respect of upgrades or downgrades that follow demand, due to for instance self-built dark fibre, it is likely that inbound calls would be less likely to affect costs. Again, then, if anything the model over-estimates the costs of backhaul where inbound calls are concerned.

3.9 Tab 4c Network – BSC, RNC, links

3.9.1 This tab calculates the number of 2G (BSC) and 3G (RNC) controllers. This has been done based on the assumptions and approach of the ICASA 2018 model. Both BSCs and RNCs vary by scenario. The number of BSCs and RNCs is computed based on cells rather than sites, counting 2 cells for instance where 2 spectrum bands were activated for 2G.

3.9.2 The model also estimates the number of backhaul links and transmission links, using the assumptions and approach of the ICASA 2018 model where possible, save for some differences. The transmission leased lines are assumed to be 218 kilometres long on average and do not vary by the number of sites. This number is from the ICASA 2018 model and relates to a large operator. Both the 500Mbps and the 10Gbps leased lines vary by scenario.

3.10 Tab 4d Network – core, transmission

3.10.1 This tab contains the number of core network elements to be used as inputs in the capital and operating cost calculations of the model for the baseline and no incoming voice scenarios. The assumptions and broad approach of the ICASA 2018 model have been used. The number of units to buy are calculated for each year, taking into account that replicated units will have to be replaced. Of the core network equipment, only the SBC, MGW, MSCS, Wholesale Billing System, and IMS Call Server Hardware vary by scenario.

3.10.2 In addition to these elements, the core network leased links and total length of leased lines have also been calculated. Again, the assumptions and approach are broadly in line with the ICASA 2018 model. However, the core transmission leased lines have been assumed to be 32 kilometres long on average and do not vary by the number of sites, unlike in the ICASA 2018 model. This number is from the ICASA 2018 model. The number of links and total length of leased lines do not vary by scenario.

3.11 Tab 5 Cost Results

3.11.1 A summary of the model results is presented here. Unit costs from the various economic depreciation tabs are drawn into a table, and routing factors applied, to compute the final termination rate. The present value of revenue recovery is compared to the present value of costs to ensure that revenues are recovered.

3.12 Economic depreciation tabs

3.12.1 The Authority's capex and opex unit costs were based on the operator with the lowest total unit costs, with some exceptions:

3.12.1.1 Estimates from the Eurorate model were used for SBC costs. SBC capex is assumed to be the equipment capex. The same price trends of other core network items have been used for both SBC equipment and annual opex.

3.12.1.2 The costs for 500Mbps leased transmission lines draws on data from more than one operator.

3.12.1.3 A stakeholder commented that their equipment cost for MGW is higher than suggested in the model. The basis upon which we have determined this cost is explained in para 3.12.1.2. While the equipment cost in the model is significantly lower than this operator's equipment unit cost, the installation and opex is considerably higher. Overall, the present value of the operator's total unit cost is just 3% higher than in the model.

3.12.1.4 A stakeholder commented that the costs for 4G macrocells ought to be only 1.7x the cost of 2G equipment, following the experience in the Eurorate model. Cost information provided by stakeholders was orders of magnitude greater than this, and industry experience suggests that the latter were substantially higher than costs observed in other networks. Furthermore, as explained above, 4G technology is expected to have greater efficiencies and thus ought to result in a lower cost minute of inbound calls. A factor of 1.7x was thus applied to the costs of 2G network infrastructure to estimate the costs of 4G network elements in the current model.

3.12.2 Stakeholder comments to the effect that their costs are higher, such as for macrocell-base and spectrum bands, may suggest their network is different in one or another way from (i) the modelled hypothetical operator, or (ii) from other networks in South Africa. Cost inputs were compared for the operators in order to model the efficient operator, and the lowest cost was used, save for the items explained above.

3.12.3 A stakeholder commented that the number of units of core network sites and network management systems used for inbound calls needs to be added to the ED tabs. However, these network elements are not affected by incoming traffic, and so there are no incremental network elements avoided when incoming calls are switched off.

3.13 Additional tabs, notes, and considerations

3.13.1 The model results in a variety of outcomes that can be calibrated using actual network equipment, operating and capital expenditure.

