Report for ACM

Conceptual specification for the update of the fixed and mobile BULRIC models

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1 Introduction

Autoriteit Consument & Markt (ACM) has commissioned Analysys Mason Limited (Analysys Mason) to update the bottom-up long-run incremental cost (BULRIC) models of fixed and mobile networks in the Netherlands, for the purposes of pricing wholesale fixed termination and wholesale mobile termination. These two services fall under the designation of Markets 1 and 2 respectively, in the European Commission's (EC) Recommendation on relevant markets (2014/710/EU).[1]

Analysys Mason and ACM have agreed a process to update the BULRIC models, which will be used by ACM to inform its market analysis for wholesale fixed and mobile termination after the current regulation is due to end in September 2016. This process presents industry participants with the opportunity to contribute at various points during the project.

The original BULRIC models ('v4') were published in April 2010, following a year-long period of development.[2] They were further updated in 2012–2013, with the final version of the updated BULRIC models released in July 2013 ('v6 BULRIC models'). A conceptual specification (document reference 35097-343, the '2012 concept paper') was finalised as part of this update. The published materials form the starting point for this latest update.[3]

In this section, we provide:

- the background to the overall process
- an explanation of the scope of this document
- the overall timeline of the project and opportunities for industry stakeholders to contribute and application of the BULRIC models to pricing of regulated services
- the structure of this conceptual specification.

1.1 Background to the process

ACM is seeking to update a set of BULRIC models for both wholesale fixed and mobile termination services in the Netherlands (Markets 1 and 2 according to the EC relevant markets). ACM also plans to undertake new market analyses of both markets in 2016, with the BULRIC models ready for the completion of these analyses. This will allow ACM to complete an update to the termination rate regulation which is due to expire in September 2016.

1 Formerly Markets 3 and 7, as defined in the EC Recommendation on relevant markets (2007/879/EC).

2 See https://www.acm.nl/nl/publicaties/publicatie/10004/Ontwerp-marktanalysebesluit-vaste-en-mobiele-gespreksafgifte/.

3 See https://www.acm.nl/nl/publicaties/publicatie/11645/Notificatie-ontwerpbesluit-marktanalyse-vaste-en-mobiele-gespreksafgifte-2013-2015/ and https://www.acm.nl/nl/publicaties/publicatie/11321/Ontwerpbesluit-marktanalyse-vaste-en-mobiele-gespreksafgifte-2013-2015/.

As part of the BULRIC model development and subsequent draft decisions, ACM would like to take into account the Recommendation on termination rate costing published by the EC in May 2009.[4] As far as can be justified, ACM also intends to continue to apply consistent principles to both the fixed and mobile BULRIC models.

1.2 Scope of conceptual discussion

Thirty-seven concepts were defined in the final conceptual approach document as part of the development of the v6 BULRIC models of fixed core and mobile networks in the Netherlands, released in April 2010.[5] These were revisited in the update of 2012–2013. The final consultation paper for that update, released in October 2012 (the '2012 concept paper'), should be read in conjunction with the original conceptual approach document. The issues to be considered are classified in terms of four dimensions: operator, technology, services and implementation, as shown below.

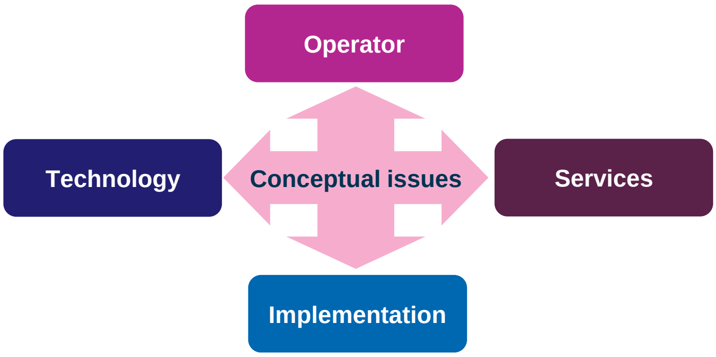


Figure 1.1: Framework for classifying conceptual issues [Source: Analysys Mason, 2016]

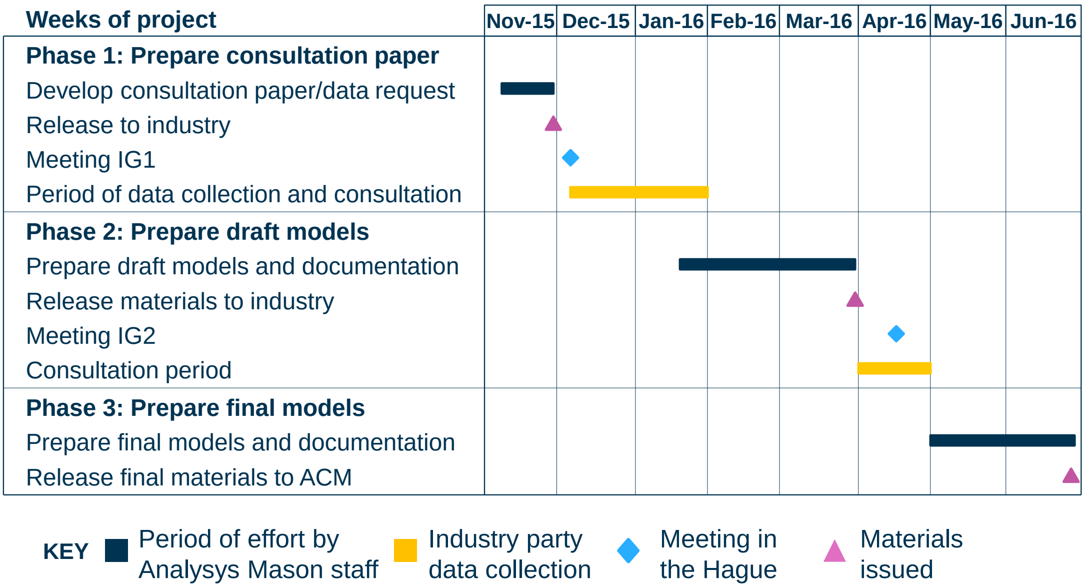
1.3 Project and consultation timetable

This specification presents the conceptual approach for the update of ACM's BULRIC models for both wholesale fixed and mobile termination in the Netherlands. The issues described here for the update will be presented to industry parties at the first Industry Group meeting (IG1), outlined in the overall timetable in Figure 1.2.

4 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.

5 See https://www.acm.nl/nl/download/bijlage/?id=12110.

Figure 1.2: Outline expected project plan [Source: Analysys Mason, 2016]



ACM is looking to set price caps for both fixed and mobile voice termination services after 2016, when the current regulation is due to expire. ACM will undertake a full market analysis and plans to start the national consultation of the BULRIC models later in 2016. The updated BULRIC models should be available by June 2016.

We note that there is an on-going judicial process regarding wholesale voice termination pricing.[6] This process constitutes a separate issue from this update of the BULRIC models.

1.4 Structure of this document

The remaining sections of this document summarise the concepts as finalised in the original project and discuss the aspects of the BULRIC models that should be updated.

- Section 2 describes revisions we propose related to the operator dimension
- Section 3 discusses revisions we propose related to the technology dimension
- Section 4 sets out revisions we propose related to the service dimension
- Section 5 explores revisions we propose related to the implementation dimension.

The report includes one annex (Annex A) that expands the acronyms used in this document.

We highlight any revisions made to the draft concepts in order to arrive at the final concepts using red text. Where we do not propose to change a concept, we leave the concept as is. We label the concept from the previous update in 2012/13 as "Original concept", our revision as "Proposed concept" and a final version following consultation as a "Final concept".

6 For example, see https://www.acm.nl/nl/publicaties/publicatie/14079/CBb-stelt-Europees-Hof-vragen-over-marktanalysebesluit-vaste--en-mobiele-gespreksafgifte/.

2 Operator issues

The following concepts are considered in this section.

Figure 2.1: Decisions on the operator-related conceptual issues taken for the v6 BULRIC models, and items requiring modification in light of this update [Source: Analysys Mason, 2016]

No.	Conceptual issue	Recommendation for the v6 BULRIC models	Revise?
1	Type of operator	Develop models of hypothetical existing operators	Yes
2	Network footprint of operator	National levels of coverage, with indoor coverage for the mobile networks	No
3	Market share	50% market share for the fixed operator and 33.3% market share for the mobile operator	Yes
4	Roll-out and market share profile	Hypothetical profile applied consistently to both the fixed and mobile models	No
5	Scale of operations	Service provider and MVNO volumes will be included in the market, and full-scale operations modelled	No

2.1 Type of operator

The final concept from the 2012 concept paper for the type of operator was as follows:

> **Original concept 1**: We shall develop a model based on a hypothetical existing operator.
>
> The modelled operator is "hypothetical" because no actual operator has the same launch and market share characteristics, and it will have a hypothetical equal share of the relevant market, designated by 1/N. The operator modelled will therefore be:
>
> *An existing mobile operator rolling out a national 900MHz 2G network from 1 January 2004, launching 2G services on 1 January 2006, later supplementing its network with 1800MHz frequencies for extra 2G capacity. This network would also be overlaid with 2100MHz 3G voice and HSPA capacity and switch upgrades (reflecting technology available in the period 2004–2009), to carry increased voice traffic, mobile data and mobile broadband traffic.*
>
> *An existing fixed operator rolling out a national NGN IP core network and a copper access network from 1 January 2004, launching NGN services on 1 January 2006. The access network is assumed to use MDF/VDSL copper-based technology.*

A hypothetical existing operator is defined with characteristics similar to, or derived from, the actual operators in the market, except for specific hypothetical aspects that are adjusted (e.g. date of entry, mix of efficient technologies deployed). In particular, such an operator is not a new entrant. Therefore, it is not appropriate to model a low level of growth that might be anticipated from a real recent market entrant. Such an evolution is unlikely to set a reasonable cost benchmark for the existing, mature, efficient-scale operators. Instead, the operator is assumed to be rolling out a new network deployment for its existing customer base, which is then migrated onto this new network in a relatively limited period of time.

Where possible, this operator can be set up as a typical operator. In the case of the mobile market, where the three existing entrants were all 2G/3G (and now, in 2015, 2G/3G/4G) network owners, a typical operator is easier to define. In the fixed market, there is no typical operator. As a result, a modelling choice was made as to an efficient mix of the technologies to be used by the operator.

We propose to largely maintain this concept because the overarching efficiency goal and market characteristics have not changed substantially. However, we propose to now also model 4G (LTE) radio technologies, since this has now been an established technology for several years in the Dutch market (following the 2012 auction) and is starting to carry material volumes of traffic.

We therefore propose to split the above in two parts, 1a and 1b. The text in concept 1a is unchanged, whilst the text in concept 1b is updated to include 4G technology, as shown below.

Proposed concept 1a: We shall develop a model based on a hypothetical existing operator.

The modelled operator is "hypothetical" because no actual operator has the same launch and market share characteristics, and it will have a hypothetical equal share of the relevant market, designated by 1/N.

Since the spectrum auction completed in late 2012, we assume that the 4G network is deployed in 2013 and activated in 2014.

Proposed concept 1b: The operator modelled will be:

An existing mobile operator rolling out a national 900MHz 2G network from 1 January 2004, launching 2G services on 1 January 2006, later supplementing its network with 1800MHz frequencies for extra 2G capacity. This network would also be overlaid with 2100MHz 3G voice and HSPA capacity and switch upgrades (reflecting technology available in the period 2004–2009), to carry increased voice traffic, mobile data and mobile broadband traffic. An LTE (4G) network overlay will then be deployed initially from 1 January 2013, with services launching from 1 January 2014.

An existing fixed operator rolling out a national NGN IP core network and a copper access network from 1 January 2004, launching NGN services on 1 January 2006. The access network is assumed to use MDF/VDSL copper-based technology.

► *Operator comments on concept 1*

One respondent [✂] agrees with modelling an LTE (4G) network overlay that will be deployed initially from 1 January 2013, with services launching from 1 January 2014.

A second respondent [✂] considers it logical to "*model a 4G overlay network, as this represents the reality in the Dutch market. For the timing of the deployment, the service launch and the load-up AM should use an average across all Dutch mobile networks*."

A third respondent [✂] agrees to the principle of an overlay network, but reserves the right to comment on specific implementation in the resulting BULRIC model.

► *Analysys Mason response*

Proposed concepts 1a and 1b shall therefore be implemented as described.

2.2 Network footprint of operator

The final concept from the 2012 concept paper on the network footprint was as follows:

> **Concept 2**: National levels of geographical coverage will be reflected in the models comparable to that offered by current national fixed (or combined cable) and mobile operators in the Netherlands, including indoor mobile coverage. The definitions of coverage and capacity will be focused on solving the pure BULRIC calculation based on the effects of removing wholesale termination traffic from the network carrying all service demand, taking into account the requirement to provide the option or ability to make a call anywhere in the network.

