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Report for ACM

2015/16 update of the fixed and mobile BULRIC models

25 July 2016

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Ref: 2005169-283

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Contents

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1 Introduction

Autoriteit Consument & Markt (ACM) has commissioned Analysys Mason to update its fixed and mobile bottom-up long-run incremental cost (BULRIC) models, to provide cost-based information for future wholesale termination regulation that ACM may propose in the Netherlands. The previous version of the BULRIC models was updated to become the "v7D model", which was released for consultation in March 2016 so that industry could consult on the approach and implementation. Submissions were received from KPN, T-Mobile and Vodafone.

This document sets out how we have finalised the model inputs to derive the "v7F model" for ACM. The remainder of this report is structured as follows:

- **Section** 2**: Market module** – In this section we review the comments received on the v7D Market module and present our responses. We also consider whether changes are required to the inputs and calculations of the v7D Market module.
- **Section** 3**: Network design** – In this section we review the comments on the v7D Fixed and Mobile modules that are related to network design, and present our responses. We also consider whether changes are required to the calculations in the v7D Fixed and Mobile modules.
- **Section** 4**: Costing** – In this section we review the comments on the v7D model related to costing, and present our responses. We also consider whether changes are required to the v7D model costing calculations.
- Annex A summarises the changes made to the v7D model in order to reach the v7F model.

Note that throughout this report the names of the operators providing the comments are marked in such a way that ACM will later be able to publish an anonymised version of the document. In particular, confidential data has been redacted and is indicated by the use of square brackets and the scissor symbol '[✂…]'.

> We have implemented a number of corrections or modifications to the v7D BULRIC models based on operator feedback, to derive the v7F BULRIC models. Analysys Mason and ACM have finalised the inputs in the v7F model as part of this process.

Waterfall charts are provided below indicating the impact of the major changes to the v7D model on the final MTR cost results (the FTR cost results have changed by less than 0.5%, due to some revisions of the demand forecasts and the update of the weighted-average cost of capital (WACC)). Increases in the results are shown in light blue, whilst decreases are shown in pink.

Figure 1.1 indicates the changes to the Pure BULRIC from the mobile BULRIC model.

Figure 1.1: Impact of the changes on the Pure BULRIC [Source: Analysys Mason, 2016]

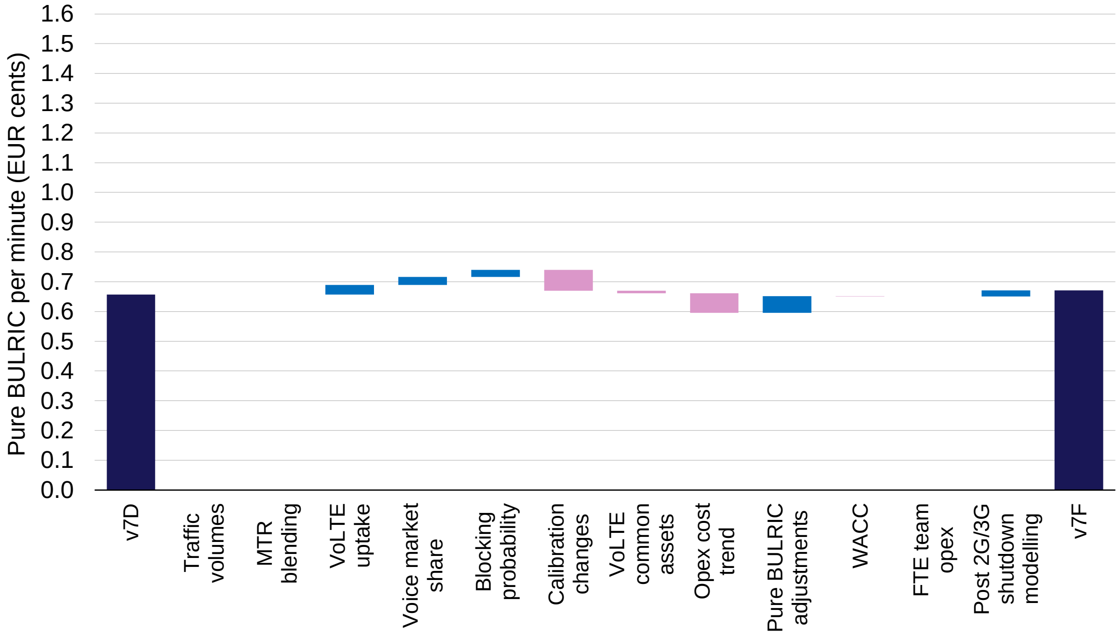
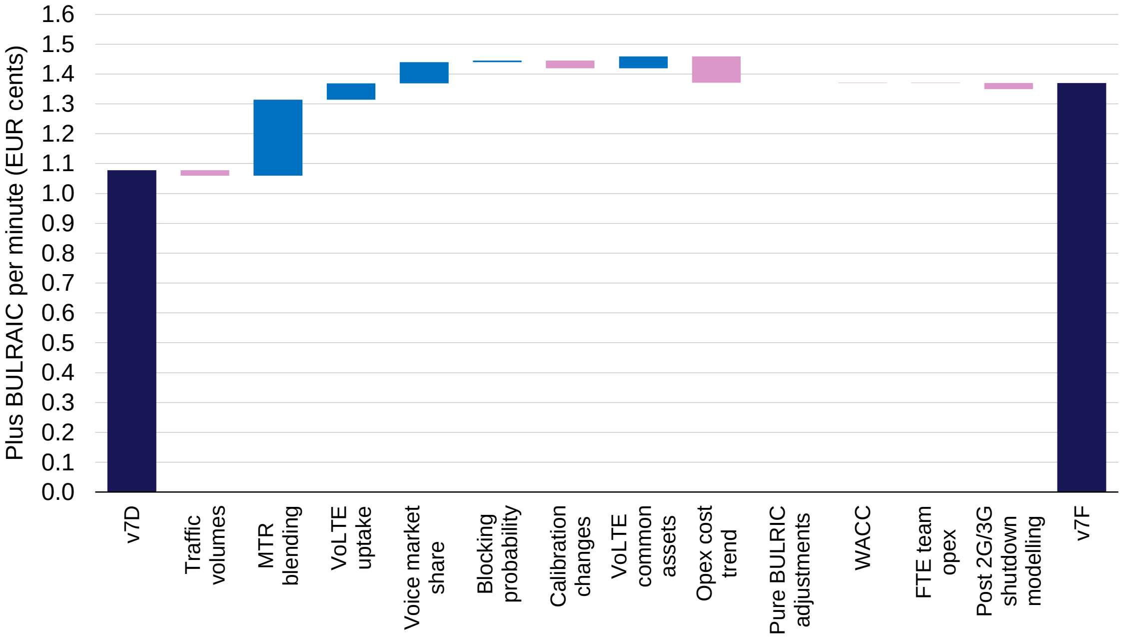


Figure 1.2 indicates the changes to the Plus BULRAIC from the mobile BULRIC model.

Figure 1.2: Impact of the changes on the Plus BULRAIC [Source: Analysys Mason, 2016]



2 Market module

Figure 2.1: Summary of comments related to the Market module [Source: Analysys Mason, 2016]

Number	Issue
1	Traffic forecasts
2	Modelled voice volumes
3	Uptake of VoLTE

2.1 Traffic forecasts

2.1.1 Comments by the operators

One respondent [✂] states:

In 2012, during the process of MTA/FTA IV ACM, Analysys Mason and [✂] had some discussions about the (voice) traffic developments included in the model. As a result Analysys Mason adjusted the traffic development in a decrease of the total (fixed and mobile) originating traffic of 2–2.5% in the years 2012–2016. With hindsight one can conclude that the total market traffic-volume remained more or less stable in these years, with a decrease of about 7% of the fixed traffic, and an increase of the mobile traffic.

In the new model traffic growth for the year 2016 and later is 0%, with a slight increase of mobile traffic and decrease of fixed traffic. Despite the development of traffic the last couple of years, [✂] is of the opinion that this is quite optimistic. The decrease of the fixed traffic of about 7% will sustain the coming years, and [✂] expects the mobile traffic will become more or less stable, due to more and more OTT applications. This expectation is the basis of [✂]'s Strategic Plan, and also seen in analyst reports, like the 'OTT Consumer VOIP forecast 2015–2020' of OVUM. OVUM estimates growth of mobile OTT traffic as 0.5 billion minutes in the years 2013–2015, but accelerating to 1–2 billion in the years 2016–2020. [✂] doesn't believe that this 'loss' of voice traffic on the mobile network is compensated by the on-going fixed-mobile substitution and/or a growth of total voice-traffic.