3.13.2 The model applies asset demand that has been smoothed over time considering the following factors:

3.13.2.1 Network assets are removed only after the asset has been fully depreciated;

3.13.2.2 Network assets are replaced according to network demand over time.

<u>Spectrum costs</u>

3.13.3 A stakeholder commented that reduction in the value of radio frequency spectrum avoided without inbound calls ought to be taken into account in the cost model. However, it would be unreasonable to include costs of avoided spectrum in South Africa, since:

3.13.3.1 There are substantial spectrum constraints as evidenced by the value yielded in ICASA's recent spectrum auction, and there are no examples of licensees surrendering IMT spectrum for any purpose, in at least the 700MHz-3.6GHz spectrum bands. Rather, the opposite. Licensees have avoided in-band migrations in the 900MHz to avoid giving up even 1MHz of spectrum, the deadline for which was 31 March 2020, and which had not been achieved by December 2022.[14] It is thus difficult to see how spectrum holdings would decline in the event there was no incoming voice.

3.13.3.2 Moreover, spectrum investments in the latter IMT bands are made to accommodate growing demand for data services, and have very little, if anything, to do with voice. The value of existing holdings of radio frequency spectrum and future acquisitions is thus unlikely to vary materially with and without inbound calls.

3.13.3.3 Furthermore, the value of net interconnection revenues to the mobile operators accounts for a very small (less than 0.5%) proportion of revenues for the mobile operators, as set out in the ICASA's decision on the methodology for setting termination rates. The link between the value of radio frequency spectrum and the absence of inbound calls is thus negligible.

3.13.4 It is thus highly unlikely that any spectrum costs in the above IMT bands would be avoided in the absence of inbound calls. The costs of annual IMT spectrum fees and spectrum purchased at auctions are thus excluded from the model. This was also the approach in ICASA's 2018 model when computing pure LRIC, which the 2018 model estimated by deducting joint and common costs from LRAIC costs when computing pure LRIC.

3.13.5 The costs of avoided microwave spectrum used for backhaul purposes is included in the model.

[14] See: Government Gazette 47788, 20 December 2022, available at: https://www.icasa.org.za/uploads/files/Radio-Frequency-Spectrum-Assignment-Plan-for-the-frequency-band-880-MHz-to-915-MHz-and-925-MHz-to-960-MHz.pdf

Macroeconomic tabs

3.13.6 A stakeholder commented that applying the mid-point of the SARB's target range of 3%-6% for inflation, of 4.5%, underestimates inflation. However, the SARB has a good reputation for fighting inflation in South Africa, and so the assumption of 4.5% is maintained in the model.

4 Calibration tabs

4.1.1 Calibration tabs are designed to provide network element unit counts, operating expenditure and capital expenditure.

4.1.2 The purpose of the top-down information gathering process was to calibrate the bottom-up models. A range of TD information has been provided, and used to compare with the outcomes of the BU model.

4.1.3 Asset counts by geotype and site type are provided, as is the present value of capex and opex.

4.1.4 A stakeholder also commented that a LRAIC model would assist the Authority to assess whether all costs have been taken into account in the modelling process. However, the model includes present values of mobile network investments which correspond to top down information provided by stakeholders, and so a separate LRAIC model is not needed.

4.1.5 Stakeholders commented that the network constructed in the model does not replicate their own network. But this is not the purpose of modelling a hypothetical efficient network for the purposes of estimating pure LRIC termination rates. The purpose of the model is to identify costs that a hypothetical efficient operator would avoid if there were no incoming calls, not replicate one or other of the licensee's networks.

5 Bottom up fixed line network

5.1.1 The bottom-up fixed line model broadly follows the same approach as the bottom-up mobile network, except that, for fixed voice termination, only core network elements are relevant from a dimensioning perspective, and the common unit is voice minutes. This is because access network elements in a modern fixed line network do not vary with call termination. A similar approach to volumes, WACC and economic depreciation described above in respect of capex and opex is also used for the fixed bottom-up network.

5.1.2 In respect of the individual tabs:

5.1.2.1 The 'Summary' tab shows the termination cost results, and permits users to select the market share for the hypothetical operator. Since stakeholders did not comment on currency and volume growth scenarios, these scen

5.1.2.2 The '1 Volumes' tab captures volume data for 2018-2037 for three different growth scenarios. The volume data used was largely extracted from the ICASA 2018 model.