We propose to maintain this concept and will therefore apply it to the modelled 4G networks in the updated mobile BULRIC model.

We will request that the Dutch fixed and mobile operators provide updated information on their actual coverage profiles (stating the assumed signal strength). The modelled national/outdoor/indoor coverage profiles will then be considered against the actual roll-out. In particular, we will ascertain whether actual operator coverage has consistently exceeded the coverage levels specified in the mobile BULRIC model to a material extent. We will also request information on 4G coverage deployments.

► *Operator comments on concept 2*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] refers to its previous responses on this topic, which also apply to 4G networks. It also reserves the "*right to comment on (updated) network coverage assumptions in the updated BULRIC model in view of increasing pressure on mobile operators to provide even more ubiquitous coverage due to the growing importance of mobile services*".

► *Analysys Mason response*

The concept shall therefore be implemented as described.

2.3 Scale of operator

The concepts on operator scale are related to market share, roll-out and the scale of network operations. We consider these in turn below.

2.3.1 Market share

The final concept from the 2012 concept paper on the market share was as follows:

> **Original concept 3**: The modelled fixed operator will have a 50% share of the fixed market. The modelled mobile operator will have a 33.3% share of the mobile market.

In the development of the v6 BULRIC models, it was assumed that N=3 for the mobile BULRIC model. A major spectrum auction occurred during this update, which included spectrum ring-fenced for a new entrant. This spectrum was won by Tele2, which has since launched 4G services in the Netherlands during 2015. Tele2 has a (passive site) sharing agreement in place with T-Mobile.[7] The fixed operator Ziggo also acquired some spectrum holdings in the 2600MHz band.

In the original concept specification, N was based on the current number of national mobile network operators supporting voice and mobile data demand using 2G and 3G technologies in the Netherlands.

The definition of N therefore needs to be reconsidered given that 4G is now to be included within the BULRIC model. We propose that mobile traffic in the Netherlands is first divided into "total 2G/3G traffic" and "total 4G traffic". The traffic assumed to be carried by the modelled 2G/3G networks is then derived by dividing total 2G/3G traffic by N, whilst the traffic assumed to be carried by the modelled 4G networks is then derived by dividing total 4G traffic by a new input, "N4G".

We are of the view that the arguments remain strong for N=3. As we described in the previous update, Tele2 is not a fourth independent 2G or 3G mobile network, which would be necessary for having N>3.

N4G can be defined for 4G by considering the status of the five 4G network operators in the country:

- KPN, Vodafone and T-Mobile have all deployed near-national 4G networks.
- Tele2 has yet to fully establish its network operations (for example, its MVNO subscriber base has not yet been announced as having been migrated to its own network, although Tele2 announced intentions to complete this during 2015). However, Tele2 has indicated that it will

7 See http://www.tele2.com/media/press-releases/2013/tele2-ab-t-mobile-and-tele2-to-share-antenna-sites-in-the-netherlands/.

be taking on new 4G subscriptions by the end of 2015 and is deploying its national network ahead of schedule.[8]

- Ziggo only has 2600MHz spectrum holdings. We do not believe it has the spectrum holdings necessary to become a fifth nationwide 4G mobile network operator offering wide area coverage (and currently has only very limited deployments targeting business users[9]).

On this basis, we conclude that N4G=4 is appropriate for the coming regulatory period.

We do not propose to the revise the market share assumed for the modelled fixed operator (50%) because market entry conditions in the fixed market appear unchanged.

Proposed concept 3: The modelled fixed operator will have a 50% share of the fixed market. The modelled mobile operator will have a 33.3% share of the 2G/3G mobile market and a 25% share of the 4G mobile market.

► *Operator comments on concept 3*

One respondent [✂] states that it understands the concept of a 50% market share for a fixed operator "*for the access network part, but concluded earlier that the access networks are hardly a relevant cost factor in the fixed model. As for the NGN costs that are relevant to the costs in the model the Dutch market, with independent service providers based on ULL/VULA or WBA wholesale services, the approach seems questionable. A model choice for a 50% market share would exclude the existing costs and services of these alternative providers for costs they incur themselves (such as DSLAM's, transmission, switches) for their services, including for call termination. Competition and costs actually exist of more than two networks / 50% in the Dutch market.*

If however this choice would be maintained, the costs of the hypothetical operator should not be checked against the actual costs incurred by smaller operators. As [✂] has stated earlier, a modelled 50% national fixed operators should be able to offer services to all (consumer and business) customers, with all specific requirements for various market segments. The differentiation in plat-forms and services elements, necessary to serve all these segments, should be included in the model. The approach that ACM and Analysys Mason have used in the FTA 3b and FTA 4 decision – which seems to be based on more or less averaging VOIP license costs of many much smaller operators and much less differentiated than the modelled operator should be – therefore unrealistically underestimates the realistic hypothetical costs."

The same respondent states that "*it seems reasonable to use 33% for the 2G/3G mobile market, and 25% for the 4G mobile market, given the fact that the Court (College van Beroep voor het bedrijfsleven, CBb) justified the choice of ACM in 2010 not to follow the Recommendation of the EC on this issue.*"

8 See https://www.tele2.nl/newsroom/2015/tele2-lanceert-4g-abonnementen-voor-eind-2015/.

9 See https://www.ziggo.nl/zakelijk/klantenservice/z/extra-diensten/mobielbreedband/.

A second respondent [✂] "*finds it justified to assume N=4 in the model, as [✂] also argued in previous responses. The current reality of the Dutch market is that there are 4 mobile networks*."

A third respondent [✂] "*supports ACM's decision to acknowledge 4 existing nation-wide 4G networks in NL*." However, it disagrees that "*Ziggo's 2.6GHz-only holdings and limited deployment should disqualify it as a 5th competitor in the consideration for market share development over the coming regulation period. Given the rapid ramp-up of its mobile customer base (where it enjoys significant leverage from its fixed customer base) and its easy access to a vast number of potential 4G site locations (e.g. current Wifi hotspots and street hubs) Ziggo should be considered likely to reach critical mass and deploy its own 4G network within the upcoming regulation period*." The respondent therefore views N4G = 5 as a more correct representation for the upcoming regulation period.

► *Analysys Mason response*

Regarding the fixed operator market share brought up by the first respondent, we believe that our arguments as discussed in the 2012 concept paper still hold.[10] In particular:

- If a national fibre access network was deployed in the long term, then disconnection of the copper access network would be expected
- We do not consider that unbundlers can be considered as national infrastructure access operators; it is simply that they prefer to rely on unbundled access to copper and/or cable lines
- It would be unrealistic to assume three or more national operators, since there are not this many players with full national and regional transmission networks, or full national exchange building deployments. In particular, the fixed costs (economies of scale) for a national three-level fixed core network are sufficiently great that a large number of players will not set an efficient cost price for voice termination.

Consequently, we still consider it reasonable that two national networks should provide the efficient cost for fixed voice termination in the long run. Regarding the first respondent's comment on the treatment of VoIP costs, we will account for this comment during our derivation of the VoIP system cost inputs for the v7D model, although we note that this comment was brought up and considered during the previous update.

Regarding the mobile market share, we would observe that Tele2 launched its near-national 4G-only network in November 2015.[11] Further, we note the February 2016 announcement from Ziggo and Vodafone that they have agreed to form a joint venture combining their respective businesses in the Netherlands, with completion of the deal planned by the end of 2016.[12] We take this second point as evidence that the third respondent's expectations of a significant separate mobile network

[10] See https://www.acm.nl/nl/download/bijlage/?id=11923, page 14.

[11] See http://www.tele2.com/media/press-releases/2015/tele2-starts-data-revolution-in-dutch-market/.

[12] See http://www.vodafone.com/content/index/media/vodafone-group-releases/2016/lg-vodafone-merge-dutch-operations.html.

deployment by Ziggo are less likely to materialise (notwithstanding Ziggo’s limited spectrum holdings).

Taking both these developments together, we believe that the assumptions made in the draft concept paper regarding N=3 and N4G= 4 are reasonable.

The proposed concept shall therefore be implemented as the final concept.

2.3.2 Roll-out

The final concept from the 2012 concept paper on the roll-out was as follows:

Concept 4: We shall model the hypothetical existing operator with a hypothetical roll-out and market share profile. This principle will be applied identically to the fixed and mobile costing:

- the operator will already be in existence, operating on 1 January 2004, with a legacy network and legacy access connections to a hypothetical 1/N share of the market
- it will roll out its national NGN traffic-sensitive network over two years and launch service on 1 January 2006
- basic legacy services (e.g. residential voice, residential data, GSM voice, SMS and GPRS data) will be moved onto the NGN network as quickly as possible
- complex legacy services (e.g. business ISDN, business connections) will be moved onto the NGN over the period of time in which service support, emulation and customer equipment (e.g. PABXs) can be prepared for the marketplace
- traffic from new services (e.g. HSDPA, IPTV) will increase on the NGN as these services are expected to develop over time.

This is important in that it sets out the definition of the operators to be modelled. In particular, the BULRIC models consider only next-generation network (NGN) infrastructures. The legacy network is not modelled, but is relevant insofar as it provides an existing customer base that can be rapidly switched to the NGN. Loading curves are used to define how legacy subscribers and traffic are migrated onto the NGN. The loading curves used are illustrated below.

In particular, the loading curves for fixed business services are relatively slow. This is to allow for the transition time for business customers to migrate to NGN services, as well as for the necessary service support and customer equipment (such as PABX) to be developed.

Figure 2.2: Loading curves used in the fixed BULRIC model [Source: v6 BULRIC model, 2016]

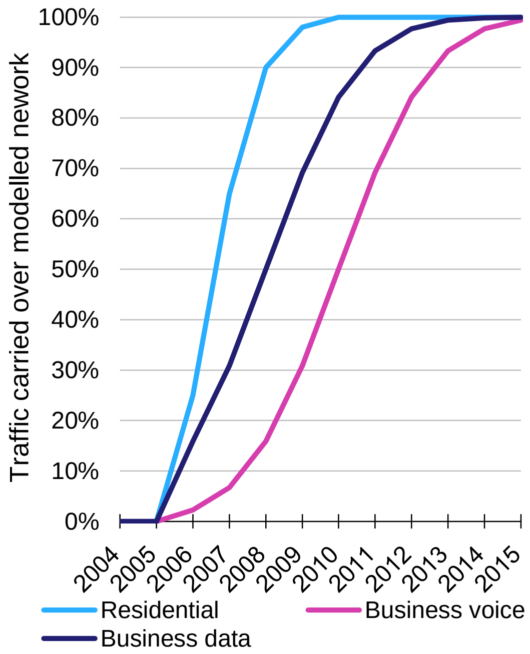
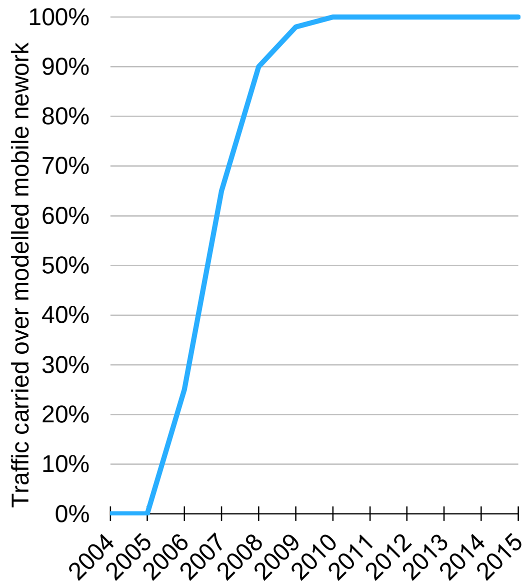


Figure 2.3: Loading curve used in the mobile BULRIC model [Source: v6 BULRIC model, 2016]



We do not think this concept needs to be changed, since the evolution of 4G traffic is captured in the last bullet.

► *Operator comments on concept 4*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to the remarks it made in the previous regulatory period. In its earlier remarks, the respondent stated that the "*approach does not allow for recovery of ramp up costs and therefore ignores a significant and unavoidable cost factor of entering into mobile business*." The respondent therefore "*disagrees with this approach that seems biased towards bringing MTA rates down rather than enabling a price level sufficient to recover an operator's unavoidable costs of entering into business.*"

► *Analysys Mason response*

With regard to the third respondent, we note that this approach was first justified in earlier concept papers, with a consistent treatment of both fixed and mobile networks considered of importance. We do not consider that implementations where the modelled operator either matched a historical roll-out or used historical operator inputs would lead to a consistent treatment of fixed and mobile network costs in an efficient, modern, forward-looking context. The actual evolution of copper, cable and mobile networks is related to events and expectations from several decades ago. Reflecting actual evolution could lead to costs that are heavily dependent on historical developments of different operators, rather than the costs which today's modern, forward-looking operators should achieve through the operation of efficient networks. Therefore, earlier concept papers concluded that the chosen approach was competitively neutral and could be applied consistently to both fixed and mobile BULRIC models.