2.1.2 Analysys Mason/ACM response

The v7D model, like its predecessor v6 model released in 2013, forecast zero growth in voice traffic. We have collated the total outgoing voice minutes for the Dutch market for the years 2012 to 2015 from ACM's Telecommonitor, as illustrated below.

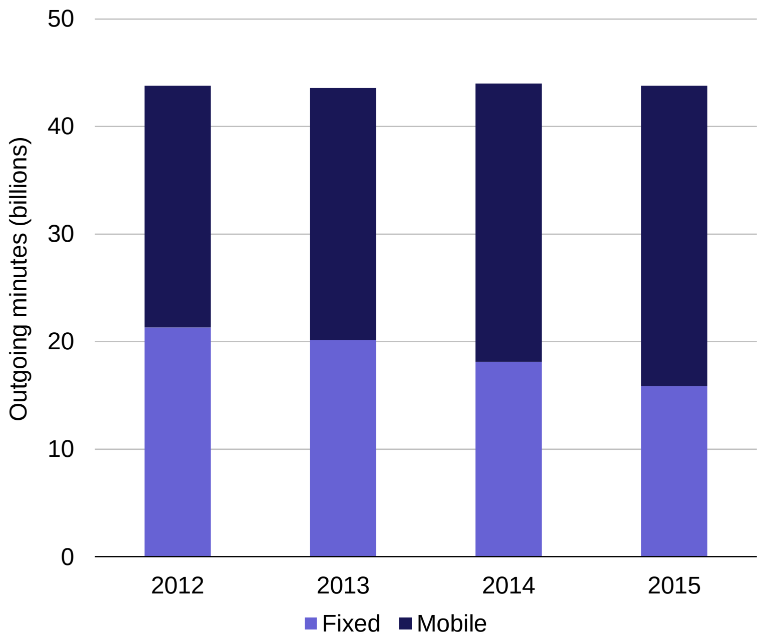


Figure 2.2: Total outgoing voice minutes for 2012–2015 [Source: ACM Telecommonitor, 2016]

As can be seen above, the total minutes are almost unchanged between 2012 and 2015. Therefore, there is no indication from historical data of a sustained decline in total traffic of any kind in the last three years.

Although independent forecasts may anticipate a decline in total volumes, we believe it is more appropriate in the context of this efficient cost model to continue the flat profile forecasted in the v6 model, and subsequently observed in the period 2012–2015.[1]

Therefore, we have retained the 0% growth in voice traffic in the v7F model.

However, the total traffic for voice and all other services has been updated to capture full-year 2015 information, released by ACM after the v7D model was released for consultation.

2.2 Modelled voice volumes

2.2.1 Comments by the operators

One respondent [✂] states:

Analysys Mason proposes to model an operator with a 33.3% share of the 2G/3G market and a 25% of the 4G market. See “Conceptual specification for the update of the fixed and mobile BULRIC models” p. 7–10. However, when calculating the modelled operator’s voice traffic, the ACM model appears to ignore Concept 3. The modelled operator’s voice traffic is derived by applying the 2/3G market share (33.3%) to total voice traffic, including 4G voice traffic (where according to Concept 3, the modelled operator should only have a 25% market share).

1 Analysys Research does forecast a small drop in total volumes for the period 2016–2020, of 1–2% per year.

As an increasing proportion of voice traffic migrates to 4G, the modelled operator's share of voice traffic should reduce to reflect N4G=4. Once all traffic is carried over VoLTE (in 2023), Concept 3 implies the HEO voice volumes should be 25% of total market volumes (and not 33.3% as modelled by Analysys). This is absolutely consistent with the reality of Tele 2's contestable share of the voice market as traffic migrates to VoLTE.

The HEO voice market share should thus be calculated as the weighted average of 33.3% for the proportion of 2G/3G voice traffic and 25% for 4G voice traffic.

2.2.2 Analysys Mason/ACM response

We accept this point, and have adjusted the Market module so that the 2G/3G market share is calculated using the migration-profile-weighted average of N and N4G over time. This means that the assumed market share for voice migrates from 1/N in 2015 to 1/N4G by 2023, when the modelled network is 4G-only. The market share for 4G data remains 25% in all years where the 4G network is active. This change has been made on the market share time series on the *Control* worksheet, with further small modifications on the *Market* worksheet.

2.3 Uptake of VoLTE

2.3.1 Comments by the operators

One respondent [✂] states:

The uptake of VoLTE is important in the cost-model, because the weighted-average cost price of 2G, 3G and 4G terminating traffic is calculated. The uptake of 4G (VoLTE) in the model is much faster than the figures [✂] communicated to Analysys Mason. [✂] considers the modelled uptake unrealistic and not feasible.

It is important to be aware that introducing VoLTE is quite complicated, and we have to be sure that a perfect quality of the calls is guaranteed to all our customers. Compared to the figures communicated earlier to Analysys Mason, [✂] has internally further lowered the expected uptake based on the latest insights to [✂]. These insights learn that we need more time to migrate our customers, dependent on the type of customer, the technical systems (especially Business Market) and the handset of the customer. Besides this, we expect that the MVNO's on our network won't give much priority to enable their network for VoLTE on the short term.

A second operator [✂] states:

ACM assumes the following VoLTE voice traffic migration in the HEO network. The ACM assumes 10% of 2016 traffic is already carried over VoLTE in 2016. This appears to be unlikely given the majority of VoLTE launch plans are focused on the second half of 2016. […] On that basis, we propose a more conservative penetration curve (with the delayed 2016 migration carried forward): 0% in 2015, 2% in 2016, 12% in 2017 and 32% in 2018.

2.3.2 Analysys Mason/ACM response

The forecast of migration to VoLTE takes the average of the forecasts received from the stakeholders for the years 2016–2020 as an input. In particular, the forecast migration for the years 2016 and 2017 (10% migrated and 20% migrated respectively) are consistent with the average of their forecasts. Therefore, we do not believe that the migration in the early years is inconsistent with respondent expectations. This remains the case when we use the updated forecast provided by the first respondent.

With regard to the second respondent in particular, we also observe that [✂].

With regard to the time given to complete the migration, we observe that the v7D model is slower than that of the v4 model released in 2010. The v4 model assumed completion in six years, as shown below by the light blue line in Figure 2.3 (shown to also start from 2016). We also show the proposed revision from the second respondent.

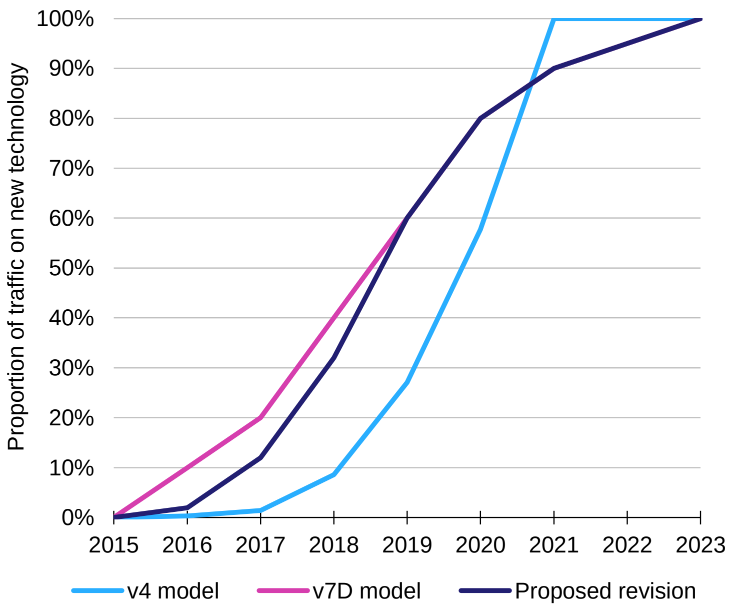


Figure 2.3: Comparison of migration profiles in v4 and v7D models [Source: Analysys Mason, 2016]

However, we observe that the migration curve assumed in the v4 model is slower in the first 2/3 years when compared to that assumed in the v7D model. Therefore, we have included the revisions proposed by the second respondent into the v7F model to incorporate a slower start to the migration.