5.1.2.3 The '2 Dimensioning' tab shows general parameters, network parameters (GSM, UMTS, LTE), core network dimensioning parameters, and conversion factors (units in the busy hour converted to megabits per second).

5.1.2.4 The '3 Network Demand' tab contains the number of network elements to be used as inputs in the capital and operating cost calculations of the model.

5.1.2.5 The '4 Cost – Capital' tab calculates the total capital expenditure of the core network between the years 2018-2037.

5.1.2.6 The '5 Cost – Opex' tab calculates the total operating expenditure of the core network between the years 2018-2037.

5.1.2.7 A summary of the model results is presented in the termination costing tab. Discounted values of Capex and Opex are brought into a table in this tab to determine the pure LRIC termination cost. The present value of revenue recovery is compared to the present value of costs to ensure that revenues are recovered. The capex tariff and opex tariff amounts that are combined to produce the pure LRIC termination rate. This is done by a series of price trends being applied to capex and opex figures respectively and considering the volumes applicable to each of these categories, capex and opex.

5.1.2.8 The ‘Asset – HCA’ tab within the calibration tab section contains the historical and book value of assets purchased in each year between 2018–2037.

5.1.2.9 The ‘Revenues, costs’ tab within the calibration tab section computes the revenue outcomes from the tariffs and tariff profile.

5.1.2.10 The ‘Volume projections’ tab takes data from the ICT Sector Report tab, and the ITU data tab and State of the ICT Sector Report tab is populated with data from the State of the ICT Sector Report 2021. The ITU tab is populated with data from the ITU Datahub. There is no adjustment for underestimated ITU total volumes in the default scenario since this does not substantially impact on the calculated termination costs.

5.1.2.11 The ‘Core Costs’ tab calculates the total capital expenditure that has been trended according to a specified capital expenditure price trend and price index. The capital price index takes into account reducing prices over time in Euros, and exchange rate depreciation in Rands. This tab does the same calculations to determine a total operating expenditure that has been trended according to an inflation trend and an operating expenditure price index.

5.1.2.12 In the core costs tab, submissions from stakeholders were compared against other models, and the best estimate of the two have been used in the model.

5.1.2.13 The ‘Financial inputs’ tab provides information on various elements that are used throughout the model, such as exchange rates, weighted average cost of capital indexes, inflation rates over time, etc.

6 Appendix A - Acronyms

BSC	Base-station controller
DPI	Deep packet inspection
EDGE	Enhanced Data for GSM Evolution
EIR	Equipment Identity Register
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
GB	Gigabyte
GERAN	GSM EDGE Radio Access Network
GGSN	Gateway GPRS Support Node
GMSC	Gateway Mobile Switching Centre
GN	Gateway Node
GPRS	General Packet Radio System
GSM	Global System for Mobile communications
GWCN	Gateway Core Network
HLR	Home Location Register
HSS	Home Subscriber Server
ICT	Information and Communications Technology
IGW	Internet Gateway
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LTE	Long-Term Evolution
MB	Megabyte
Mbps	Megabits per second
MME	Mobility Management Entity
MNO	Mobile Network Operators
MOCN	Multi-Operator Core Network

MORAN	Multi-Operator Radio Access Network
MSP	Mobile service providers
MTR	Mobile Termination Rate
MVNO	Mobile Virtual Network Operators
NFV	Network Functions Virtualization
NNI	Network to Network Interface
OCS	Online Charging System
PCEF	Policy and Charging Enforcement Function
PCRF	Policy and Charging Rules Function
PCU	Packet Control Unit
PDN	Packet Data Network
PGW	Packet data Gateway
RAN	Radio Access Network
RNC	Radio Network Controller
RRC	Radio Resource Controller function of the MME
SBC	Session Border Controller
SDN	Software Defined Network
SGSN	Serving GPRS Support Node
SGW	Serving Gateway
SMSC	Short Message Service Centre
UMTS	Universal Mobile Telecommunications Service
UTRAN	UMTS Terrestrial Radio Access Network
VLR	Visitor Location Register
WACC	Weighted Average Cost of Capital