The concept shall therefore be implemented as described.

2.3.3 Scale of network operations

The final concept from the 2012 concept paper on the scale of network operations was as follows:

> **Concept 5**: Service provider and MVNO volumes will be included in the market, however full-scale network operations will be modelled.

We have not identified a need to change this concept.

► *Operator comments on concept 5*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to the remarks it made in the previous regulatory period, in which it agreed with concept 5.

► *Analysys Mason response*

The concept shall therefore be implemented as described.

3 Technology issues

The following concepts are considered in this section.

Figure 3.1: Decisions on the technology-related conceptual issues taken for the v6 BULRIC models, and items requiring modification in light of this update [Source: Analysys Mason, 2016]

No.	Conceptual issue	Recommendation for the v6 BULRIC models	Revise?
6	Radio network	Use GSM deployed in 900MHz and 1800MHz bands, and UMTS deployed as a 2100MHz overlay	Yes
7	GSM radio spectrum	Model an operator with 33.3% of GSM/DCS spectrum	Yes
8	UMTS radio spectrum	Model an operator with 2×10MHz of UMTS spectrum	Yes
9	Spectrum payments	Derived once outcome of the 2012 auction is known	Yes
10	Mobile switching network	Deploy combined 2G+3G MSCs from launch, followed by MSS+MGW layered equipment	Yes
11	Mobile transmission network	Model a national leased dark fibre network and self-provided transmission equipment running STMn in the 2G/3G core network, with Gbit/s after 2011	Yes
12	Fixed access network	Model a copper-based fixed access network using VDSL at the MDF	No
13	Fixed switching network	An IP BAP NGN will be modelled, with associated platforms and support for a reasonable level of redundancy and service qualities	No
14	Fixed transmission network	Model IP and IP/MPLS over Ethernet and WDM in the fixed next-generation core network	No
15	Network nodes	Apply the modified scorched-node principle	No

3.1 Modern mobile network architecture

This section describes our proposed revisions to the modelled network architectures in both the mobile and fixed BULRIC models. We requested updated unit capital expenditure information for the key assets in their respective networks, i.e.:

- BTS, TRX, NodeB, BSC, RNC, MSC and MGW in the mobile BULRIC model
- VoIP-related equipment, DSLAMs, routers and buildings in the fixed BULRIC model.

This allowed the capital cost trends to be updated in the *Cost_trends* worksheets in the Fixed and Mobile modules. We will invite the IG to provide updated information as to the capacities and utilisation levels of the assets that are considered in both the fixed and mobile BULRIC models.

3.1.1 Radio network

The final concept from the 2012 concept paper for the modelled radio network was as follows:

Original concept 6: The mobile model will use both 2G and 3G radio technology in the long term, with GSM deployed in 900MHz and 1800MHz bands, and 3G deployed as a 2100MHz overlay.

In the original conceptual specification, only 2G technologies (using 900MHz and 1800MHz frequencies) and 3G technologies (using 2100MHz frequencies) were included in the mobile BULRIC model network design. This was on the basis that both technologies are proven and available, and also consistent with the EC Recommendation.

We believe there are three issues to consider in this update, which we discuss below:

- whether 4G data/voice technologies should be included in the BULRIC model
- whether alternative frequencies should be considered for 2G and 3G technologies
- whether S-RAN technology should be considered in the BULRIC model.

4G technologies (including 4G voice)

Previously, it was concluded that although fourth-generation (4G) mobile technologies such as LTE may be deployed in the long term in the Netherlands, these networks were expected to be focused on delivering higher-rate mobile data services. Given the large capacities available in a modern network using 900MHz, 1800MHz and 2100MHz frequencies, a fourth-generation overlay was considered unlikely to be used to deliver large volumes of wholesale mobile voice termination in the short to medium term.

We observe that five operators acquired frequencies in the auctions in 2010 and 2012 (KPN, T-Mobile, Vodafone, Tele2 and the cable operator Ziggo).

There are economies of scope through deploying a 4G overlay with the 2G/3G networks, due to asset sharing. For example, 4G base stations can be co-located at existing radio network sites and can also share the use of the transmission networks. Based on our experience in other jurisdictions, the inclusion of 4G technologies in a mobile cost model has some impact on the Pure BULRIC of wholesale mobile termination and a larger impact on the Plus BULRAIC of wholesale mobile termination.

ACM has indicated in its own reporting that it believes that 4G investment is largely completed.[13] Therefore, we conclude that 4G technology needs to be captured in the mobile BULRIC model to understand its impact. We assume that the technology will use the 800MHz, 1800MHz and 2600MHz spectrum made available in the 2010/2012 auctions.

The v6 BULRIC model assumes that the 2G and 3G networks are shut down by 2019, which falls within the timeframe of the next regulatory period. In late 2015, several Dutch operators have announced forthcoming commercial launches of VoLTE (including KPN, T-Mobile and

[13] See https://www.acm.nl/en/publications/publication/14306/Telecommonitor-Q4-2014/.

Tele2[14,15,16]). Therefore, we conclude that modelling a VoLTE platform (as the next generation of mobile telephony) is necessary to understand the cost impact of the technology on wholesale termination within the forthcoming regulatory period.

Alternative frequencies for 2G and 3G technologies

In the original conceptual specification, the 2G network design was assumed to use 900MHz and 1800MHz frequencies, whilst the 3G network design was assumed to use 2100MHz frequencies. We have requested data from operators to ascertain how they plan to use their spectrum holdings for 2G and 3G technologies in the Netherlands in the future.

As a result of the auction in late 2012, operators have access to frequencies in the 800MHz, 900MHz, 1800MHz, 2100MHz and 2600MHz bands. Of these five bands, we do not believe that the 800MHz and 2600MHz frequencies are needed for an efficient use of 2G and 3G technologies (these are mainly intended for 4G). We still consider that the only frequencies relevant to 2G technologies are the 900MHz and 1800MHz frequencies.

With respect to 3G technologies, the v6 BULRIC model assumed that the modelled network achieved 92% 3G population indoor coverage in the long term, using only 2100MHz frequencies. The equipment specific to the 2G and 3G networks was shut down (and all costs recovered) by 2019.

Current levels of actual 3G coverage with 2100MHz frequencies in the Netherlands are high. Therefore, incremental coverage using 900MHz frequencies in the future (if any) would be small. It would also require an assumed reduction in the spectrum assumed for 2G 900MHz use, to allow frequencies to be used for 3G 900MHz. Although it could be the case that 3G 900MHz coverage is deployed in the Netherlands, it is an outcome within the control of actual operators and not obligated by any frequency package allocation. Therefore, our starting position will be to retain our existing assumption of using only 2100MHz frequencies for 3G deployments.

The v6 mobile BULRIC model contains HSDPA technology up to 21Mbit/s. If it is found that 42Mbit/s (‘HSPA+’) or higher speeds have been deployed by existing operators to carry a higher data traffic load, then we can update the 3G network design to reflect this development.

Treatment of S-RAN

The v6 BULRIC model deploys BTSs and NodeBs, i.e. 2G-only base stations and 3G-only base stations. In recent years, replacement of these units with “combined” base stations (i.e. units that provide 2G and/or 3G and/or 4G functionality) have been designed by vendors and are commonly

14 See http://corporate.kpn.com/pers/persberichten/kpn-maakt-mobiele-ervaring-nog-beter-met-bellen-over-4g.htm.

15 See http://www.telecompaper.com/news/t-mobile-nl-to-introduce-volte-on-4g-network-next-year--1106825.

16 See http://news.cision.com/tele2-ab/r/tele2-starts-data-revolution-in-dutch-market,c9865160.

referred to as single-radio access network (S-RAN) technology. Having fewer base station units can lead to lower operating costs per site (e.g. through more efficient power and container space use) and lower backhaul costs (given that only one backhaul link is required per site, rather than one per base station). Such advances could be recognised in the updated mobile BULRIC model by defining new “combined base station” assets, which are deployed as replacements for existing base stations over a defined period of time. We are aware of at least one Dutch operator (T-Mobile) implementing an S-RAN upgrade.[17]

Although S-RAN is a more efficient 2G/3G technology than its standalone equivalents, we do not believe it would be efficient in the context of ACM’s v6 BULRIC model, which assumes 2G/3G networks are shut down by 2019. Deploying an S-RAN would require replacement of the existing standalone 2G/3G units, which, as can be seen below in Figure 3.2, start being replaced in 2012 (after the initial eight-year asset lifetime has expired).

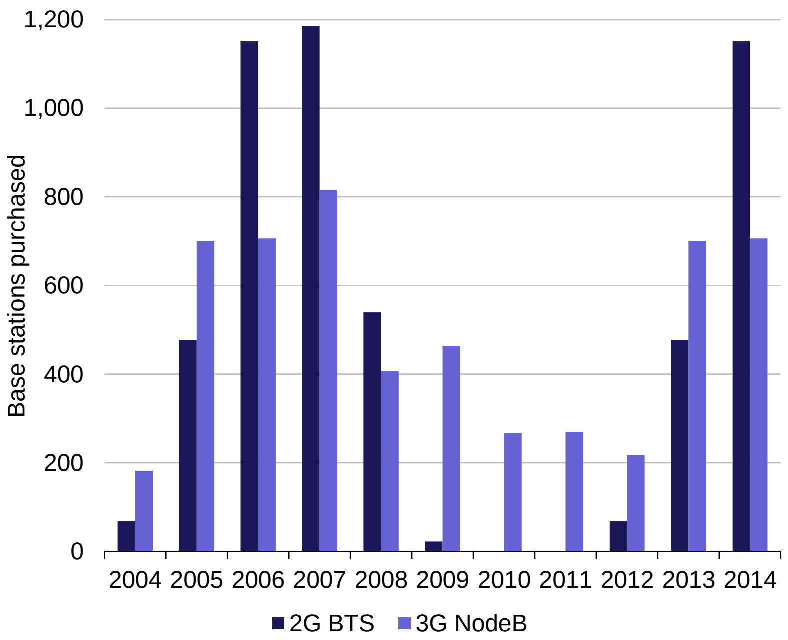


Figure 3.2: Illustration of 2G/3G base station deployments in the period 2004–2014 [Source: v6 BULRIC model, 2016]

If an S-RAN was deployed as a national “hot swap” at any point in time after 2012, then these assets would be:

- replacing a significant proportion of almost brand new, standalone 2G/3G equipment
- shut down in 2019 well in advance of their useable lifetime.

We do not believe this to be an efficient assumption. We instead propose to keep the standalone 2G/3G equipment operational until 2019, at which point it is shut down as is currently the case in the v6 BULRIC model.

17 See http://newsroom.t-mobile.nl/t-mobile-nederland-sluit-contract-met-huawei-voor-bouw-lte-netwerk.

Conclusion

Proposed concept 6: The mobile model will use both 2G and 3G standalone radio technology, with 2G deployed in 900MHz and 1800MHz bands, and 3G deployed as a 2100MHz overlay. 4G radio technologies will also be deployed as an overlay, using the 800MHz, 1800MHz and 2600MHz bands.

► *Operator comments on concept 6*

One respondent [✂] makes a number of points related to this concept:

- "[✂]
- *The assumption to shut down the 2G/3G by 2019 is far from realistic. [✂] will still rely on the circuit switched voice service. These customers either use devices which are only enabled for 2G/3G or 4G devices that are not VoLTE-enabled (and use circuit switched fall-back on 2G/3G for voice). Besides our own customers, lots of roamers visitors or MVNO customers that we provide our services for, are also not using VoLTE devices.*
- *We assume that the 2G radio network will be in place [✂]*
- *Looking forwards to 2019 (and further), most of the data will be carried by 4G; using most of the spectrum (and radio equipment) of 1800MHz, 2100MHz and 2600MHz. The usage of the 900-spectrum (and also for the specific 2G/3G equipment) however is mainly driven by voice*."

A second respondent [✂] states that, with regard to the proposal to leave out S-RAN, "*The overarching goal should be to ensure that the outcomes from the model are an accurate reflection of the costs incurred by an efficient operator in the Dutch market. To the extent that AM can make it likely that their modelling choices do not have an artificial negative impact on the outcomes, it might be justified to deviate – within reasonable limits - from the actual situation*."