3 Network design modules

Figure 3.1: Summary of comments related to the Fixed and Mobile modules [Source: Analysys Mason, 2016]

Number	Issue
1	Cost of the VoIP system in the fixed BULRIC model
2	Spectrum costs
3	2G/3G migration
4	3G/4G sector dimensioning
5	Quality of service
6	Costs of the VoIP system in the mobile BULRIC model

3.1 Costs of the VoIP system in the fixed BULRIC model

3.1.1 Comments by the operators

KPN states the following:

It is important to base the estimate of costs of an efficient operator on realistic achievable practices; even an efficient operator has to deal with migrations and integration of different platforms. This is the more important for KPN, which as (equal to other operators longer on the market) has to deal with the ongoing migration of TDM to VOIP. For these costs KPN is not compensated because the hypothetical operator is a construction of only the actually efficient networks based on IP. But it is equally relevant for UPC and Ziggo, who have to integrate platforms. Reasoning the other way around; an efficient scale of 50% of the total market is probably realistic looking at the access network, but on the level on the core network and the necessary platforms it is not realistic. The evolution of new technologies and services is not always straightforward and foreseeable. Operators (such as KPN) often have to deal with several platforms for different brands (in our case con-sumer, business, XS4All, Telfort), Ziggo has to deal with integrating two companies/brands. This market reality doesn't mean the companies are not efficient.

A second respondent [✂] states:

The approach to VoIP costs lacks transparency and results in the majority of the fixed termination rate costs being driven by this VoIP platform factor, making the FTR relatively insensitive to developments in data traffic. This is inconsistent with the mobile model in which costs are driven down by data volumes.

We also note that there may be a modelling error as the Pure BULRIC asset contribution is calculated based on a unit opex of five times the Plus BULRAIC scaling factor to VoIP platform costs for efficient operator of 104%. In particular, it appears that the uplift should be adjusted to reflect the ratio of the scaling factors.

We also point out that the migration to NGN technologies in the case of fixed networks appears to increase the FTR. This is inconsistent with the point of principle that customers, in this case operators interconnecting with the fixed networks, should not pay more for the same service functionality simply because it is delivered with a new technology. Given that the fixed VoIP costs have been based on information provided by fixed operators, we believe it is important for these costs to be subject to independent verifications.

3.1.2 Analysys Mason/ACM response

The costs of integration of two platforms by UPC and Ziggo are not long-run efficient costs, but short-run costs from merging sub-national operations. In order to accommodate an estimated reasonably efficient level of ongoing systems management costs, we have already included 50% of KPN's system integration costs in the latest VoIP cost benchmark (with the assumption that the other 50% is borne by the legacy services). We do not see any reason to include additional costs in the benchmark calculation.

Regarding the first comment by the second respondent, the calculation of the VoIP platform costs are as follows:

- the capex is calculated by adjusting the unit capex for the assets related to the VMS, IN platform, SBCs and call server by the calibration factor of 104%
- opex is also calculated for each of these assets (calculated as a proportion of capex, meaning that the calibration factor flows through to this opex automatically)
- an additional opex of EUR5 per subscriber per year (intended to relate to software licence fees), is also included, adjusted based on the calibration factor of 104%.

The calibration factor of 104% is therefore applied globally to all costs related to the VoIP platform in the fixed BULRIC model. The cost described in the last bullet is the one referred to by the second respondent, but we think their comment is a misinterpretation of the input "5" (it is a unit cost of EUR5 per subscriber, not a scalar). This opex is not being included erroneously.

Regarding the second comment by the second respondent, the BULRIC models developed for ACM (in 2009/10, 2012/13 and now in 2015/16) have only ever been models of NGN technologies, hence there is no new situation giving rise to the claimed higher costs from NGN. We assume that the respondent is comparing the price levels in the v6 and v7D BULRIC models (i.e. it is comparing two NGN-based models). The reason for the increase in the results between the two models was described in the IG2 presentation: namely that more recent cost benchmarks have been used in the v7D model, which we believe is likely to better reflect the costs of VoIP platforms in the Netherlands (as such platforms are now more established and therefore their costs better quantified). This is therefore down to an improvement in available data. In addition, on-going currency inflation tends to cause prices to rise in nominal terms.

3.2 Spectrum costs

3.2.1 Comments by the operators

One respondent [✂] states:

> The 2012 auction in the Netherlands spectrum in the 800 MHz band of 2×10MHz was set aside for new entrants, not being one of the existing mobile network operators. As a consequence, Tele2 was able to acquire at an extremely low price of €161m whereas the other operators paid much higher amounts for their packages. As was the case in the UK, the spectrum reservation led to average prices in the Dutch 2012 auction for 800MHz that are well below the current market value of the spectrum. ACM/AMs BULRIC models aim to represent the efficiently incurred costs of an existing mobile operator. Therefore, 800MHz spectrum should instead as a minimum be valued on the basis of the auction prices paid excluding the spectrum reserved for new entrants.

A second respondent [✂] states:

> The costs for the 800-spectrum in the model are based on the average amount paid by Vodafone, Tele2 and KPN. Two existing operators paid substantially more for the 800-spectrum than the average amount, due to the auction-rules, which included entry assistance for new licensees. [✂] is of the opinion that in this approach existing operators are punished twice; once during the auction (where we were forced by the rules to pay much more for the spectrum than Tele2) and secondly in this process of setting the MTR in the Netherlands. Therefore, the costs of the 800 spectrum should be based only on the amount paid by KPN and Vodafone and not take into account the fact that the new entrant paid significantly less than the market value for this spectrum.

3.2.2 Analysys Mason/ACM response

We do not agree with the proposal of the respondents (namely to calculate the 800MHz spectrum cost based only on the price paid by KPN/Vodafone), as the model is now calculating costs for a generic operator in the Netherlands that will use 4G technology in the long term, which should capture the characteristics of Tele2 as well.

In the auction, the three existing operators bid for two lots, while two new entrants bid for one lot. Therefore, the price paid for the ring-fenced lot broadly represents the level at which *Ziggo* was no longer willing to continue in the auction, whilst the price paid for the other two lots broadly represents the level at which *T-Mobile* was no longer willing to continue.

The respondents are effectively arguing that the ring-fencing of one block should not be considered. Another way of removing the ring-fencing effect would be to estimate the value of 800MHz spectrum if all five bidders (existing and new entrants alike) bid over three identical lots.

In the v7F model, we have added calculations for the value per MHz per capita of the 800MHz spectrum that de-average KPN/Vodafone and Tele2 from our overall average of EUR1.43 (this is possible since Tele2 only purchased 800MHz spectrum). We get values of EUR1.94 and EUR0.40 respectively, as shown below in Figure 3.2.

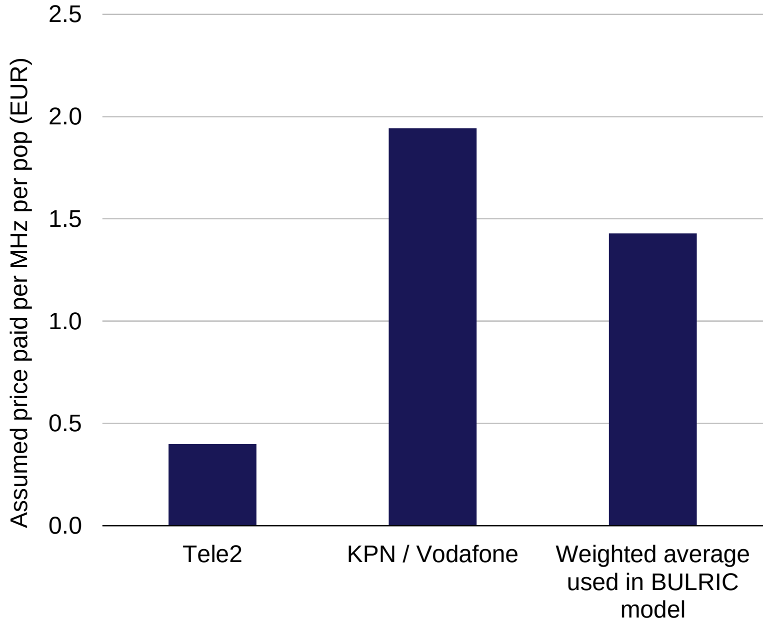


Figure 3.2: Averaged and de-averaged values for the 800MHz band using the auction results [Source: Analysys Mason, 2016]

In the open market five-bidder auction situation we hypothesise above, all things being equal, we would expect the average price to be determined by the level at which *Tele2* is no longer willing to continue in the auction (as Ziggo and Tele2 would drop out as entrants, leaving T-Mobile, Vodafone and KPN to acquire the three lots with no further bidding). We would expect this to be highly unlikely to exceed the level paid by KPN/Vodafone or the weighted average used in the BULRIC model (if Tele2 in theory had such a high willingness to pay for spectrum, then it would likely have won spectrum from other bands). Therefore, we can conclude that the price paid in such a situation would likely lie between EUR0.40 and EUR1.94.

