Final report for the Commission for Communication Regulation (ComReg)

Suitability of the benchmarking approach proposed by ComReg for setting mobile termination rates in Ireland

21 November 2012

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Ref: 31969-474bp PUBLIC VERSION

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1 Introduction

In May 2009, the European Commission issued its Recommendation on the regulatory treatment of fixed and mobile termination rates in the EU[1] (referred to as 'the Recommendation' throughout this report). The Recommendation sets out a specific method for national regulatory authorities (NRAs) to apply when setting cost-based interconnection regulation for both fixed and mobile termination. This method involves termination rates being based on long-run incremental costs (LRIC) excluding a mark-up for common costs ('pure' LRIC).

In order to prepare for future regulatory decisions on the setting of interconnection rates in Ireland, the Commission for Communications Regulation ('ComReg') is seeking to establish robust economic, principled and practical criteria on which to base its upcoming activities in this area. The criteria must take utmost account of the Recommendation, as well as the specific situation of the Irish market.

In this context, ComReg has commissioned Analysys Mason Limited ('Analysys Mason') to assist it in choosing an approach for regulating the interconnection services provided by fixed and mobile operators in Ireland that have been found to have significant market power (SMP) in their respective markets, for a multi-year regulatory period.[2]

Following this initial study, ComReg set out in its document 12/67 the following proposals regarding mobile termination rates:

- Cost orientation by means of a pure LRIC methodology is the most appropriate approach to set Termination Rates in Ireland.
- It is necessary to use an alternative approach based on benchmarking in the absence of an appropriate model or models from MSPs.

This new report provides additional analysis on the appropriateness of the use of a benchmarking method to set mobile termination rates (MTRs) as well as suggestions on the way this method should be implemented. The remainder of this document is laid out as follows:

- **Section 2** assesses the suitability of using benchmarking for setting MTRs in Ireland, based on economic and legal criteria as well as the consistency with the EC Recommendation
- **Section 3** assesses the robustness of the benchmarking approach proposed by ComReg by analysing whether such a benchmark could likely result in MTRs which would materially differ from the outcome of a cost model
- **Section 4** concludes on the suitability of the use of benchmarking for setting MTRs in Ireland until at least 1 July 2014.

1 COMMISSION RECOMMENDATION of 7 May 2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU (2009/396/EC). Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:124:0067:0074:EN:PDF

2 Analysys Mason final report for ComReg for purposes of ComReg Consultation 12/67 (26 June 2012), *Fixed and mobile termination rates in Ireland*. Available at: http://www.comreg.ie/_fileupload/publications/ComReg1267a.pdf.

2 Suitability of benchmarking for setting mobile termination rates in Ireland

In its evaluation report of possible price controls for voice termination rates in Ireland,[3] ComReg proposes in ComReg Consultation 12/67 the use of benchmarking for setting MTRs. Section 7.29 of the ComReg Consultation 12/67 states the following:

"*In the absence of any sufficient information received from the SMP[4] MSPs[5] to date which would assist in determining the actual pure LRIC cost of MVCT[6] on their networks, and given the resource constraints which it currently faces, ComReg considers that it is left with no option but to proceed on the basis of a benchmark of pure LRIC rates, based on the result of pure BU-LRIC models adopted by NRAs in other EU Member States."* ComReg nonetheless "*intend[s] to commence a pure BU-LRIC cost modelling exercise in respect of MTRs in 2013* […] *to meet the timelines as set out in the 2009 Termination Rate Recommendation, i.e. 1 July 2014*."[7]

This section assesses the suitability of using benchmarking for setting MTRs in Ireland based on economic and legal criteria as well as the consistency with the EC Recommendation.

2.1 Using benchmarking for setting MTRs in Ireland has the same efficiency, competition and equity effects as one based on a pure LRIC BU cost model

In our report[2] assessing possible pricing approaches for termination rates in Ireland, we assessed separately the pure LRIC (implemented via a cost model) and pure LRIC (implemented via a benchmark).

The conclusion reached in Section 6 of that assessment was that in general, the methodology used to establish a cost-oriented price would not affect efficiency, competition or equity considerations, unless it produced a different result for costs.