Additionally, this respondent questions the "*assumption that Dutch mobile operators can switch-off 2G entirely by 2019, and by doing so no longer support end-users that do not have VoLTE enabled handsets. However, if Analysys Mason had to model this hypothetical option it is clear that significant costs would be associated with such a rigorous course of action on the part of mobile operators. These costs could, for example, be found in the need to subsidize VoLTE handsets more actively to increase the VoLTE enabled handsets in the customer base or to stop selling non-VoLTE enabled handsets (which means a loss of customers to operators that would continue selling these handsets). Other costs would include the loss of customers after the completed 2G switch-off to other networks that continue to support non-VoLTE handsets. An actual operator needs to make constant trade-offs between network rationalisation and the overall financial impact on the company as a whole. An efficient operator will at any time focus on efficiency at the company level given the various trade-offs it faces in order to minimise costs and increase its profit base. In a competitive market, where operators cannot switch-off 2G simultaneously, an individual efficient operator cannot afford to unilaterally decide to switch-off. AM should model an operator that is constrained by other competitors rather than a hypothetical* *situation where operators can act as monopolists. From earlier responses of AM we have learned that AM has considered costs that directly result from network optimization, but are outside the network domain, should not be included in the model. However, not including such costs, for example because these costs are incurred in the retail domain (as is the case if customers are lost due to network decisions that are sub-optimal from a total company perspective), will lead to a situation where a network is modelled that will never exist in a competitive market. Thus, AM should model a network that is efficient from an overall company perspective, not from a narrow network optimisation perspective. In case of the high costs/revenue losses associated with a relatively early switch-off, AM should internalize these costs in the model.*

A similar concern stems from the fact that AM models a network based on information that at the time of network deployment was not available. Today, with hindsight, it might in theory be optimal to not have deployed S-RAN equipment in earlier years. However, the problem with this is that this decision is made with the current knowledge on when 2G and 3G could be phased-out. However, at the time when operators made the decision to invest in S-RAN, they faced much more uncertainty with regard to how long 2G and 3G would need to be supported. Efficient operators need to make robust technology choices, that will lead to acceptable outcomes in various future scenarios. It's obvious that these acceptable outcomes will generally be less efficient in comparison to a hypothetical scenario in which operators have perfect foresight. If one models an efficient operator with perfect foresight, this will again lead to a network that will not exist in reality. In a real life situation, efficient operators deal with uncertainty with regard to technological evolution, market developments and demand patterns. Any model thus needs to reflect market realities in a sufficient way to ensure realistic modelling outcomes.

Another potential modelling issue is that investment cycles in reality can differ significantly from the assumptions made in the model. Whereas AM assumes rather 'discrete' investment cycles, where equipment is replaced in a very straight-forward way at the end of the accounting lifetime, in reality there are all kinds of trade-offs made by network engineers. In many instances equipment is retained longer or shorter than its accounting lifetime. Often trade-offs need to be made between full replacement or partial upgrades (e.g. a software upgrade, or replacing certain hardware elements). The result is that the network constantly evolves, to be able to keep up with competing networks. AM needs to make sure that their simplifications (that can be justified by the need to manage complexity) do not lead to an underestimation of the network costs."

A third respondent [✂] "*disagrees with the 2G/3G network shutdown in 2019 as proposed by ACM/Analysys Mason*". It expects "*phase-out of handsets suitable for only 2G and/or 3G to slow down significantly […] As a consequence, mobile operators will likely be required to offer 2G and 3G connectivity for a significantly longer period, at least until 2025.*" The respondent also disagrees with the assumption "*that deployment of 3G in 900MHz is optional and therefore inefficient. Also in view of slower phase out of 2G/3G technologies and considering increasing pressure on mobile operators to provide highest grade coverage anywhere in the Netherlands, for both voice and data services, deployment of 3G in 900MHz is likely becoming a necessity for any operator intending to serve a representative share of the market. As a consequence, at least 2×5MHz of 900MHz spectrum should be allocated to 3G technology. Due to lesser spectrum reuse* *efficiency in low bands, the allocation of 2×5MHz spectrum in 900MHz to 3G cannot be fully deducted from the spectrum allocation in 2100MHz.*"

► *Analysys Mason response*

Based on the recent forecast information received from operators, we have concluded that the modelled networks should retain the capability to serve 2G- and 3G-enabled handsets beyond 2019. The assumed migration, whilst still beginning in 2016, will now continue until 2023, at which point both 2G and 3G technologies will be shut down and removed from the BULRIC model. We also assume that no new/replacement capex in 2G/3G technologies will occur after 2019, i.e. within half an asset cycle of the assumed 2G/3G network shutdown.

With regard to the use of UMTS 900MHz, we assume that these frequencies are retained for use by the 2G network until the end of its lifetime. As previously stated, 3G coverage in the Netherlands is extensive (and the model specifically assumes this is achieved by 2100MHz frequencies). Therefore, incremental coverage using 900MHz frequencies in the future would be relatively small and these base stations would only be used for one asset cycle before being deactivated. We therefore make the simplifying assumption that any additional 3G coverage achieved (where this coverage is informed by operator data) is only achieved using 2100MHz frequencies.

We therefore finalise the concept as follows:

Final concept 6: The mobile model will use both 2G and 3G standalone radio technology, with 2G deployed in 900MHz and 1800MHz bands, and 3G deployed as a 2100MHz overlay. 4G radio technologies will also be deployed as an overlay, using the 800MHz, 1800MHz and 2600MHz bands. Migration away from 2G and 3G networks will still start in 2016 as in the v6 BULRIC model, but will continue until 2023 rather than 2019.

3.1.2 Radio spectrum

The final concepts from the 2012 concept paper for the modelled radio spectrum were as follows:

Original concept 7: We shall model an operator with 2×11.6MHz of GSM spectrum. We shall model an operator with 2×18.2MHz of DCS spectrum.

Original concept 8: We shall model an operator with 2×20MHz of UMTS spectrum.

The holdings across the four current national mobile network operators (rather than just the three that were in scope in the previous BULRIC model update) are as shown in Figure 3.3.

Figure 3.3: Paired spectrum holdings by operator and band [Source: Telecompaper,[18] 2015]

Operator	800MHz	900MHz	1800MHz	2100MHz	2600MHz
KPN	2×10	2×10	2×10 + 2×10	2×20	2×10
Vodafone	2×10	2×10	2×10 + 2×10	2×20	2×10
T-Mobile	–	2×10 + 2×5	2×10 + 2×10 + 2×10	2×20	2×5
Tele2	2×10	–	–	–	2×10 + 2×10
Total	**2×240**	–	–	–	–

As described in Section 2.3.1, we have argued to exclude Ziggo from the context of the BULRIC model. We also believe that unpaired 2600MHz spectrum can be excluded, since the focus of the BULRIC model is on technologies using paired spectrum.

If we now reformulate Figure 3.3 in terms of coverage and capacity spectrum for 2G, 3G and 4G technologies, then this allows us to define an allocation of spectrum for the hypothetical operator in the BULRIC model that is largely consistent with the current allocations in the Dutch market, as shown in Figure 3.4 below.

We have highlighted allocations that we have moved around compared to Figure 3.3 above with corresponding text of different colours (this is mainly undertaken for T-Mobile, as can be seen in Figure 3.3 above).

Figure 3.4: Spectrum holdings by operator and band/technology [Source: Analysys Mason, 2016]

Operator	4G coverage (mainly 800MHz)	2G coverage (900MHz)	2G capacity (1800MHz)	4G capacity in (mainly 1800MHz)	3G (2100MHz)	4G capacity (mainly 2600MHz)
KPN	2×10	2×10	2×10	2×10	2×20	2×10
Vodafone	2×10	2×10	2×10	2×10	2×20	2×10
T-Mobile	2×10	2×10	2×10	2×10	2×20	2×5 + 2×5
Tele2	2×10	–	–	2×10	–	2×10
No. of operators	4	3	3	4	3	4
BULRIC operator	**2×10 of 800**	**2×10 of 900**	**2×10 of 1800**	**2×10 of 1800**	**2×20 of 2100**	**2×10 of 2600**
Total	**2×240**					

We believe that concepts 7/8 are appropriate for the BULRIC model up to the point at which the main refarming and migration to 4G commences (the ‘refarm date’), after which we would

[18] For 2.1GHz holdings, we have used https://www.internetconsultatie.nl/bedrag_verlenging_2100_mhz_vergunningen/document/1758.

propose that the modelled operator has the spectrum profile as shown above. We will define this point in time in conjunction with information from the operators on their current spectrum usage.

Should the refarm date be later than 2013 (when the 4G network is assumed to be first deployed), then we will assume that the network does not have access to 1800MHz spectrum in the intervening period.

Proposed concept 7: We shall model an operator with 2×11.6MHz of GSM spectrum until the refarm date and 2×10MHz thereafter. We shall model an operator with 2×18.2MHz of DCS spectrum until the refarm date and 2×10MHz thereafter.

► *Operator comments on concept 7*

Two respondents [✂] provide no specific comments on this concept in their response.

A second respondent [✂] "*disagrees with the exclusion of any spectrum holdings as proposed by ACM, including holdings by Ziggo and of 2.6GHz TDD […] any hypothetical operator modelled to serve a certain share of the market (be it 33%, 25% or 20%) should be equipped with an equal and representative share of total spectrum holding as actually held by all existing operators over the relevant regulation period. Excluding actual spectrum holdings (i.e. costs) on the basis that they are not used seems arbitrary as operators do actually incur costs to hold this spectrum. Also these holdings cannot be considered inefficient as license durations are long and opportunities to purchase spectrum are few. As a consequence much spectrum is held by operators in anticipation of future usage and therefore are and intrinsic part of their cost base. [✂] also again disagrees with rounding this holdings to multiples of 5MHz in absence of any technological restrictions, referring to its previous response on this subject.*"

► *Analysys Mason response*

As can be seen above, we have included all the paired spectrum holdings of the four operators in the Netherlands that we consider to be directly relevant to the BULRIC model (we do not consider Ziggo's allocations in the 2600MHz band to be relevant, as described above). In particular, based on the set-up in Figure 3.4 above, the modelled operator is assumed to have precisely 1/N of spectrum used for 2G/3G purposes and 1/N4G of the spectrum that is used for 4G purposes.

We do not agree with the second respondent that assuming multiples of 5MHz is unreasonable for the model: 3G and 4G technologies most commonly use spectrum in contiguous 5MHz blocks and it is also the minimum quantum by which the spectrum was auctioned in the Netherlands. Regardless of this point, in our approach above, we have not needed to round any of the values we have calculated.

The proposed concept shall therefore be implemented as the final concept.

Proposed concept 8: We shall model an operator with 2×20MHz of UMTS spectrum.

For the purposes of the 4G network, from the refarm date onwards we shall model an operator with 2×10MHz of 800MHz spectrum, 2×10MHz of 1800MHz spectrum and 2×10MHz of 2600MHz spectrum. Prior to the refarm date, we shall assume the 4G network does not have access to the 2×1800MHz spectrum holdings.

► *Operator comments on concept 8*

One respondent [✂] agrees with the spectrum assignment to the generic operator, however it states that "*the cost (allocation) of the 800-spectrum should take into account that this bandwidth is used for coverage; for data as well as for voice (VoLTE). Therefore it is not correct to allocate the cost (and equipment) of the 800MHz, only based on capacity. When capacity in Mb will be the only allocation driver, most of the costs of 4G will be allocated to the data-service, while it is increasingly important to deliver also voice-service*."

A second respondent [✂] believes that the assumptions relating to the 800MHz spectrum are debatable, as the amount of 800MHz spectrum is only sufficient for three 4G operators. It states that "*This could potentially lead to an underestimation of the actual costs of efficient Dutch operators. Whether this will be the case depends on the way this will be reflected in the model. Important factors that could lead to an underestimation are among others an undervaluation by AM of 800MHz spectrum and whether the trade-off between the number of sites and the amount of spectrum is determined correctly*." However, "*provided that the eventual modelling will sufficiently reflect realities, …, consider it justified to assume that the hypothetical efficient operator will deploy 800MHz for its 4G network.*"

A third respondent [✂] "*would see all available spectrum distributed proportionally across the assumed number of hypothetical operators per technology. As ACM makes a differentiation in number of operators on 2/3G and 4G, this raises the issue of distribution of voice and data traffic between 3G and 4G technologies*." It reserves the right to comment on the exact distribution between 2/3G and 4G spectrum after analysis of the updated BULRIC models, with updated traffic development forecasts included as well as on the 'refarm date', if and when implemented in the mobile BULRIC model.

► *Analysys Mason response*

The 800MHz spectrum is used for both voice (VoLTE) and 4G data. However, it is an established principle of the BULRAIC calculation that the average incremental cost of the services is calculated. This means that whilst the 800MHz spectrum does support both voice and data, it is shared between the services according to the occupancy of capacity (bandwidth) and not the relative importance of the services in the opinion of industry parties (or consumers).

The valuation of spectrum is discussed in the next section. The distribution of spectrum is discussed in the previous section. The refarming is supported by operator data, which indicates that operators have already refarmed some 1800MHz spectrum for 4G purposes.

The proposed concept shall therefore be implemented as a final concept. We have, however, corrected the wording at the end of the concept, so that it now reads:

Final concept 8: We shall model an operator with 2×20MHz of UMTS spectrum.
For the purposes of the 4G network, from the refarm date onwards we shall model an operator with 2×10MHz of 800MHz spectrum, 2×10MHz of 1800MHz spectrum and 2×10MHz of 2600MHz spectrum. Prior to the refarm date, we shall assume the 4G network does not have access to the 1800MHz spectrum holdings used for 2G.