In conclusion we believe that our approach to valuing 800MHz spectrum is very reasonable since:

- The assumed price level lies between the bounds of the de-averaged values we have calculated, and in fact lies above the midpoint (which could be an alternative assumption)
- More importantly, the value assumed can be used to reverse-calculate the total spectrum fees paid in the auction across all actual Dutch 4G operators (including Tele2).

In particular, the counterproposal from the operators (suggested by both respondents) would end up implicitly reflecting a total value significantly in excess of the amount paid in reality. The effect of the second respondent's suggestion can be characterised as buyers of wholesale interconnection services being punished by contributing to spectrum fees greater than the amount incurred in reality, *and* the Dutch Government being punished for not receiving the additional fees being requested by the second respondent in the aggregated cost modelling. Finally, no party was forced to pay any specific amount in the auction, as bidders willingly undertook bidding and were able to withdraw at any time.

3.3 2G/3G migration

3.3.1 Comments by the operators

One respondent [✂] states:

> AM assumes that 2G and 3G technologies will be fully phased out in the Netherlands by 2023. While there may be some countries that are decommissioning 2G or 3G technologies, the general expectation is that 2G and potentially also 3G need to be, and therefore will be continued in the long run. Reports by the GSMA and AM suggest that within Europe, factors including 2G's ubiquitous coverage, M2M's reliance on the legacy 2G network, the cost of decommissioning as well as the difficulty in upgrading 2G handset subscribers will lead to the technology being maintained in the long run although some spectrum refarming is not unlikely. The assumption of 2G and 3G technologies being continued is also consistent with the European Commission's Recommendation on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU which states that "The bottom-up model for mobile networks should be based on a combination of 2G and 3G employed in the access part of the network, reflecting the anticipated situation, while the core part could be assumed to be NGN-based". And in addition, recent international regulatory decisions also show that other regulators believe that it is sensible to assume continuation of 2G and 3G, alongside 4G.

A second respondent [✂] states that:

> [✂]. The ACM model's 2G/3G traffic mix should take the following issues into account:
>
> (i) The high quality requirements by Dutch consumers [✂] has led [✂]
> (ii) For the very same reason, [✂].
> (iii) Some users still select 2G-only network setting on a 3G capable phone as a means of saving battery life.
>
> International benchmarking of LRIC models also suggests the ACM's assumed 3G proportion is relatively high. Our proposal is to re-align the traffic migration path [✂].

3.3.2 Analysys Mason/ACM response

With regards to the first respondent, we note that the reasons it summarises from the GSMA/Analysys Mason reports are solely related to 2G technologies. We consider each of these in turn below.

Ubiquitous 2G coverage

While this could be a more relevant issue in countries with extensive rural areas, we do not consider this to be the case in the Netherlands. Moreover, all Dutch 4G operators already have extensive 3G and 4G coverage and we would expect it to be similarly ubiquitous well before our forecast shutdown of the 2G/3G networks in 2023.

Reliance of machine-to-machine (M2M) services on the 2G network

While we acknowledge that some M2M customers do make use of the 2G network, we believe that these terminals could be served (even from today) with a minimal capacity 2G wide area coverage network. We would also expect very few active M2M customers in the Netherlands today to be locked into 2G-only contracts beyond 2023.

In any case, the costs of maintaining such a network specifically to fulfil M2M contracts are not relevant to the costs of mobile voice termination and should not be recovered by MTRs, especially since voice will have largely migrated away from 2G.

Difficulty in decommissioning/upgrading 2G handsets

We have assumed that the 2G network is not shut down until seven years in the future. We believe this is ample time for (non-M2M) 2G devices to be efficiently and economically replaced by 4G-capable handsets.

Consistency with the 2009 EC Recommendation

With regards to the 2009 EC Recommendation, this is now almost seven years old and reflected technologies as they stood at the time.[2] In particular, the quote by the first respondent is of part of point 12 in the 2009 EC Recommendation. The full point reads as follows:

<u>The cost model should be based on the efficient technological choices</u> <u>available in the time frame considered by the model, to the extent that they can be identified</u>. Hence, a bottom-up model built today could in principle assume that the core network for fixed networks is Next-Generation-Network (NGN)-based. The bottom-up model for mobile networks should be based on a combination of 2G and 3G employed in the access part of the network, reflecting the anticipated situation, while the core part could be assumed to be NGN-based.

We have underlined a key part of the point not quoted by the second respondent. In 2009, the efficient technology choice was 2G/3G, as 4G could not yet be identified. However, in 2016, 4G is an identifiable efficient technology choice and therefore can be justifiably considered in the modelling.

Consistency with other international regulatory decisions

The BULRIC model has been designed taking into account the principles adopted in the Netherlands, carefully developed since they were first formulated in 2009.

The first respondent submitted "*A further element is regulatory consistency over time. Where a regulator's statutory objectives remain the same, then the regulator should be expected to*

2 European Commission C(2009) 3359 final COMMISSION RECOMMENDATION of 7.5.2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:124:0067:0074:EN:PDF.

maintain its general costing approach from one regulatory period to the next. This helps reduce regulatory risk and thereby supports ongoing investment in the industry" (page 16, submission dated 12 October 2009). ACM's previous MTR regulation, which has yet to be approved by the court, is also based upon the assumption of 2G and 3G being shut down in the medium-term future. Therefore, we do not believe there is sufficient evidence to substantially change our position on migration off 2G and 3G in ACM's efficient voice costing model, and substantially raise regulatory uncertainty by adopting the alternative approach.

With regards to the first comment of the second respondent, [✂.]

With regards to the comment of the second respondent related to the relatively high proportion of traffic on 3G (which they highlight as 65% in 2015), we would note that this is based on the approximate average of stakeholder data received via the data request and is therefore reflecting the situation of the Dutch market.

We therefore believe the forecast of migration between the 2G and 3G networks is reasonable and will be retained for the v7F model.

3.4 3G/4G sector dimensioning

3.4.1 Comments by the operators

One respondent [✂] states:

The ACM model makes two intertwined assumptions:

a) Each sector on a site has the same traffic load as the others; so
b) Each sectors can be utilized up to 100% of its design capacity before upgrade is required.

In reality, [✂]'s data shows the busiest sector on site is c.50% more loaded than the average of all sectors on the site at the busy hour. We are advised that [✂] implements the same amount of carriers/carrier frequencies on all sectors of a 3G and LTE site. So, for example there is no 2-1-1, or 3-2-2 3G configurations in the network. This has been done to optimize the customer experience and site performance: an uneven distribution of carriers over sectors has been observed to lead to a poor handover performance between the sectors, lower data throughputs and more handovers to GSM. Given Dutch quality requirements, this would not be acceptable.