3 ComReg (28 June 2012), *Voice Termination Rates in Ireland: Proposed Price Control for Fixed and Mobile Termination Rates, Consultation and Draft Decisions*, ComReg 12/67. Available at http://www.comreg.ie/_fileupload/publications/ComReg1267.pdf.

4 Significant market power.

5 Mobile service providers.

6 Mobile voice call termination.

7 ComReg 12/67, op. cit., Section 7.4 and 7.21.

2.2 Using benchmarking for setting MTRs in Ireland is permissible under EU and Irish law

We note, as ComReg did in Section 7.27 of its report[8], that benchmarking is an approach consistent with EU and Irish legislation as Regulation 13(3) of the Access Regulations[9] provides that:

"The Regulator shall ensure that any cost recovery mechanism or pricing methodology that it imposes under this Regulation serves to promote efficiency and sustainable competition and maximise consumer benefits. In this regard, the Regulator may also take account of prices available in comparable competitive markets".

2.3 Using benchmarking for setting MTRs in Ireland would be consistent with the EC Recommendation, at least until 1 July 2014

Article 12 of the Recommendation explicitly indicates that an alternative methodology for setting MTRs, such as a benchmark, can be considered to be compliant with the Recommendation until 1 July 2014 if its outcome "*[does] not exceed the average of the termination rates set by NRAs [building a bottom-up LRIC model]*" (Analysys Mason's emphasis).

The use of benchmarking for setting MTRs in Ireland until 1 July 2014 would therefore be consistent with EU guidelines provided its outcome does not exceed the average of the termination rates set by NRAs implementing a bottom-up LRIC model, as described in the Recommendation.

Some leniency may be granted by the EC after 1 July 2014 to keep using a cost methodology other than a bottom-up LRIC model – as indicated in Article 12 of the Recommendation – but this has not yet been tested by any NRA. However, as ComReg intends to have its own model built by this date, this provision should not apply to the setting of MTRs in Ireland.

We note as well that BEREC agrees with the EC on the way to calculate benchmarks for setting termination rates. In its 'Serious Doubts' and 'Comments' letters issued to the Estonian and Slovakian NRAs, the EC indicates that the use of a benchmarking approach for setting MTRs "*has also been recently endorsed by BEREC*". The endorsement refers to the benchmark being based on models that use pure-LRIC and not LRIC/LRAIC plus, and on benchmarking target rates at the end of their glide paths (i.e. forward-looking termination rates).[10]

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8 ComReg (28 June 2012), *Voice Termination Rates in Ireland: Proposed Price Control for Fixed and Mobile Termination Rates, Consultation and Draft Decisions*, ComReg 12/67. Available at http://www.comreg.ie/_fileupload/publications/ComReg1267.pdf.

9 European Communities (Electronic Communications Networks and Services) (Access) Regulations 2011 (S.I. No. 334 of 2011)

10 In its 'Serious Doubts' and 'Comments' letter issued to the Slovakian NRA, the EC states that "*if the alternative methodology chosen is benchmarking, it should be performed by taking into account average MTRs only of those Member States which have implemented the recommended cost methodology as of 1 January 2013, which is pure BU-LRIC and not BU-LRIC plus. Further to that, rates used for benchmarking should represent the cost efficient target rates at the end of the respective glide paths. Such an approach has also been recently endorsed by BEREC*."

2.4 Using benchmarking can be considered appropriate for setting MTRs in Ireland, even if it may have been considered and rejected for other regulated telecoms services

There is a long history of benchmarks being used to determine regulated MTRs in Europe – alongside the development of cost models – and regulators such as ComReg have used benchmark methodologies for setting the LRAIC+ of mobile termination[11].

In our opinion, benchmarking is still suitable to set MTRs for the pure LRIC of termination. Indeed we observe that mobile network unit costs calculated based on pure LRIC models are broadly similar across European countries. Our analysis in Section 3 explains our view that there are structural reasons why this is the case.