3.1.3 Spectrum payments

The final concept from the 2012 concept paper for the spectrum payments was as follows:

Original concept 9: The assumed values of EUR per MHz per pop shall be revisited once the outcome of the 2012 auction is known.

Following the completion of the 2012 concept paper, the auction completed in late 2012 and we derived a calculation for estimating the value of each band individually depending on it use. These were implemented in the v6 BULRIC model for the spectrum payments attributed to the spectrum used for 2G/3G purposes.

We are of the view that the underlying assumptions of these spectrum values should be left unchanged, as there have been no further changes in spectrum allocation since the auction in 2012.

Therefore, the underlying assumed values per MHz per pop for 900MHz 2G spectrum, 1800MHz 2G spectrum and 2100MHz 3G spectrum will not be revised in the BULRIC model.

In order to value the new relevant spectrum allocations for the mobile BULRIC model (i.e. 1800MHz 4G capacity, 800MHz 4G coverage, 2600MHz 4G capacity), we propose to use the values derived from the bottom-up method derived in the last update (all expressed in EUR per MHz per pop, 2009 Euros, 15-year licence duration). This was developed following the spectrum auction in late 2012 and relies on the following bottom-up assumptions:

- low-frequency coverage spectrum for voice = EUR0.70
- high-frequency capacity spectrum for voice = EUR0.30
- mobile broadband capability = EUR0.15
- new spectrum (not currently occupied by mobile traffic, so is additive to the total spectrum available and can be deployed without clearance or migration issues) = +50%
- scarce spectrum (e.g. not enough lots for existing players, so the scarcity results in a higher price/value) = +50%
- not scarce spectrum (e.g. the margin value of spectrum decreases if operators already hold significant spectrum in that band) = –50%.

This approach results in the following valuations for modelled 15-year licences:

- 800MHz = new, scarce, 4G = (0.70+0.15) × (100%+50%+50%) = EUR1.70
- 1800MHz for 4G capacity = high frequency for mobile data = (0.30+0.15) = EUR0.45
- 2600MHz for 4G capacity = mobile broadband, not scarce = (0.15) × (100%–50%) = EUR0.075.

Payments for new spectrum allocations shall be assumed to be incurred as and when the spectrum is used for the modelled 4G network.[19]

Proposed concept 9: The assumed values of EUR per MHz per pop derived for the v6 BULRIC model shall be retained. Payment schedules for 2G, 3G and 4G technologies will be defined according to the usage, amount and corresponding value of spectrum in each period.

► *Operator comments on concept 9*

One respondent [✂] disagrees with the intended valuing of the spectrum. It is "*of the opinion that it is not relevant why the market value of spectrum has a certain level. Operators had to pay that value, also for the use of the spectrum for the voice service. Any hypothetical operator would have had to pay the same amounts in order to be allowed to enter the market*." The respondent states that "*the outcome of the 2012 auction is there-fore the only relevant criterion and not 'retroactive wisdom' can be applied as to the 'realistic level' thereof.*

So the following valuation would be more in line with the outcome of the spectrum auction:

- *800: 1,70 euro/MHz/pop*
- *900: 0,85 euro/ MHz /pop*
- *1800: 0,45 euro/ MHz /pop*
- *2100: 0,45 euro/ MHz /pop*

However, a more in depth look into the outcome of the auction learns that the allocation of the total paid amount is not in line with the outcome of the primary round of the auction. See the report of SEO Economisch onderzoek ('Waarde verlenging mobiele vergun-ningen', 31 January 2013, par 8.1., pg 44). In our opinion it is obvious that outcome should be used, because it reflects better the real value of the different spectrum bands as seen by the operators during the auction in December 2012. The value for 900MHz and 1800MHz spectrum is respectively €3,958,676 and €929,863 per 100kHz, This is approximately a factor 4 between these values. The ratio between 800 and 900 is correct, this is 2. Therefor the actual results to be included in the models should be:

- *800: 2,13 euro/ MHz /pop*
- *900: 1,06 euro/ MHz /pop*

19 It should be noted that the initial payments for the modelled 900MHz/1800MHz/2100MHz spectrum in the v6 BULRIC model are renewed in 2019.

- *1800: 0,25 euro/ MHz /pop*."

A second respondent [✂] refers to its previous comments that Analysys Mason should base its valuations on the actual results of past auctions, stating that "*there is no objective justification for relying on an arbitrary bottom-up model, if there are outcomes of recent auctions. In particular, taking into account that AM will now include 4G in the model – based on 800 MHz deployment – there is ever more reason to base the spectrum valuation primarily on the multiband auction results.*

They *"strongly disagree with the fact that AM uses different values for the same spectrum bands. In cases where, for example,1800 spectrum is used for 2G or 3G, AM uses a much lower valuation in the model compared to a scenario where the same spectrum is used for 4G. As a matter of fact there is only a single market price for spectrum, regardless of the purpose of spectrum use. In the model, the artificial differentiation of the same spectrum leads to the remarkable effect that the model from the re-farm date of the 1800 spectrum onwards suddenly increases the value of the 1800 spectrum block. In other words, AM will replace the value of 1800 instantaneously at a certain point in time, without any objective reason.*

Similarly, they *"do not understand why the existing 900MHz valuation for the previous BULRIC model is retained. Consistency requires that the same valuation principles are applied across all spectrum bands relevant to the model. If AM choses to apply this – in the opinion of [✂] arbitrary – bottom-up model, it should not only apply this to spectrum used for 4G, but to all spectrum including 900MHz*."

A third respondent [✂] makes no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent stated that to "*use actual prices from the upcoming spectrum auction for the 900MHz and 1800MHz is flawed and demonstrates insufficient understanding of the type of the CCA auction and the prices that will be determined in the auction.*" It also reserves the right to provide further comments based on review of the updated BULRIC model.

► *Analysys Mason response*

We have reviewed the SEO report cited by the first respondent.[20] The cited pages present values for 900MHz and 1800MHz spectrum, which can be expressed on a 'per MHz per capita' basis. If we adjust these values for the modelled 15-year licence duration and express them in 2009 currency, then we derive values of EUR0.98 for 900MHz spectrum and EUR0.23 for 1800MHz spectrum respectively. By using actual spectrum auction information, the 2.6GHz result of EUR0.0012 per MHz per capita can also be applied in the BULRIC model.[21] We also assume that

20 Available from http://www.seo.nl/uploads/media/2013-06_Waarde_verlenging_mobiele_vergunningen.pdf.

21 See https://www.rijksoverheid.nl/ministeries/ministerie-van-economische-zaken/nieuws/2010/04/26/frequentieveiling-mobiel-breedband-afgerond.

the unpaired spectrum auctioned in the 1900MHz/2600MHz has the same value as the paired 2.6GHz band.

If we retain the 2100MHz spectrum value per MHz per capita from the v6 model, then this allows the value for 800MHz spectrum to be back-calculated to agree with the total amount paid in the auction by KPN, Vodafone, T-Mobile and Tele2. On this basis, we have derived a value of EUR1.43 per MHz per capita for the 800MHz spectrum.

A comparison of the resulting spectrum prices per MHz per population in these particular bands is shown below in Figure 3.5, which includes three sets of values, from: our proposal in the draft concept paper, the proposal of the first respondent, and our values in the final concept paper. We also calculate the total amount that would have been paid for the spectrum auctioned in 2012 based on these assumptions.

This can be compared to the total fees of EUR3.8 billion actually paid in the auction, although the calculations below exclude any contribution from the 1900MHz, 2100MHz and 2600MHz spectrum also auctioned. Therefore, we would expect the resulting total values in Figure 3.5 to be somewhat lower than EUR3.8 billion.

Figure 3.5: Comparison of spectrum valuations per MHz per population for the BULRIC model and how this translates into total auction fees incurred (EUR) [Source: Analysys Mason, 2016]

Band	Allocation (MHz)	Analysys Mason (draft paper)	First respondent's submission	Analysys Mason (final paper)
800	2×30	1.70	2.13	1.43
900	2×35	0.70	1.06	0.98
1800 (2G)	2×30	0.30	0.25	0.23
1800 (4G)	2×40	0.45	0.25	0.23
Total paid[22]		**4.120 billion**	**4.763 billion**	**3.748 billion**

As can be seen above, the proposal from the first respondent leads to a spectrum valuation that far exceeds EUR3.8 billion (this is a result of the first respondent assuming the 800MHz value is double the 900MHz value). The approach we have set out in this final concept paper leads to a total spectrum value slightly below EUR3.8 billion, which is in good agreement with the values paid at the auction. Therefore, we have implemented these values and our underlying calculations in the v7D BULRIC model (see the *Network_design_inputs* worksheet of the Mobile module).

Based on the new spectrum fee implementation in the v7D model, the 1800MHz spectrum fee is now assumed to be the same for both 2G and 4G technologies.

The final concept therefore reads as follows:

22 This includes adjustment for inflation and the 17-year licence duration, and uses the modelled population in 2012.

Final concept 9: The assumed values of EUR per MHz per pop have been derived using the SEO report and the results of the auctions in 2010 and 2012, expressed in real 2009 EUR for 15-year licences. Payment schedules for 2G, 3G and 4G technologies will be defined according to the usage, amount and corresponding value of spectrum in each period.

3.1.4 Switching network

The final concept from the 2012 concept paper for the mobile switching network was as follows:

Original concept 10: We shall model the evolution of the core architecture from 2004 onwards: combined 2G+3G MSCs from launch, followed by MSS+MGW layered equipment.

This concept addressed the modern deployments for a core network supporting a 2G/3G core network. With our inclusion of 4G technology in the mobile BULRIC model, additional network elements are required to handle 4G traffic in the core. For the 4G network to be able to handle voice calls, a suitable platform (voice-over-LTE, or VoLTE) is also required. We consider these separately below.

4G core network elements

An industry-standard architecture for the 4G core network is an Evolved Packet Core (EPC), whose main components are deployed as an overlay. These are:

- serving gateway (SGW) – routes data between the end-user device and external networks
- mobility management entity (MME) – main node for signalling control (for mobility/security)
- other servers/for managing data traffic
- home subscriber server (HSS) – the 4G equivalent of the HLR.

4G voice platform elements

VoLTE requires the deployment of an IP multimedia subsystem (IMS) in the core network. The main component in an IMS core is the call server (CS), which contains several voice service functions. Session border controllers (SBCs) and telephony application servers (TASs) must also be deployed to manage voice services (the TAS in particular manages call forwarding, waiting and transferring). These assets are summarised in Figure 3.6 below.

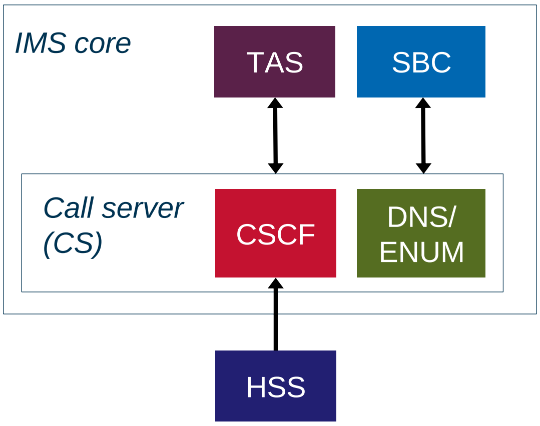


Figure 3.6: Outline of an IMS core [Source: Analysys Mason, 2016]

The VoLTE platform must also communicate with the 4G data platform (via the MME/SGW), meaning that upgrades are required to certain existing network elements (e.g. the MSS).

A VoLTE platform shares many of the components of a VoIP platform in a fixed network. Therefore, whilst we will include an appropriate network design for these assets (derived using operator data), we will include the option in the mobile BULRIC model to assume the cost contribution per minute for the VoLTE platform is equal to the contribution per minute for the VoIP platform from the fixed BULRIC model. This will ensure consistency between the costs of fixed VoIP and mobile VoLTE platforms.

Proposed concept 10: We shall model the evolution of the core architecture from 2004 onwards: combined 2G+3G MSCs from launch, followed by MSS+MGW layered equipment. An EPC overlay will be launched with the 4G network, with a VoLTE platform launched ahead of voice being carried over the 4G network.

► *Operator comments on concept 10*

One respondent [✂] agrees with modelling an LTE (4G) network overlay that will be deployed initially from 1 January 2013, with services being launched from 1 January 2014.

A second respondent [✂] states that "*AM should look carefully into synergies between the VoIP platform and the VoLTE platform*." It states that it is "*committed to provide guidance to make sure the detailed assumptions in the model reflect the actual deployment. As there will be a considerable period where the VoIP platform operates in parallel to the VoLTE platform, it is inevitable that this will lead to higher costs. These higher costs should be fully recovered by the voice services, including the termination service modelled by AM*."