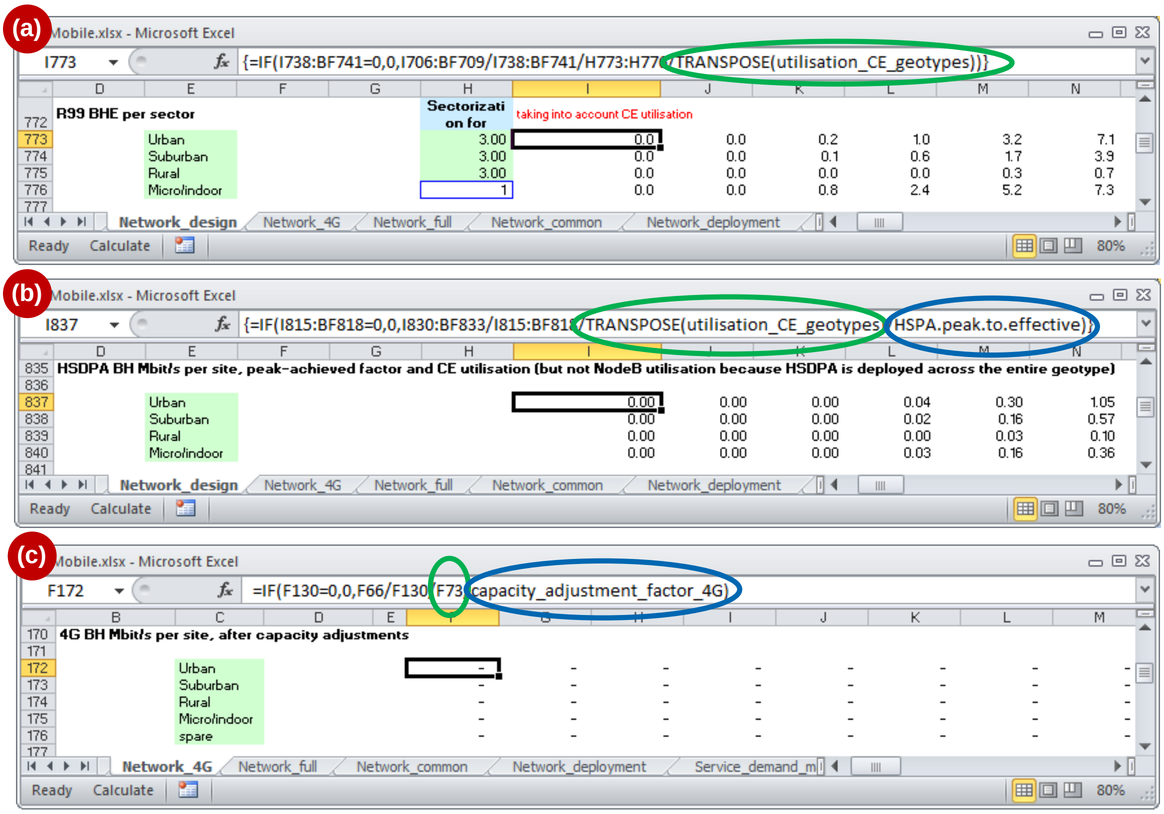
What this implies is all sectors on a 3G or LTE site will be upgraded on the basis of the busiest sector's reaching full capacity (and in advance of all other sectors reaching 100% utilization). This effect needs to be taken into account in the ACM model by dividing utilization rates for 3G and LTE by a factor of 1.50.

3.4.2 Analysys Mason/ACM response

The respondent is incorrect that sectors in both the 3G and 4G network designs are assumed to be utilised to 100% of its design capacity. Utilisation factors are applied to increase the assumed busy-hour Mbit/s when dimensioning the network. This is done for each type of traffic in the 3G/4G network designs (i.e. 3G R99, 3G HSPA and 4G). Moreover, for the high-speed data traffic, additional factors are included to capture traffic inhomogeneity within a geotype. Therefore, we believe that these factors fully capture the issue of traffic loading on each site and sector.

The relevant formulae from the Mobile module are shown from the v7D model in Figure 3.3(a), (b) and (c) respectively below. The utilisation factors are ringed in green and the adjustment reflecting traffic peak-to-effective inhomogeneity are ringed in blue.

Figure 3.3: Illustration of where utilisation factors are applied in the mobile BULRIC model [Source: Analysys Mason, 2016]



Specifically, the assumed utilisation and adjustment factors used above are as follows:

- 3G carrier utilisation (*utilisation_CE_geotypes*) of 53%
- 4G carrier utilisation of 53% (cell F73 above)
- peak-to-effective adjustment factor for 3G high-speed data of 40% (*HSPA.peak.to.effective*)
- peak-to-effective adjustment factor for 4G data of 40% (*capacity_adjustment_factor_4G*).

In particular, the utilisation input of 53% was calculated for the purposes of the v6 mobile BULRIC model. It took into account two aspects: (a) a factor of 67% for cell busy-hour and seasonal variability, and (b) a factor of 80% to capture daily variability, busy-hour variability, unforeseen peaks and spare capacity for traffic growth.

Therefore, we do not believe that any additional adjustments are required to further capture inhomogeneity and a realistically-less-than-100% utilisation of the network.

3.5 Quality of service

3.5.1 Comments by the operators

One respondent [✂] states:

> The ACM model assumes an air interface blocking probability of 2%. This assumption represents a fairly low quality of service assumption when compared to QoS used in other jurisdictions. The Dutch market is characterized by exceptionally high quality requirements which led all operators to invest heavily in spectrum, coverage and capacity. This is sustained investment means all three leading Dutch operators are currently at the very top of the P3 Communications network quality benchmarking, both overall and voice-only. The fact that all three main operators are at the top of the European quality league suggests this quality investment is a real market requirement (rather than an inefficient investment by a single player). [✂]. These demand-led quality requirements have driven a substantial investment in improving network availability. In this respect, we observe the ACM model forecasts a significantly lower BTS and TRX count than deployed in the [✂] network. In our view, the ACM QoS assumptions should reflect the exceptionally high Dutch quality requirements by:
>
> - Reducing air interface blocking rates from 2% to 0.1%. This is the value used by the [✂] for network dimensioning purposes). We note that [✂] average call set-up success at the busy hour shows a [✂].
>
> - Reducing 3G and 4G carriers assumed utilization. Given local quality requirements (across all voice and data services), we suggest 3G utilization be aligned with 2G.

3.5.2 Analysys Mason/ACM response

We consider the issues related to the assumed blocking probability and the carrier utilisation factors separately below.

Blocking probability assumptions

Regarding the blocking probability, we would first note that it is important to distinguish between *cell-by-cell upgrade* blocking probability, and *achieved network* blocking probability, where the model input of 2% is cell-by-cell upgrade blocking probability. We believe that the measure of [✂] as quoted by the respondent is closer to achieved network blocking probability.

The modelled achieved blocking probability for the 2G and 3G networks can be estimated based on the mix of traffic-driven base stations (which will have 2% blocking) and non-traffic-driven (coverage) base stations (0% blocking). “Unblocked” base stations are likely to occur in rural areas, which will not be traffic-driven.

When first used in the model development in 2009/10, the cell-by-cell upgrade blocking probability of 2% was based on data from Dutch operators at the time. The base-station-weighted-average blocking probability in the v7D model, which still uses this input of 2%, is shown below.

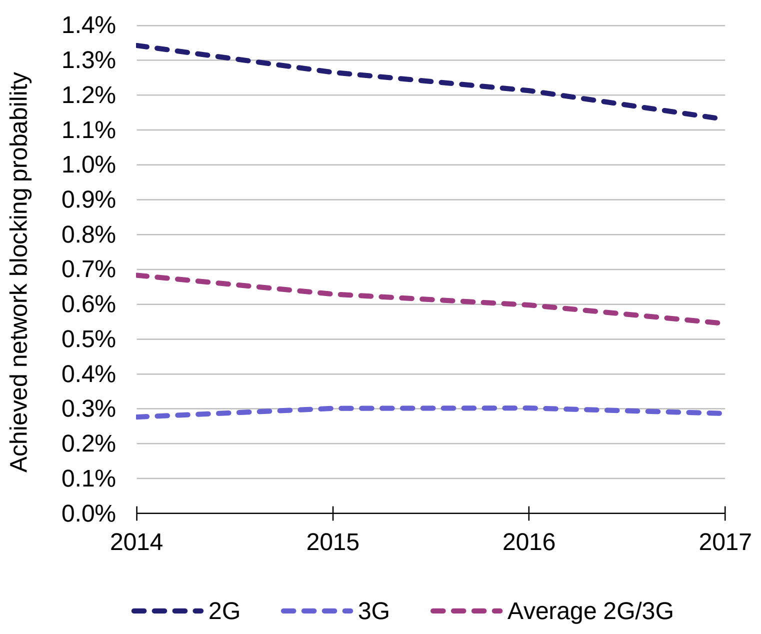


Figure 3.4: Base-station-weighted-average blocking probability with a cell-by-cell upgrade blocking probability of 2% for the v7D model [Source: Analysys Mason, 2016]

As can be seen above, the estimated achieved network blocking probability is around 0.6% in the v7D model.

We have tested using the respondent’s suggestion of 0.1% cell-by-cell upgrade blocking probability, but this leads to an achieved network blocking probability of less than 0.05% (lower than the measure quoted by the respondent). Therefore, assuming a value of 0.1% cell-by-cell upgrade blocking probability is, in our view, inappropriate.[3]

If we consider the benchmark values provided by the respondent, then half of the cases assume 2% and the other half assume 1%.[4] In particular, there are no examples of a cell-by-cell blocking probability of below 1%. We do also observe that the UK model reduced the assumed blocking

[3] The v7D model does, however, assume a *core* network blocking probability of 0.1% (see cell Network_design_inputs!C422 in the Mobile module)

[4] Additional examples would be the published models in Norway (which assumes 2%) and Denmark (which assumes 1%), meaning the split of cases is still 50:50.

probability from 2% to 1% in the most recent update in 2013–2015, based on operator data (the value assumed for historical years was kept at 2%).[5]

If we therefore assume a cell-by-cell upgrade blocking probability of 1% from 2013 onwards, then this produces an achieved network blocking probability of approximately 0.3%, as shown below in Figure 3.5.