However, we believe that it may not be appropriate to use benchmarking for all regulated products and services. Certain fixed network/access products, for example local loop unbundling (LLU), are much more sensitive than mobile termination to various factors, such as:

- *Topography* – this factor affects the deployment of a wired network to every household.
- *Technology architecture* – the choice (or mix) of aerial and buried wireline networks have cost implications in different countries – according to the nature of the ground (rocky, soft, wet), weather (wet, windy), etc.
- *Regulatory requirements* – the fixed incumbent operator has a universal service obligation which does not exist for mobile operators. The cost of this obligation can vary widely from one country to another (especially in relation to the two previous factors).
- *The existence of a competing technology* – mobile services are provided using a single type of technology (mobile telecoms networks), and the different generations of this technology (2G, 3G and 4G) are used at comparable levels across EU countries. In contrast, fixed services can be provided with a range of access technologies (traditional copper lines, coaxial cable TV lines, fibre, fixed wireless access), whose availability varies widely across countries.

For these different reasons, a benchmarking approach, which is suitable for setting MTRs, may not be appropriate for setting the rates of a range of other regulated products and services, especially for fixed networks (depending on the relevant market being assessed).

2.5 Analysys Mason's opinion

Based on economic and legal criteria, as well as the consistency with the EC Recommendation, we believe that it is reasonable for ComReg to adopt a benchmarking approach for setting MTRs in Ireland for the next regulatory period, until 1 July 2014.

[11] The benchmark to date was not based on any kind of cost model but on a voluntary glidepath based on a simple average of the MTRs of the 27 countries included in the biannual BEREC 'snapshot' reports

Some NRAs have already built pure LRIC cost models to determine MTRs, and other NRAs have already used the results of these models to produce a benchmark to set MTRs in their own country. Four examples of this situation are presented in Annex A and give an idea of the way the EC thinks a benchmark should be designed:

- It should include a large enough number of countries, and up to all relevant EU countries.
- It should only consider EU countries, as non-EU countries are not subject to the Regulatory Framework.
- It should only consider countries which have developed a pure bottom-up LRIC model, as this is the cost methodology set out in the Recommendation.
- It should be based on forward-looking rates; that is, rates for a defined (target) period in the future should be based on rates published for the same period in the countries benchmarked, not on the rates in these countries at the time the benchmark is calculated.
- It should be based on the target result in the final pricing decision published by NRAs whose rates (calculated from a pure LRIC model) are used to calculate the benchmark value.
- The glide path adopted should fully reflect pure bottom-up LRIC rates from 1 January 2013, not later, unless it is duly justified[12].

Having assessed the suitability of using a benchmarking approach for setting MTRs, this report now focuses on the robustness of the benchmarking approach proposed by ComReg in ComReg Consultation 12/67 by analysing whether such a benchmark could likely result in MTRs which would differ materially from the outcome of a cost model.

[12] The NRA in Spain provided adequate justification for its exception from this requirement.

3 Assessment of the robustness of the benchmarking approach proposed by ComReg

This section assesses the robustness of the benchmarking approach proposed by ComReg in the ComReg Consultation 12/67 by analysing whether a benchmark based on the bottom-up pure LRIC models used by NRAs in other Members States would be suitable to reflect the pure incremental costs incurred by an Irish mobile operator in the provision of termination to a third party.

In order to do so, we start by identifying which country-specific characteristics can have an influence on the unit cost results of termination calculated using a pure LRIC approach. Then we compare Ireland with a number of countries having developed bottom-up pure LRIC models, on the basis of those characteristics and assess whether each characteristic could unambiguously lead to a materially different pure incremental cost in an Irish cost model. This finally leads us to conclude on whether a benchmark-based approach is likely to result in MTRs which would materially differ from the outcome of a pure LRIC model.

3.1 A number of country-specific characteristics can influence the cost of termination

The experience of EU regulators over the last decade has shown that a number of country-specific characteristics have the potential to influence the cost of mobile termination. These characteristics typically include geographical, demographic and economic characteristics, as well as specific aspects of the mobile industry in the relevant market.

However the recent trend towards the development of bottom-up pure LRIC models shows that country-specific characteristics do not affect LRAIC+ and pure LRIC cost models equally:

- LRAIC+ reflects **all** the incremental and common cost elements needed to deliver a mobile termination minute, including radio spectrum, radio sites and their equipment, backhaul and transmission networks, core servers/platforms, etc. As a consequence the LRAIC+ unit cost tends to be sensitive to any characteristic that can affect the cost of any part of the network used by termination.

- pure LRIC reflects just the **incremental** costs of wholesale termination volumes. As a consequence not all cost elements contribute to the pure LRIC of termination and therefore the pure LRIC unit cost tends to be sensitive only to characteristics that affect the increment. One would therefore expect a pure LRIC model to be sensitive to fewer country specific variations.