A third respondent [✂] in principle "*agrees with the technical similarities between a mobile VoLTE platform and a fixed VoIP platform and stresses that also cost-wise they are treated consistently in the mobile and fixed BULRIC models*." However, it regards "*the description of this topic as too high-level to judge whether it is appropriate or not and will take the opportunity to comment on the actual implementation in the BULRIC model*."

► *Analysys Mason response*

The proposed concept shall therefore be implemented as the final concept.

3.1.5 Transmission network

The final concept from the 2012 concept paper for the mobile transmission network was as follows:

> **Original concept 11**: We shall model a national leased dark fibre network and self-provided transmission equipment running STM-n links in the 2G/3G core network and Gbit/s links from 2011 onwards.

We have not identified a need to change this concept from the perspective of the core network.

However, with respect to the last-mile access (LMA) transmission to the radio network, the current LMA technologies in the mobile BULRIC model are E1-based leased lines or microwave links, which are likely to have insufficient capacity for the 4G radio network. We will revisit the backhaul calculations and review operator data to identify appropriate backhaul options for the radio layer that can serve the modelled 4G network (e.g. more extensive use of the fibre LMA option already included in the mobile BULRIC model, as well as Ethernet microwave links).

> **Proposed concept 11**: We shall model a national leased dark fibre network and self-provided transmission equipment running STM-n links in the 2G/3G core network and Gbit/s links from 2011 onwards. The model shall be refined to ensure it has appropriate availability of LMA technologies with sufficient capacities for 4G purposes.

► *Operator comments on concept 11*

One respondent [✂] provides no specific comments on this concept in its response.

A second respondent [✂] agrees that "*the LMA technologies in the model should reflect the projected deployment in future years, including an increasing deployment of fiber*."

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent agreed in principle with the approach.

► *Analysys Mason response*

The proposed concept shall therefore be implemented as the final concept.

3.2 Modern fixed network architecture

3.2.1 Access network

The final concept from the 2012 concept paper for the fixed access network assumed to be served by the modelled fixed core network was as follows:

> **Concept 12:** We shall model a copper-based fixed access network using VDSL[23] at the MDF.

Our understanding is that whilst the KPN-owned Reggefiber footprint now passes just over 25% of Dutch households with fibre-to-the-home (FTTH) technology, significant further expansion is unlikely as KPN's current focus is on using pair bonding and vectoring technologies to upgrade its existing copper cabinets to provide faster speeds (i.e. a fibre-to-the-cabinet (FTTC) deployment).[24] Therefore, it appears that the long-term mix of next-generation access architectures in the Netherlands will be a mix of FTTC and FTTH.

The question arises as to whether it is reasonable for wholesale voice termination charges to be based on a fixed network cost model which includes the additional core network (traffic-sensitive) investments during the next price control period for a sub-national FTTC/VDSL deployment that is intended to offer faster broadband access in the long term. We would argue that these costs are not necessary for traditional wholesale fixed voice services and, even if they were included, when allocated on a traffic basis, the majority of their costs would be allocated to broadband data traffic.

As in the development of the v6 fixed BULRIC model, we believe the focus should be on calculating the cost contribution of the fixed VoIP platform to wholesale fixed termination.

Therefore, we see no need to revise this concept.

► *Operator comments on concept 12*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent agreed in principle with the approach.

► *Analysys Mason response*

The concept shall therefore be implemented as described.

---

23 We would note that, in the finalisation of the original fixed BULRIC model, the level of video-on-demand traffic was applied to reflect that a copper access MSAN-based network would be unable to provide VDSL signals to all homes in the area (due to copper line length).

24 See http://www.telecompaper.com/nieuws/reggefiber-ftth-hp-groei-in-q3-laagste-ooit--1110184 and http://www.kpn-wholesale.com/media/637640/20150821_wba_vdsl_binnenringen_2.pdf.

3.2.2 Switching network

The final concept from the 2012 concept paper for the fixed switching network was as follows:

Concept 13: An IP BAP NGN will be modelled, with associated platforms and support for a reasonable level of redundancy and service qualities.

As set out in the concept, an IP/Ethernet broadband access platform next-generation network (IP BAP NGN) was deployed in the v6 fixed BULRIC model. This was consistent with the EC Recommendation. The IP BAP NGN aggregates all varieties of service lines, including legacy interfaces, from IP-enabled line cards aggregated at a Gigabit Ethernet core.

We have not identified a need to revise this switching architecture in the fixed BULRIC model.

However, we will revisit the network design calculations for the hardware and software components of the VoIP platform and its related servers. This will take into account the prevailing VoIP platform architectures of the major Dutch fixed operators and their associated costs, cost-drivers and (if possible) scope of functionalities. This will be based on data requested from the operators and a comparison with data received in the development of the v6 BULRIC model. An illustration of the key components is provided below in Figure 3.7.

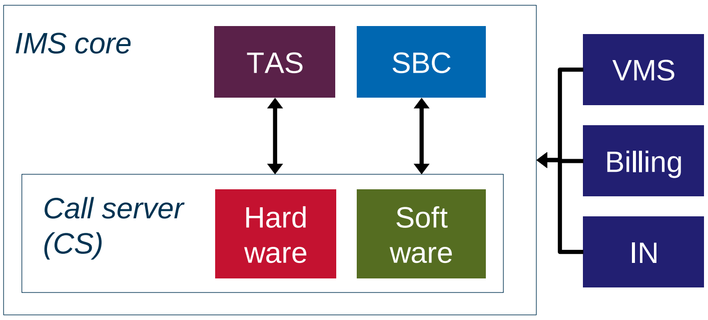


Figure 3.7: Illustration of the key components of a VoIP platform [Source: Analysys Mason, 2016]

The platform includes an IP multimedia subsystem (IMS), the main component of which is the call server (CS), which oversees several voice service functions. Session border controllers (SBCs) and telephony application servers (TASs) are used to manage voice services and the platform must also interface with the voicemail system (VMS), intelligent network (IN) and wholesale billing system.

This part of the network design has implications for all the costing calculations in the Service costing module, as described in more detail in Section 5.1.

We have not identified a need to change the concept.

► *Operator comments on concept 13*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent agreed in principle with the approach.

► *Analysys Mason response*

The concept shall therefore be implemented as described.

3.2.3 Transmission network

The final concept from the 2012 concept paper for the fixed switching network was as follows:

Concept 14: IP and IP/MPLS over Ethernet and WDM will be modelled in the fixed next-generation core network.

We have not identified a need to change this concept.

► *Operator comments on concept 14*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent agreed in principle with the approach.

► *Analysys Mason response*

The concept shall therefore be implemented as described.

3.3 Network nodes

The final concept from the 2012 concept paper for the scorched-node principle was as follows:

Concept 15: The modified scorched-node principle shall be applied to generate a realistic modern network using modern traffic-sensitive assets at current node locations.

As described in the 2012 concept paper, the principle of scorching is related to network efficiency and is therefore an important costing issue. Both fixed and mobile networks can be considered as a series of nodes (with different functions) and links between them. In developing deployment algorithms for these nodes, it is necessary to consider whether the algorithm accurately reflects the actual number of nodes deployed. Allowing the BULRIC models to deviate from the operators' actual number of nodes may be allowed in the instance where the operators' network is not viewed as efficient or modern in design. When modelling an efficient network using a bottom-up approach, there are several options available.

The v6 BULRIC models use the modified scorched-node approach, which assumes the historical locations of the actual network node buildings are fixed, and that the modelled operator can choose the best technology to configure the network at and in-between these nodes to meet the optimised demand of an efficient operator and can also ensure inefficiencies related to historical locations are eliminated. We have not identified a need to change this concept.

► *Operator comments on concept 15*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent supported the proposed modified scorched-node concept in as far as it is more consistent with the actual costs approach than a pure scorched-node approach.

► *Analysys Mason response*

The concept shall therefore be implemented as described.

4 Service issues

The following concepts are considered in this section.

Figure 4.1: Decisions on the service-related conceptual issues taken for the v6 BULRIC models, and items requiring modification in light of this update [Source: Analysys Mason, 2016]

No.	Conceptual issue	Recommendation for the v6 BULRIC models	Revise?
16	Service set	Provide all the commonly available Dutch voice and non-voice services. The associated economies of scope will be shared across all services	No
17	Fixed voice services	All voice traffic will be modelled, independent of specific technologies (such as ISDN) that can be used	No
18	Fixed non-voice services	Fixed transmission services, interconnection establishment, co-location and xDSL data backhaul will be modelled as different services	No
19	Fixed NGN services	All fixed services are defined as technology-independent and thus can be conveyed via an NGN	No
20	Mobile services	Aggregate mobile traffic across all subscriber types	No
21	Traffic volumes	Apply a market-average profile to the modelled 1/N operator	No
22	Points of interconnect	Fixed and mobile interconnection will both be modelled at four points	No
23	Interconnection and co-location	A separate module will be constructed to calculate the costs of services applicable to voice interconnection. These costs will not be allocated to voice minutes	No
24	Wholesale or retail costs	Only wholesale network costs will be included in the cost models. Retail costs will be excluded	No

4.1 Service sets

The final concepts from the 2012 concept paper as to the modelled service sets were as follows:

Concept 16: The modelled operator should provide all the commonly available (current and planned) Dutch non-voice services (broadband access, messaging, leased lines, TV) alongside voice services (originating and terminating voice, VoIP, transit traffic). The associated economies of scope will be shared across all services, although care will be taken where uncertain growth forecasts significantly influence the economic cost of voice (and therefore forecast sensitivities will be explored).

Concept 17: All voice traffic will be modelled, independent of specific technologies (such as ISDN) that can be used.

Concept 18: Leased lines and other fixed transmission services, interconnection establishment and co-location will be separately identified. xDSL data backhaul will be modelled as a different service, with transmission across the core to the access seeker's own point of presence.

Concept 19: All services described above are defined as generic services that can be delivered independent of technology – in this case with an NGN.

Concept 20: Mobile traffic will be aggregated for all subscriber classes, and a full-scale mobile operator will be modelled to accommodate its share of the traffic.

For Concept 18, we will request information from the operators on the amount of TDM voice interconnection and IP voice interconnection. If IP voice interconnection is expected to be a material proportion of the traffic volumes over the regulatory period, then we will cost interconnection traffic separately, and make corresponding adjustments to the Interconnection module in the BULRIC model.

The forecast mobile demand will now be split across 2G/3G/4G networks and a material proportion will now be on the 4G network (with this proportion increasing further in the future). For example, the Market module will consider all data megabytes and then a proportion to be carried by 4G will be separated out. 4G data volumes can then be passed through the 4G network design. The remaining megabytes will then be further divided between the 2G and 3G networks.

► *Operator comments on concepts 16–20*

Two respondents [✂] provide no specific comments on these concepts in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period for concepts 17–20, in particular that "*including significant elements in the model which are still to be realized in practice is highly speculative and should therefore be omitted. This also holds for planned services that mostly do not, as yet, exist. Only existing services with significant volume of which the development can be accurately predicted should be taken into account.*" Regarding concept 16, and on the topic of VoLTE, it states that "*Although it is clear that VoLTE will become reality over the upcoming regulation period, many aspects are still unknown and uncertain. Therefore any modelling of costs should take a prudent approach in that resulting cost levels should not be too low*."

► *Analysys Mason response*

The concepts shall therefore be implemented as described.

4.2 Traffic volumes

The final concept from the 2012 concept paper as to the consideration of traffic volumes is as follows:

Concept 21: We shall develop a market forecast and apply a market-average profile for the modelled 1/N operator; the discussion of N is covered under concept 3.

We have not identified a need to change this concept.

In relation to the modelled traffic volumes, we will request operator service volumes for the full calendar years 2013, 2014 and 2015 if available, so that they can be used to update the Market module. We will also check with the latest versions of the third-party sources used in the Market module, such as those from within ACM (Telecommonitor) and Analysys Mason's Research division. We will review the forecasts of voice and data traffic in the BULRIC models and update them where necessary.

► *Operator comments on concept 21*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent observed that "*future growth in mobile data is likely to be much slower than previously forecast. For example, the amount of billable traffic on mobile network is likely to be reduced by WiFi offloading, necessarily increasing prices for mobile data and reduced usage of mobile dongles*."

► *Analysys Mason response*

The concept shall therefore be implemented as described. Stakeholders will have an opportunity to comment on the data forecasts assumed in the BULRIC model.

4.3 Interconnection establishment and co-location

The final concepts from the 2012 concept paper as to the treatment of interconnection establishment services were as follows:

Concept 22: Fixed interconnection will be modelled at four points. Mobile interconnection will be modelled at four points.

Concept 23: A separate module will be constructed to calculate the costs associated with regional interconnection establishment and related co-location services. For fixed NGA/NGN, the NGA/NGN equivalents of existing co-location and interconnection services will be modelled. The costs of co-location and interconnection services will be constructed by a build-up of individual cost components. The costs of co-location and establishing interconnection at the (regional) switches of a mobile network will also be calculated. Co-location services will be limited to those applicable to establishing voice interconnection at an operator's premises.