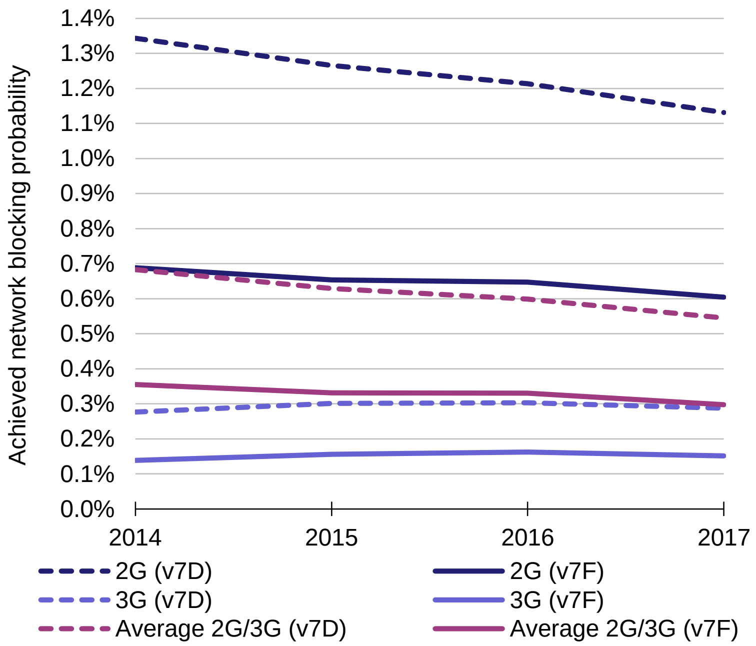


Figure 3.5: Base-station-weighted-average blocking probability with a cell-by-cell upgrade blocking probability of 1% [Source: Analysys Mason, 2016]

Since this is closer to the measure quoted by the respondent, while also still being consistent with their benchmarks provided, we have updated the assumed value in the v7F model to 1% from 2013 onwards.

Carrier utilisation assumptions

We would recap from the previous mobile BULRIC model update that the utilisation factor assumed for the 2G TRX (33%) is effectively the 3G utilisation factor with an additional calibration factor of 62% applied. This was done in order to achieve closer agreement of the TRX volumes to operator data in the previous calibration exercise undertaken on the BULRIC model in 2013.[6]

When comparing the mobile BULRIC model to the assets of a particular operator, it is necessary to align several inputs (rather than just scale). In particular, those that we align in our calibration are:

- market share (of voice minutes)

[5] See http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-call-termination-14/annexes/analysys-mason-Report_for_Ofcom.pdf, Section 2.5.

[6] See https://www.acm.nl/nl/download/bijlage/?id=11926, Figure 3.10.

- spectrum allocation
- 2G BTS sectorisation
- network busy hour proportion
- migration profiles between the 2G/3G/4G networks.

When we replace the assumptions in the BULRIC model with assumptions reflecting the specifics of the respondent, as well as reflecting the new blocking probability of 1%, then the modelled TRX volumes are in fact above those of the respondent. Therefore, we have increased the additional utilisation factor for TRX from 62% to 75% to improve the agreement in the period 2013–2015.

Although the 2G BTS counts is still lower than that in the respondent's network, we believe this is reasonable since [✂]. Therefore, no further adjustments have been made to the 2G utilisation factors.

The NodeB asset counts (of the largely coverage-driven 3G network) are slightly higher than those of the respondent under these settings, so whilst we have not adjusted the 3G carrier utilisation factors, we have increased the scorched node overlap coverage coefficient (SNOCC) for 3G in rural areas from 0.80 to 0.85 (cell Network_design_inputs!F288) to reduce the number of NodeBs.

With these additional adjustments, the achieved network blocking probability remains 0.3%, as shown below in Figure 3.5.

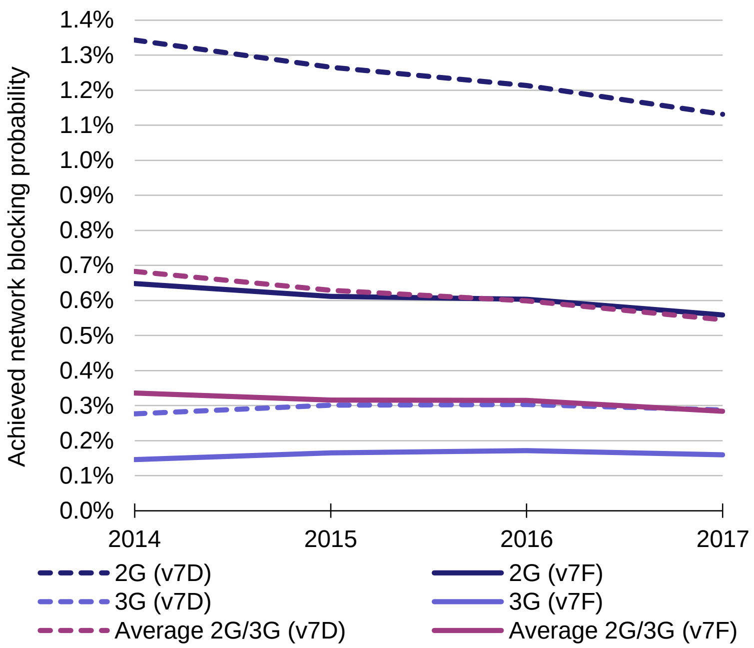


Figure 3.6: Base-station-weighted-average blocking probability with a cell-by-cell upgrade blocking probability of 1% and a TRX utilisation of 75% [Source: Analysys Mason, 2016]

3.6 Costs of the VoIP system in the mobile BULRIC model

3.6.1 Comments by the operators

One respondent [✂] states:

In the mobile model, the VOIP platform consists of the following elements: Call server, Telephony Access Server, SBC hardware and SBC software.

Important in the modelling of the costs is that a part of the platform elements are fixed, common costs. These elements are needed anyhow, independent of the volume of traffic. For example the call server, 1 element is needed anyhow. The common cost are added as a mark-up to the plus cost price. In the opinion of [✂] this method doesn't result in appropriate cost prices for the voice services, because the common costs of the VOIP platform are also allocated to data (and SMS) services. In case of the costs of the call server, one can see that the incremental costs per unit output of the call server are 0 in the years 2016–2018. This is because only 1 call server is needed, and the costs of 1 server are common cost. Common costs are added to the costs of the network elements as a percentage; costs of the call server are still 0. Common costs of the VOIP platform are proportionately allocated to the costs of all network elements, also elements that are mostly used by data traffic.

The calculation of the pure cost price follows a different methodology. In case the hypothetical operator doesn't deliver the terminating voice service, Capex and Opex is avoided. Economic depreciation of the avoided costs is calculated, and divided by the volume of the terminating service. In this calculation one can see that only a part of the call servers is avoided in some years. So the VOIP platform costs as a part of the MTR pure cost price only consists of some costs of the call server (0,004 eurocents in 2017). This differs from the calculation in the Fixed model, and [✂] is of the opinion that the same methodology should be used.

3.6.2 Analysys Mason/ACM response

Regarding the first comment from the respondent, the VoLTE platform elements that are defined as common are set on the *Network_common* worksheet in the Mobile module, as shown in Figure 3.7 below. As observed by the respondent, these inputs are causing VoLTE costs to be allocated to both voice and non-voice services. Therefore, in the v7F model, cells within the dashed red line below have been set to zero to the end of the modelling period. As a result, all VoLTE platform costs are now incremental to voice.