Figure 3.1 below presents the various country-specific characteristics that can potentially affect the cost of mobile termination and assesses the possible impact of each of these characteristics on the

pure LRIC of mobile termination, based upon our knowledge of the approach taken by other NRAs as well as our own expertise.

Figure 3.1: Country-specific characteristics potentially affecting the cost of mobile termination and assessment of possible impact on the pure LRIC of termination[13] [Source: Analysys Mason, 2012]

Characteristic	Assessment of impact on the pure LRIC of termination	General impact on a pure LRIC result (and likely causality)
Spectrum fees	Spectrum fees are typically a fixed amount for block allocations of frequencies. There can be a trade-off between additional spectrum and network infrastructure (e.g. cell sites) as a spectrum-constrained network must re-use frequencies more tightly and would require a smaller cell spacing to provide the same capacity density as a spectrum-unconstrained network.	Low
Spectrum allocation	A limited amount of spectrum may force an operator to deploy more capacity sites to serve traffic. However, there is a trade-off between the sites added for capacity and the fees paid for (less) spectrum. Thus, this characteristic can have a lower impact on the pure LRIC of termination when taken with corresponding spectrum fees.	High (less spectrum leads to higher pure LRIC)
Market share adopted for the operator in the model	The market share directly influences the amount of traffic on the network of the operator modelled. It can differ from *1/n* (usually used for the generic operator, where *n* is the number of operators in the market; the EC Recommendation also aims at symmetry, which implicitly leads to a single market share percentage).	High (higher market share leads to higher pure LRIC)
Population density	Countries with low population density are dominated by coverage networks which are less traffic driven than in dense countries.	High (higher pop density leads to higher pure LRIC)
Topography	Population that is distributed across highly mountainous areas, islands, etc. require a lot of isolated base stations, and therefore increases the share of the network deployed for coverage.	High (spread topography leads to lower pure LRIC)
Extent of network coverage	An extended coverage network means the network will cover low population density areas where the network will not be driven by capacity. As a result, a part of the termination traffic (in these coverage areas) will not	High (extended coverage leads to lower pure LRIC)

13 Note, that it is the presence of avoidable costs which drive the pure incremental cost of wholesale termination. Avoidable costs arise in areas where there is a capacity constraint (e.g. traffic cells) and do not arise in areas where there is a coverage constraint (e.g. because the avoidance of wholesale termination traffic does not remove the need to provide coverage, therefore avoids few if any costs). The resulting pure LRIC is therefore a mix of avoidable costs in some parts of the network and zero (or very low) avoidable costs in other parts of the network. Due to this mix effect, there may be *pure LRIC scale dis-economies* in the Irish mobile operators' networks: the implication of this is that operators with, for example, more traffic, higher market share, or less coverage, may have more traffic driven network assets and a higher incremental (avoidable) cost in total and per minute of traffic. Analysys Mason presented this possible general outcome at the 2nd Annual Mobile Termination Rates Forum, in Brussels, on 12 February 2009, and we have also found this to be the case in some of our other pure LRIC models in Europe. This outcome is opposite to the typical scale economy effect which dominates in LRAIC+ cases (where fixed and common costs can be increasingly shared out amongst higher traffic volumes).