Operator information submitted as part of the data request process will be taken into account. Costs which are driven by the activities of interconnection, number of port connections and co-location space, etc., will be allocated to the *interconnection establishment services*, and not allocated to minutes.

We propose to maintain these concepts. However, we will request up-to-date cost data related to these services. If data is available, then it will be used to refine the inputs in the Interconnection module.

Both the v4 and v6 BULRIC models assume that the four points of interconnection described in Concept 22 occur in main cities (the cost per square metre inputs are based on this assumption[25]). We will request data regarding the cost per square metre for locations outside of these main cities, to determine the impact a different location has on the calculated prices of interconnection establishment services.

► *Operator comments on concepts 22–23*

One respondent [✂] has no additional comments relating to these concepts, as "*Since the decision of ACM of August 2013 we have not received new requests for direct interconnection to our mobile net-work and therefore we have not gained additional information on e.g. project costs*."

A second respondent [✂] provides no specific comments on this concept in its response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent agreed "*with the proposed approach to model 4 interconnect points for mobile networks*" but disagreed "*with the proposed approach for fixed networks to limit the number of interconnect points for fixed networks to only 4 creates inefficiency and therefore causes unnecessarily high costs for both the modelled operator and interconnected larger operators*." In addition, it observes that "*AM proposes to model the costs for interconnection, i.e. the costs that include the interconnect switch ports, billing and interconnect department separately to voice services. Interconnecting operators would pay for these services separately through the regulated costs for switch ports. Under a proper cost orientation regime, such an approach could be valid as long as certainty is provided to operators that are subject to*

25 See the Interconnection module, 'equipment costs' worksheet, row 29.

this regime that all relevant costs made for mobile termination and interconnection will be able to be recovered."

► *Analysys Mason response*

With regard to the comment on concept 22, we would observe that during the original model construction, five parties submitted that a maximum of four to five PoIs would be resilient and efficient and therefore should be modelled. The modelling approach does not prevent operators from negotiating access at many more locations in practice, but for the purposes of establishing efficient network costs we shall maintain the assumption of four efficient PoIs.

With regard to the comment on concept 23, we observe that in the case where termination was priced using Pure BULRIC, interconnection establishment and co-location would continue to be priced using Plus BULRAIC.

The concept shall therefore be implemented as described.

4.4 Wholesale or retail costs

The final concept from the 2012 concept paper as to the treatment of wholesale and retail costs was as follows:

> **Concept 24**: Only wholesale network costs will be included in the cost models. Retail costs will be excluded.
>
> A 50% network share of business overheads will be included in the *Plus BULRAIC* models. The "wholesale interconnection business unit" will also be included as part of the overall overheads, but will be allocated to the service of *establishing and maintaining interconnection* rather than per-minute traffic charges.
>
> In the *Pure BULRIC* models, general business overheads will be assumed to be invariant with the wholesale termination increment. A proportion (e.g. the half related to incoming interconnection) of the wholesale interconnection business unit would be avoided in the absence of wholesale termination volumes, and thus some interconnection establishment costs would be incremental to wholesale termination.

For the avoidance of doubt:

- The modelled business overheads are intended to cover only the activity component that is common to network and retail functions in the long run – as such, variable overheads costs such as HR are included in the opex mark-ups associated with each of the network elements.
- It would be inappropriate for the costs (e.g. legal support) relating to challenging ACM's market review decisions and pricing decisions to be included in the costs allocated to termination services.

- The costs associated with establishing and maintaining interconnection are already covered in the separate Interconnection module.
- Although elements of business such as The Board, Finance, Technology, Legal/Regulatory and Human Resources are all functions that spend some time on termination services, this does not necessarily mean that the common component of these costs would decrease in size in the absence of termination.

We have not identified a need to revise this concept.

► *Operator comments on concept 24*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent disagreed with "*the exclusion of customer related costs, as the costs of marketing and selling services and providing customer case (etc.) are clearly causally related to the provision of mobile termination services and therefore should be included – without customers, an operator would not earn termination revenues. AM also proposes to include a proportion of 50% of 'business overhead' into the BULRAIC model*." The respondent "*disagrees with this concept for two reasons: Firstly as argued above, as retail costs are intrinsic to providing the mobile termination service and must be included, also a proportional share of business overheads should be included. This implies that the business overheads included in the model should be near to 100% rather than 50%. For pre-pay customers, there are clearly not separate subscription charges so that business overheads must be recovered in per minute charges and they should be efficiently spread across both termination and outgoing services. While contract customers do pay monthly charges, these are fundamentally payments for bundles of services included in the contract. Again, business overheads should be efficiently spread across termination and outgoing services. Secondly, even in the case where only the network, some IT and the interconnection facilities and organization would be included, these combined costs would constitute a significantly larger share of non-overhead costs than the 50% that AM assumes. In order to arrive at an accurate allocation, it is essential that AM request relevant data from the operators and consult on the appropriate allocation methodology*."

The respondent also "*disagrees with AM's proposal to consider business overheads invariant to presence or absence of the termination increment. The costs of business overheads do and will vary to some extent with the substantial volume of minutes and revenues associated with this increment.*"

► *Analysys Mason response*

With respect to the third respondent on the treatment of business overheads, our position has been made clear in the bullet points in this section on the draft concept.

With respect to the third respondent’s comment on the inclusion of customer-related costs, we do not agree with this assertion. We observe that high subscriber-related retail costs may arise in a saturated market such as the Netherlands since operators compete for subscribers (with the competing operators including both mobile and fixed operators). However, there is no reason for inter-operator wholesale termination charges to include an allowance for operators to pay each other for these retail support activities for both of the customers of competing operators who are involved in an inter-operator voice call termination event.

The concept shall therefore be implemented as described.

5 Implementation issues

The following concepts are considered in this section.

Figure 5.1: Decisions on the implementation-related conceptual issues taken for the v6 BULRIC models, and items requiring modification in light of this update [Source: Analysys Mason, 2016]

No.	Conceptual issue	Recommendation for the v6 BULRIC models	Revise?
25	Increment approaches	Calculate Pure BULRIC, Plus BULRAIC and Plus Subscriber BULRAIC	No
26	Demarcation between traffic- and access-related costs	Assumed to be the first point of traffic concentration in the network such that resources are driven by traffic load	No
27	Depreciation method	Use economic depreciation	No
28	Modelling timeframe	Employ a 50-year modelling timeframe	No
29–36	Derivation of the WACC	Updated as part of a separate process	Not applicable
37	Mark-up mechanism	Use EPMU for the Plus BULRAIC and Plus Subscriber BULRAIC models. No mark-up is required in the Pure BULRIC case. Include facility for non-EPMU	No

5.1 Choice of increment

This section in the 2012 concept paper considered increment approaches and the demarcation point in the modelled networks between traffic-related and access-related costs.

5.1.1 Increment approaches

The final concept from the 2012 concept paper on the choice of increment was as follows:

> **Concept 25**: In order to allow ACM to understand the cost implications of each costing approach (consistency with the EC Recommendation, comparability with earlier costing approaches, and competitive neutrality towards mobile versus fixed operations), the model will calculate *Pure BULRIC*, *Plus BULRAIC* and *Plus Subscriber BULRAIC* results.

With regard to the choice of increment, we do not propose any revisions to the wording of the concept. However, we do propose to revisit the implementation of the Pure BULRIC and Plus BULRAIC costing calculations. Specifically, we intend to review the network design calculations and costs in both the fixed and mobile BULRIC models. The final decision as to which approach will be adopted for pricing will be taken separately within ACM's market analysis.

We consider the Plus BULRAIC and Pure BULRIC approaches in turn below.

Plus BULRAIC

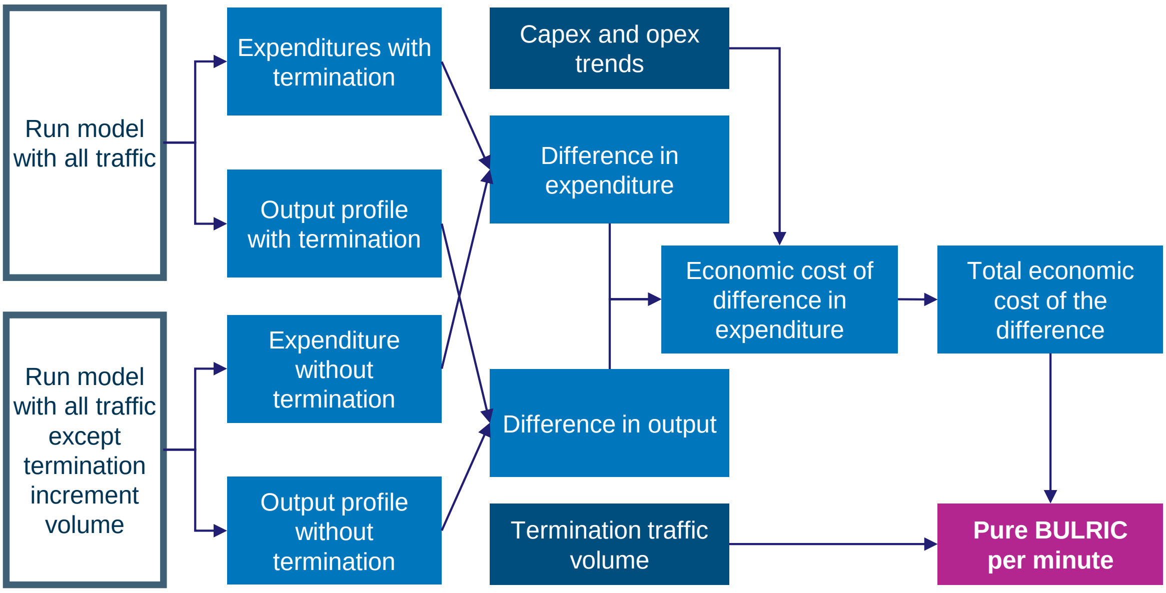
Bottom-up long-run average incremental costing (BULRAIC or Plus BULRAIC) can be described as a large increment approach – all services which contribute to the traffic economies of scale in the network are added together in a large increment and treated together. A second increment to capture subscription (i.e. connection) sensitive costs is also applied to the BULRIC models. Individual service costs are identified by sharing out the large (traffic) incremental cost according to average resource consumption routeing factors. The adoption of a large increment in the form of aggregate "traffic" means that all the services that are supplied are treated together and equally.

Where one of those services may be regulated, the regulated service benefits from the average economies of scale rather than either greater or lower economies. We believe therefore that the correct approach for Plus BULRAIC is for average traffic incremental costs to be identified according to average resource consumption routeing factors. This is also consistent with the approach taken by the majority of regulators in Europe making similar mobile network cost calculations.

Pure BULRIC

For reference, the Pure BULRIC calculation structure is shown in Figure 5.2.

Figure 5.2: Overview of Pure BULRIC calculation in the original fixed/mobile BULRIC models [Source: Analysys Mason, 2016]



In the fixed BULRIC model, the network design and costs of the VoIP platform, and the resulting allocations of these costs to fixed termination, is of particular significance, where its behaviour both with and without terminated voice traffic can have a large impact on the Pure BULRIC result. We will therefore consider the hardware and software components of the VoIP platform and its related servers. This will take into account the prevailing VoIP platform architectures of the major

Dutch fixed operators. It was explained in the previous update that not all underlying voice platform costs are understood to vary with traffic (some vary with subscribers, or are entirely fixed costs). Our analysis of the industry information supplied will indicate the proportion of total voice platform costs that are traffic-sensitive, and hence assumed to be included in the Pure BULRIC of voice termination.

In the mobile BULRIC model, we will consider the sensitivity of the modelled mobile network assets to the wholesale termination traffic increment. As set out clearly in our previous update, we consider that spectrum and site capacity equipment are interchangeable to serve higher traffic loads (i.e. more spectrum on existing sites, or more sites using existing spectrum). Therefore, in considering the removal of this increment, either site capacity can be avoided; or spectrum can be avoided, but not both simultaneously.

► *Operator comments on concept 25*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period, in which it stated that it would *"support OPTA's attempt to understand the implications of different costing approaches where those approaches are all capable of being implemented. However, this parallel development of major costing alternatives seems to go beyond this to reflect OPTA's uncertainty on the validity of different costing approaches and the extent to which they will or will not be approved in court."* The respondent *"believes that OPTA should seek and publish legal advice at an early stage on what approaches will be valid so as to avoid AM and the parties spending considerable time in developing costing approaches that may not even be valid to apply."*

► *Analysys Mason response*

The concept shall therefore be implemented as described.

5.1.2 The first point of traffic concentration

The final concept from the 2012 concept paper on the first point of traffic concentration was as follows:

> **Concept 26**: The demarcation point between core (traffic-) and access-related costs is where the first point of traffic concentration occurs *such that resources are driven by traffic load*. In a mobile network, traffic-sensitive assets therefore occur from the air interface. In fixed networks, traffic-sensitive assets exist from an exchange/node demarcation point, which depends on the choice of technology.