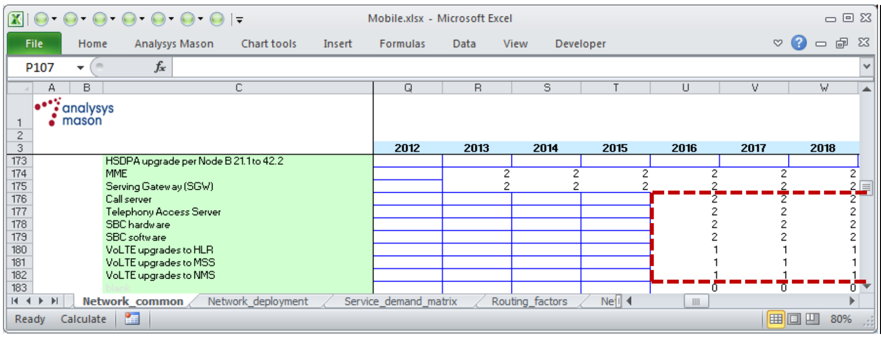


Figure 3.7: Illustration of common network inputs for the VoLTE platform [Source: v6 model, 2016]

We have then compared the Plus BULRAIC and Pure BULRIC contributions *from only the VoIP platform in the fixed model and the VoLTE platform in the mobile model*. The fixed BULRIC model contributions are calculated per incoming NGN minute, while the mobile BULRIC model contributions are calculated per incoming 4G minute.

A comparison for the v7D BULRIC models released for consultation is shown below in Figure 3.8.

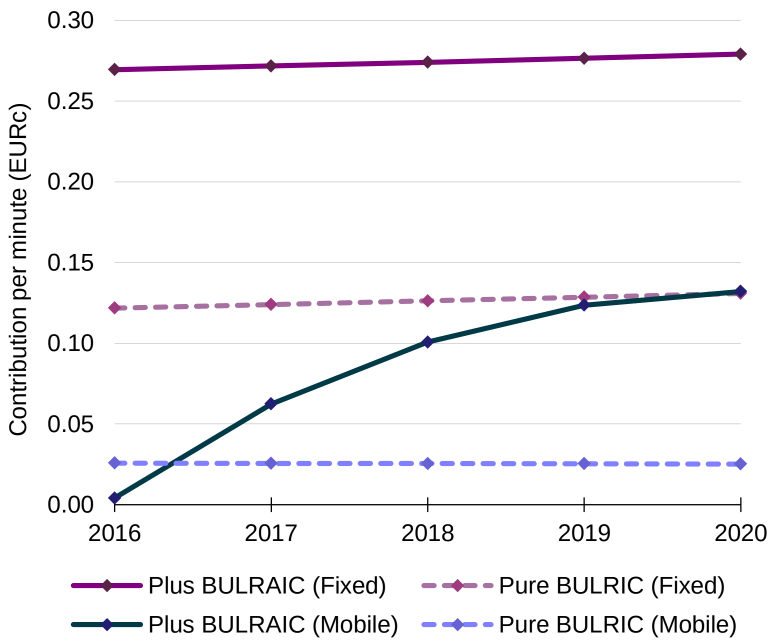


Figure 3.8: Comparison of VoIP/VoLTE cost contributions for the v7D fixed and mobile BULRIC models [Source: Analysys Mason, 2016]

After the adjustment of the VoLTE platform common cost inputs described above, there is an increase in the Plus BULRAIC for the mobile BULRIC model, as shown below in Figure 3.9. As a result, the total cost levels of the two platforms are comparable.

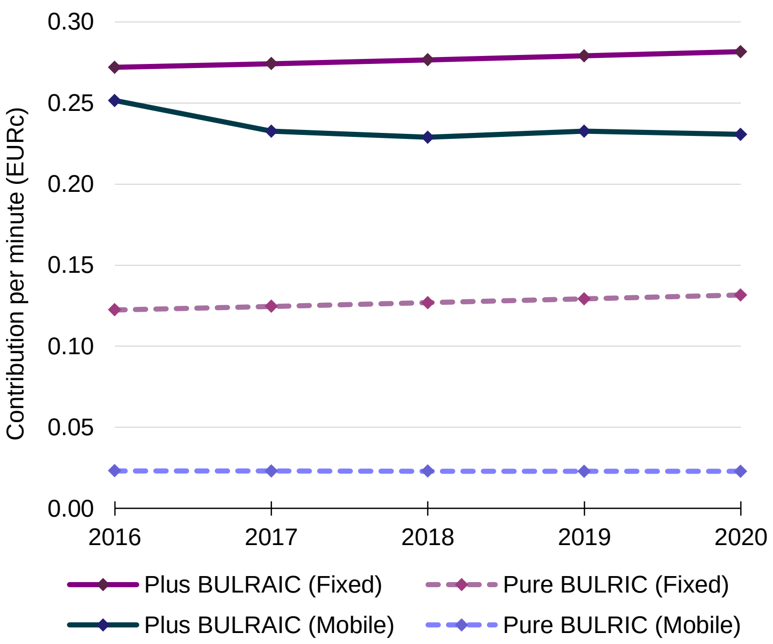


Figure 3.9: Comparison of VoIP/VoLTE cost contributions for the v7F fixed and mobile BULRIC models [Source: Analysys Mason, 2016]

As can also be seen above, the Pure BULRIC contribution in the fixed BULRIC model is higher than that for the mobile BULRIC model. Further recalibration of the mobile BULRIC model (described above in Sections 3.3–3.5) leads to further convergence of the Pure BULRIC and Plus

BULRAIC contributions from their respective modelled voice platforms. We have therefore considered the adjustments made to the Pure BULRIC calculated for the mobile network.

In the fixed BULRIC model, 79% of the per-minute Plus BULRAIC of the per-subscriber VoIP software costs is included in the Pure BULRIC. We have therefore implemented the equivalent contributions in the mobile BULRIC model for the (non-traffic-sensitive) VoLTE platform assets i.e.:

- Telephony Access Server
- VoLTE upgrades to NMS
- VoLTE upgrades to HLR.

The net effect of these amendments is to narrow the gap between the Pure BULRIC contributions, as shown below in Figure 3.10.

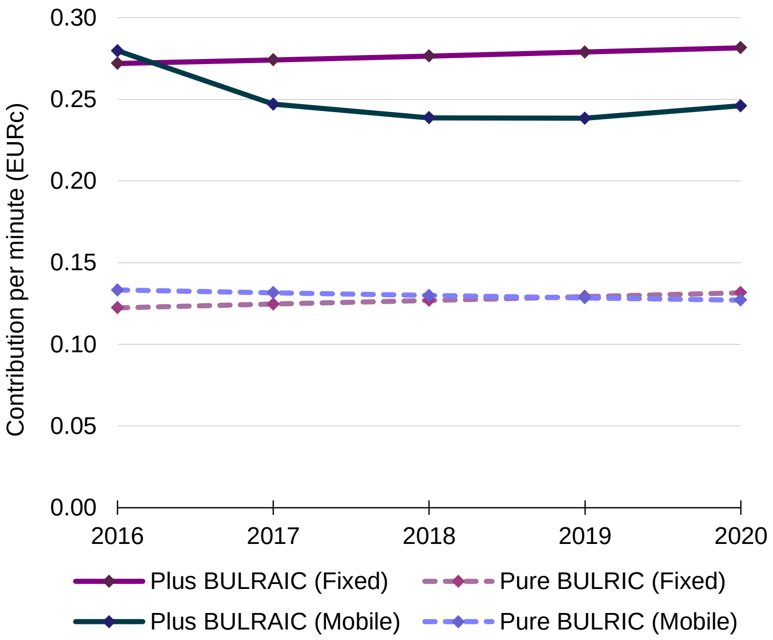


Figure 3.10: Comparison of VoIP/VoLTE cost contributions for the final v7F fixed and mobile BULRIC models [Source: Analysys Mason, 2016]

4 Service costing module

Figure 4.1: Summary of comments related to the Service Costing module [Source: Analysys Mason, 2016]

Number	Issue
1	Calculation of MTR

4.1 Calculation of MTR

4.1.1 Comments by the operators

One respondent [✂] states:

The MTR plus cost price is the result of the weighted averaged cost price of 2G, 3G and 4G traffic. This calculation is made in the Module 'Service Costing', sheet 'Results_mobile'. In the opinion of [✂] this calculation is not correct, because 4G originating (onnet and offnet) traffic is incorporated.

4.1.2 Analysys Mason/ACM response

This formula has been corrected in the Service Costing module in the v7F model.

Annex A Summary of changes made to the BULRIC models

This annex describes the changes made to the BULRIC models as part of this update. In particular:

- Annex A.1 summarises the major updates made to the BULRIC models in 2015/16
- Annex A.2 states the adjustments made to the v7D models to derive the v7F models
- Annex A.3 describes a reconciliation adjustment made to the opex in the v7F models.

A.1 Updates made to the v6 BULRIC models

We describe the main updates in relation to fixed services, mobile services and interconnect services in turn below.