This concept is most relevant to the Plus BULRAIC cost structures used for the fixed and mobile BULRIC model, which we show below.

Figure 5.3: Fixed network Plus BULRAIC model cost structure[26] *[Source: Analysys Mason, 2016]*

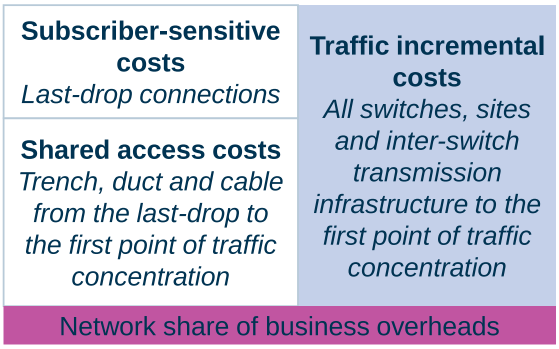
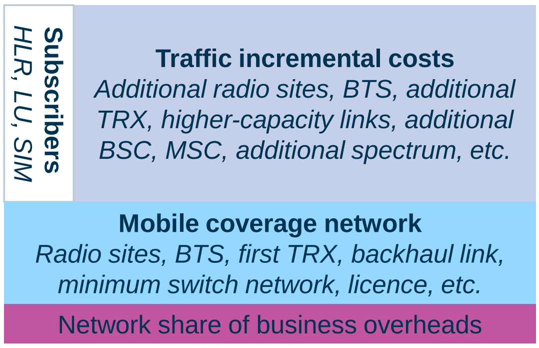


Figure 5.4: Mobile network Plus BULRAIC model cost structure [Source: Analysys Mason, 2016]



In the case of the mobile BULRIC model, we observe that coverage network costs are allocated across both the traffic and subscriber increments. In particular, common costs are applied via EPMU to both the incremental costs of subscribers (a small number of costs relating to assets such as the HLR) and traffic costs (the majority of all other equipment, transmission, etc.).

The network costs are caused by two drivers: the amount of voice/data traffic, and the number of subscribers (handsets) registered and active on the network. Subscribers and handsets incur costs related to the HLR, VLR and location updates, independent of the amount of traffic carried. Thus, the coverage network is also necessary to provide the "subscriber service", providing an air interface control channel layer across the entire coverage network. The coverage network is therefore common to both the traffic increment and the subscriber increment.

In the previous update, we described the relevance of a subscriber service. The position of any mobile network operator (MNO) in the Netherlands is that it will sell traffic to *any* mobile user in the world *except* to subscribers of another Dutch MNO. Users from outside of the Netherlands do not need to subscribe to the MNO's network to do so (they just locate it via roaming partners and make or receive a call). Customers of any other Dutch MNO are prevented from the simple activity of making or receiving a call on this network because they have not subscribed to a service on this network. In our experience, this "subscriber service" is a small activity and accounts for a small proportion of annualised costs. However, it is an *exclusive* service only for customers of that operator, and this causes some network costs relating to the subscriber registry (HLR) and location updating. These costs are exclusively caused by the service offered only to home subscribers and visiting roamers.

We see no need to revise this concept, given the arguments elaborated in the previous update.

► *Operator comments on concept 26*

Two respondents [✂] provide no specific comments on this concept in their response.

26 The traffic incremental costs in fixed networks need to be slightly modified to capture the network subscriber related costs of the VoIP platform (e.g. HSS).

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent agreed in principle with the approach.

► *Analysys Mason response*

The concept shall therefore be implemented as described.

5.2 Depreciation method and modelling timeframe

The final concepts from the 2012 concept paper on depreciation method and modelling timeframe were as follows:

Concept 27: Economic depreciation shall be applied to all expenditures in the fixed and mobile *Plus BULRAIC* models. In the *Pure BULRIC* models, economic depreciation will be applied to the difference in expenditures.

Concept 28: A 50-year model will be employed. This timeframe allows us to incorporate the economic lifetime of long-lived assets (e.g. switch buildings, fibre cabling, access network infrastructure), and to assume zero future terminal value without significant impact on today's costs.

The use of economic depreciation means that, conceptually, the BULRIC models spread the present value (PV) across the demand over the entire modelling period based on levels of demand in all of those years. In the case of the Pure BULRIC calculation, an asset avoided in year *n* can be recovered from avoided termination volumes across the entire modelling period.

We would emphasise that although the full duration of the BULRIC models is 50 years, the v6 BULRIC models assume a 2G/3G technology-specific lifetime of 15 years. That is, all of the modelled 2G/3G-specific expenditures were recovered from the technology's volumes during the 15-year period 2004–2019. Assets that are effectively technology-agnostic and could continue to support the next-generation traffic (e.g. mobile network sites, fixed network buildings) do not have these migration profiles applied. These assets are therefore deployed and maintained for the full 50-year period, and their costs are recovered over all forecast traffic in that period.

While we propose to maintain the principles associated with cost recovery over time, it will be necessary to gather information and assess the extent to which migration off the modelled technologies needs to be reflected in the calculations. In the v6 BULRIC models, migration off technologies in the period 2016–2019 did not have a direct impact on the regulated prices (because regulated prices were not set in those years), although there was an indirect impact on costs through the cost-recovery requirement. In particular, if voice interconnection traffic is expected to be migrating off a technology in the period 2016–2019, then the rate of migration and the future network on which it is carried may need to be modelled (or assumptions on that technology need to be made). Information from operators and third-party forecasts will be used to project voice traffic by technology. It may be necessary to modify (e.g. lengthen) the off-migration profiles to reflect the current expectations for the voice interconnection market evolution.

► *Operator comments on concepts 27–28*

Two respondents [✂] provide no specific comments on these concepts in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent noted that "*there are a number of ways in which economic depreciation can be implemented and the choice of detailed assumptions can lead to significant differences in the path of prices over time and hence to consumer outcomes*". It will provide comments on the depreciation approach once it has had the opportunity to review a draft of the model, including the specific assumptions made in implementing economic depreciation. In response to concept 28, the respondent raises concerns with the decision to model a mobile business over a 50-year period. The respondent "*believes this approach carries a serious risk of over-estimating the period in which mobile operators can recover the cost of their investments. In particular, significant changes in technology, demand and market players could lead to a need for assets to be recovered in a much shorter period than their theoretical life*."

► *Analysys Mason response*

With respect to the third respondent's comments on concept 28, we would emphasise that, although the model duration is 50 years, the original BULRIC models assume a technology-specific lifetime. That is, all of the modelled technology-specific expenditures are recovered from the technology's volumes during that lifetime period. Assets that are effectively technology-agnostic and could continue to support the next-generation traffic (e.g. mobile network sites, fixed network buildings) do not have these migration profiles applied. These assets are therefore deployed and maintained for the full 50-year period, and their costs are recovered over all forecast traffic in that period. A systematic allowance for the cost of assets to be recovered over a much shorter period than the lifetime assumed in the model (as suggested by the third respondent) would grossly overstate the efficient cost of termination, hence there is no need to bias the results of the model in this way.

The concept shall therefore be implemented as described.

5.3 WACC

Concepts 29–36 from the 2012 concept paper considered the calculation of the WACC for the BULRIC models. However, for the purposes of this update, the WACC calculation will be developed in a parallel workstream.

5.4 Mark-up mechanism

The final concept from the 2012 concept paper on the mark-up mechanism was as follows:

Concept 37: An EPMU will be applied in the Plus and Plus Subscriber BULRAIC models. There is no mark-up required in the Pure BULRIC case. The facility for non-EPMU will be provided but is not proposed for calculating termination service costs.

We have not identified a need to revise this concept.

In particular, the EPMU approach was applied in the cost modelling in 2006, 2009–2010 and 2012–2013. EPMU is commonly applied by regulators (when using Plus BULRAIC methods of costing) and has broadly been adopted and accepted. EPMU relies on the individually calculated and transparent BULRAIC of the services which are supported by the common costs in question.

► *Operator comments on concept 37*

Two respondents [✂] provide no specific comments on this concept in their response.

A third respondent [✂] has no comments additional to its earlier remarks in the previous regulatory period. In its earlier remarks, the respondent stated that "*EPMU and even more so BULRIC would fail OPTA's statutory duties (under the Access Directive) to promote efficiency and to maximize consumer benefits. In particular, efficient pricing that maximizes consumer benefits requires that common costs be recovered across all services with the mark-up on each service being set in inverse proportion to the relative demand elasticity of each service (i.e. Ramsey pricing).*"

The respondent goes on to state that "*Oftel (Ofcom's predecessor in the UK) has previously stated why a relatively higher mark-up should be set on termination relative to the mark-up on outgoing calls: "Oftel said that the existence of the cross-price elasticity with respect to the price of calls from mobiles meant that the mark-up over cost in this price would be smaller than the mark-up on termination. Oftel said this was because increasing the price of calls from mobiles created a larger welfare loss than an increase in the price of fixed-to-mobile calls, since the former also resulted in a reduction in the number of subscribers (via the cross-price elasticity).'*""

The respondent also states that "*An example of how subscription charges can be incorporated into a Ramsey pricing framework was provided by the Ramsey model of mobile pricing submitted by Oftel to the Competition Commission in its 2002–2003 inquiry. The model took into account assumptions about the elasticity of demand for subscription and other services, as well as the interrelationship between demand for different services, and included a mark-up over marginal cost for termination. The model found an efficient termination charge level of 6.3ppm which was above the LRIC+ level of 4.51ppm determined by the CC in 2003 (Table 2.11, p.90 of the 2003 report).*" The respondent believes that Analysys Mason should apply a Ramsey-based model to determine an efficient mark-up for termination.

► *Analysys Mason response*

With respect to the third respondent, we would re-iterate the viewpoint of BEREC (formerly ERG). BEREC believes that Ramsey pricing is not feasible in practice, due to the complex and dynamic information requirements regarding demand elasticities.[27] Therefore, a Ramsey construction will not be considered in the BULRIC model. Furthermore, Oftel's opinions have been superseded by the position of Ofcom, which for many years has adopted a pure BULRIC approach to the cost-based regulation of mobile voice termination.

The concept shall therefore be implemented as described.

27 ERG COMMON POSITION: Guidelines for implementing the Commission Recommendation C (2005) 3480 on Accounting Separation & Cost Accounting Systems under the regulatory framework for electronic communications, page 23.

Annex A Expansion of acronyms

2G	Second generation of mobile telephony
3G	Third generation of mobile telephony
4G	Fourth generation of mobile telephony
ACM	Autoriteit Consument & Markt
BAP	Broadband access platform
BSC	Base station controller
BTS	Base transmitter station or base station
BULRAIC	Bottom-up long-run average incremental cost
BULRIC	Bottom-up long-run incremental cost
CS	Call server
CSCF	Call session control function
CWDM	Coarse wave division multiplexing
DCS	Digital cellular service
DNS	Domain name system
DSLAM	Digital subscriber line access multiplexer
DWDM	Dense wave division multiplexing
EC	European Commission
ENUM	Electronic numbering
EPMU	Equi-proportionate mark-up
FTR	Fixed termination rate
FTTC	Fibre to the cabinet
FTTH	Fibre to the home
Gbit/s	Gigabits per second
GPRS	General packet radio system
GSM	Global system for mobile communications
HLR	Home location register
HSDPA	High-speed downlink packet access
HSPA	High-speed packet access
HSS	Home subscriber server
HSUPA	High-speed uplink packet access
IG	Industry Group
IMS	IP multimedia subsystem
IN	Intelligent network
IP	Internet Protocol
IPTV	Internet Protocol television
ISDN	Integrated services digital network
LTE	Long-term evolution
Mbit/s	Megabits per second
MDF	Main distribution frame
MGW	Media gateway

MHz	Megahertz
MPLS	Multiprotocol label switching
MSAN	Multi-service access nodes
MSC	Mobile switching centre
MSS	MSC server
MTR	Mobile termination rate
MVNO	Mobile virtual network operator
NGA	Next-generation access
NGN	Next-generation network
NodeB	Denotes the 3G equivalent of a BTS
OTT	Over the top
PABX	Private automated branch exchange
PBX	Private branch exchange
PoI	Point of interconnect
PV	Present value
RNC	Radio network controller
SBC	Session border controller
SMS	Short message service
STM	Synchronous transport module
TAS	Telephony application server
TDM	Time division multiplex
TRX	Transceiver
UMTS	Universal mobile telecommunications systems
VDSL	Very-high-bitrate digital subscriber line
VLR	Visitor location register
VMS	Voicemail system
VoIP	Voice over Internet Protocol
VoLTE	Voice over long-term evolution
WACC	Weighted average cost of capital
WDM	Wavelength division multiplexing
xDSL	Digital subscriber line technologies