A.1.1 Fixed BULRIC model

Update of market volumes	The Market module has been updated with actual statistics for the Dutch market up to the end of 2015. Forecasts have also been revisited where necessary.
Update of the cost adjustments for the VoIP platform	The model uses two adjustment factors to model the costs of the VoIP platform. One is applied to the costs of the VoIP platform-related assets for the purposes of the Plus BULRAIC calculation. The second is applied to the BULRAIC contribution per terminated minute for the "CN: VoIP software per subscriber" asset, for inclusion in the Pure BULRIC value. Both factors were derived for the v6 BULRIC models and this analysis was revisited. The new factors were derived as 104% and 79% respectively.
Removal of migration profile	The migration profile forecast for fixed network traffic off of the NGN platform onto a future technology has been removed, so that the modelled costs per minute apply fully in all future years.

A.1.2 Mobile BULRIC model

Update of market volumes	The Market module has been updated with statistics for the Dutch market up to the end of 2015. Forecasts have also been revisited if necessary.
Update of 2G/3G design	The 3G coverage profile has been updated and 42Mbit/s HSPA can now be modelled. Spectrum historically used for 2G/3G technology is migrated for 4G use after the 2G/3G shutdown is completed. The migration of traffic between the 2G and 3G networks has also been updated.
Revision of the	The profile for traffic migration from 2G/3G to the next technology (now

migration profile	modelled explicitly as 4G) has been revised to end in 2023 rather than 2019.
Inclusion of a 4G network design	Assets for a 4G network have been included in the BULRIC model, covering the radio layer, an enhanced packet core (EPC) overlay of the core network and the servers and nodes required for a VoLTE platform. Ethernet backhaul options have also been modelled as replacing E1-based backhaul.
Revision of spectrum fees	The fees paid for spectrum in the modelled bands has been adjusted to reflect the actual fees paid in the auctions held in the Netherlands in 2010 and 2012.
Revision of market share assumption	The assumption of N=3 for 2G/3G network traffic has been retained. However, 4G traffic for the modelled generic operator has been calculated based on N4G=4.

A.1.3 Interconnect model

Updates to the Interconnect module	NGN interconnect services have been included in the Interconnect module. The cost per hour of labour has also been updated. A calculation of the cost of space in exchanges outside of urban centres has also been included.

A.2 Adjustments made to the v7D BULRIC model

Inclusion of 2015 actuals (Section 2.1)	The *Market* worksheet in the Market module was updated with actuals for full-year 2015, based on data from Telecommonitor. The forecasts for GPRS/R99 data were also adjusted for 2016, following this update.
Voice market share (Section 2.2)	On the *Control* worksheet of the Market module, the voice market share was revised from 1/N (N=3) in all years to a migration from 1/N in 2015 to 1/N4G (N4G=4) in 2023.
Revision of migration VoLTE profile (Section 2.3)	On the *Control* worksheet of the Market module, the profile for the migration of voice from the 2G/3G networks to the VoLTE network was slowed in the years 2016–2018.
Blocking probability (Section 3.5)	On the *Network_design_inputs* worksheet in the Mobile module, the air interface blocking probability has been reduced from 2% to 1%.
TRX utilisation (Section 3.5)	On the *Network_design_inputs* worksheet in the Mobile module, the "Additional utilisation factor" for 2G TRX has increased from 62% to 75%.

3G rural SNOCC (Section 3.5)	We have increased the scorched node overlap coverage coefficient (SNOCC) for 3G in rural areas from 0.80 to 0.85 (cell Network_design_inputs!F288).
VoLTE common cost assumptions (Section 3.6)	On the *Network_common* worksheet of the Mobile module, the VoLTE platform assets are now assumed to have no assets designated as common network.
Pure BULRIC adjustments (Section 3.6)	On the *Results_mobile* worksheet of the Service Costing module, the Pure BULRIC for mobile termination is now assumed to include 79% of the BULRAIC for the Telephony Access Server asset and the VoLTE upgrade to the HLR/NMS assets.
Calculation of Plus BULRAIC MTR (Section 4.1)	The calculation of the Plus BULRAIC MTR on the *Results_mobile* worksheet of the Service Costing module has been adjusted to include 4G incoming voice traffic in addition to 2G/3G incoming voice traffic.
Reduction in 4G cell radii	We have reduced the 4G cell radii by reducing the scaling factor in cell Design_inputs_4G!F73 of the Mobile module from 2.0 to 1.7. This factor is more in line with the cell radius ratios in the cost models developed in other countries, such as the UK and Sweden, whilst still giving cell radii that are larger than those for higher frequencies.
Alignment of FTE interconnection opex	In both the Fixed and Mobile modules, on the *Asset_inputs* worksheets, the opex of the “Interconnection team (4FTE)” asset was hardcoded. The relevant inputs from the Interconnection module have been linked in so that the calculated opex is consistent with the Interconnection module.
Update of WACC inputs	On the *Control* worksheet of the Market module, the assumed values for the WACC have been updated, based on values provided to Analysys Mason by ACM. The value for the mobile BULRIC model has been updated from 4.6% to 4.54%, whilst the value for the fixed BULRIC model has been updated from 4.25% to 4.125% (an average of values derived for a fixed operator and for a hybrid-fibre coax operator).
Adjustments of post-2G/3G shutdown network	The v7D mobile BULRIC model did not deploy any 1800MHz 2G (capacity-driven) equipment from 2020 onwards, meaning this spectrum was not used until it was refarmed after the 2G network is shut down. We have therefore adjusted the v7F model to refarm this remaining 1800MHz spectrum early (for 4G purposes) from 2020 onwards. Also, the v7D model had an excess of sites compared to eNodeBs after the shutdown of the 2G/3G networks. These excess sites are now decommissioned after 2G/3G shutdown in the v7F model.

A.3 Reconciliation adjustment for the opex cost trends

When looking at the total actual opex for the operators, there was little change over time, as can be seen in the chart below (which shows average opex across the three operators).

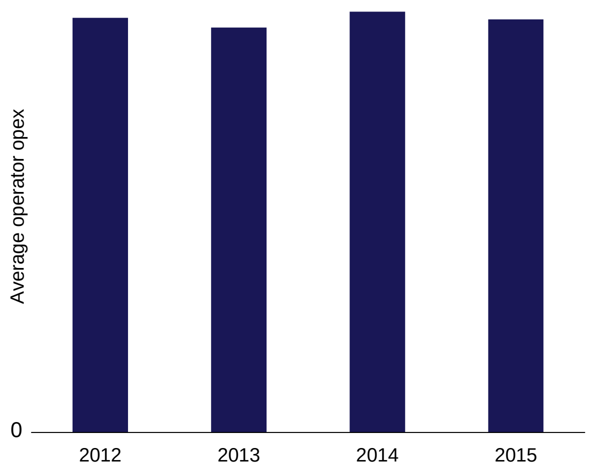


Figure A.1: Average opex across the three operators [Source: Analysys Mason, 2016]

By contrast, the level of opex in the BULRIC model is increasing over time, as shown below in Figure A.2. This indicates that total opex remains roughly flat even though there are more assets in the network. Therefore, we have reduced the opex cost trends in the period 2012–2015 to reduce the opex per asset to give more of a flat profile to the total opex, as illustrated in Figure A.3 below.

Figure A.2: Total opex prior to opex cost trend revision [Source: Analysys Mason, 2016]

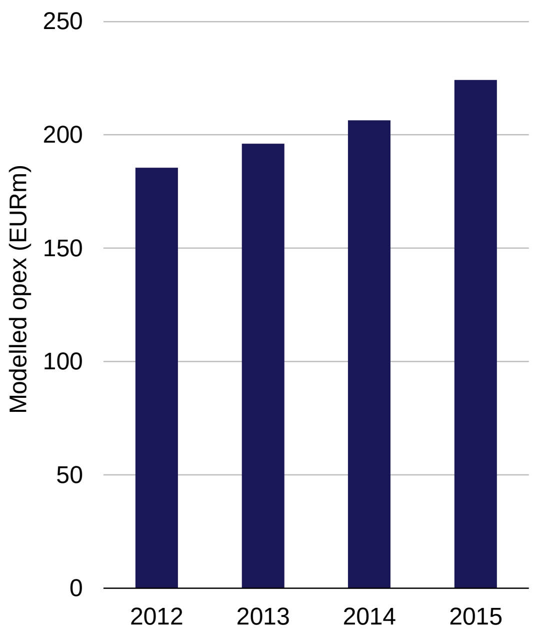


Figure A.3: Total opex after opex cost trend revision [Source: Analysys Mason, 2016]