Characteristic	Assessment of impact on the pure LRIC of termination	General impact on a pure LRIC result (and likely causality)
	contribute significantly to the pure LRIC costs of termination.	
Subscriber penetration	As the number of subscribers increases (and unless it drives down the usage per subscriber with the existence of multi-SIM users who do not use more mobile services than if they had only one SIM), a larger share of the network could become capacity driven due to higher traffic levels.	High (higher penetration leads to higher pure LRIC)
Voice usage	As voice usage increases, a larger share of the network could become capacity driven.	High (higher usage leads to higher pure LRIC)
Amount of mobile broadband data traffic	With higher data traffic, a larger proportion of network costs becomes insensitive to voice termination traffic, as additional sites need to be deployed for data capacity, and only site equipment, such as additional transceivers (TRXs) (which are much cheaper to deploy than the sites themselves) need to be added for providing termination.	Low (higher data traffic leads to lower pure LRIC)
Radio deployment costs	The radio network is a large contributor to the pure LRIC of termination. Inputs influencing its cost (e.g. high or low costs to build towers, presence of network sharing) therefore have a significant impact on the pure LRIC of voice termination.	High (higher radio costs lead to higher pure LRIC)
2G/3G mix of voice traffic	2G networks are typically more sensitive to voice traffic than 3G networks (although depending on frequency usage) and so the mix of traffic does have an important influence on the pure LRIC results.	High (higher share of 3G leads to lower pure LRIC)
Switching network topology and costs	Most of the switching network is largely unaffected by the existence or removal of the service of wholesale termination, except for the low cost of call processing in the mobile switching centres (MSCs).	Low
Backhaul technologies	The typical capacities of backhaul links used in Europe (higher than 2Mbit/s), increasing use of high capacity fibre/leased Ethernet services means that backhaul technology does not have a significant impact on the pure LRIC of voice termination.	Low
WACC	The WACC has a direct impact on all costs of the operators modelled, including the costs forming part of the pure LRIC of termination.	High (higher WACC leads to higher pure LRIC)
Duration	The time period of the modelling calculation does not significantly affect the pure LRIC of termination as this avoidable traffic is calculated over the modelling period (e.g. single-year or multi-year) and so the pure LRIC avoided costs are not strongly affected by this characteristic.	Low

3.2 Comparison between Ireland and other Member States regarding the characteristics that can affect mobile termination costs

Ireland's geographical, demographic and economic characteristics are between the lowest and highest values of other Member States characteristics[14]:

- a land area of 68 883 square kilometres, between Malta's value (316 square kilometres)[15] and France's value (549 970 square kilometres)
- a population of 4 495 351 inhabitants (2012), between Malta's value (420 085 inhabitants in 2012)[16] and Germany's value (81 843 809 inhabitants in 2012)
- a GDP per capita of EUR34 800 (2011) between Bulgaria's value (GDP per capita of EUR4800 in 2010)[17] and Luxembourg's value (GDP per capita of EUR82 700 in 2011)
- GDP growth of 0.7% (2011) between Greece's value (GDP growth of -6.9% in 2011)[18] and Estonia's value (GDP growth of 7.6% in 2011).

The fact that Ireland's geographical, demographic and economic characteristics are not dissimilar from the rest of the EU is not in itself sufficient to assess whether the remaining differences are likely to lead to a materially different outcome for the pure LRIC of mobile termination.

Figure 3.1 identifies a set of country-specific factors that can potentially affect the cost of mobile termination. Annex B details all those country-specific factors for Ireland and seven EU Member States that have developed bottom-up LRIC models (Denmark, France, Netherlands, Portugal, Spain, Sweden and the UK). Figure 3.2 below discusses how Irish values compare to those of other countries and what could be the expected impact on the pure LRIC cost of termination in Ireland.

14 Same source for each category as for the other countries mentioned in this paragraph

15 Field listing: Area (land area used), The World Factbook, CIA. http://www.cia.gov/library/publications/the-world-factbook/fields/2147.html

16 Source: Eurostat (population at 1 January). http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&language=en&pcode=tps00001

17 GDP and main components: current prices, Eurostat. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_gdp_c&lang=en

18 Real GDP growth rate – volume, Eurostat. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&language=en&pcode=tec00115

Figure 3.2: Differences between Ireland and seven EU Member States that have developed bottom-up LRIC models, and impact on the pure LRIC of termination in Ireland [Source: Analysys Mason, 2012]

Characteristic	How Irish value compares to other countries	Expected impact on the pure LRIC cost of termination in Ireland
Spectrum fees (Low)	The future (post multiband auction) spectrum fees are not known at the time of writing so cannot be compared to values in other countries. However the impact on pure LRIC is expected to be low as discussed in Figure 3.1.	**Would probably not** lead to termination cost being different from the average of the seven countries.
Spectrum allocation (High)	The spectrum allocation of the modelled operator in an Irish cost model would reflect the average spectrum allocation of Irish operators rather than individual operators' allocation. The presence of three GSM network operators and four UMTS network operators in the market is similar to a number of other countries in Europe, and in this respect Ireland is not a significant outlier in spectrum allocations available at 900MHz, 1800MHz and 2100MHz.	**Not obvious** whether it would lead to termination cost being higher or lower in Ireland than the average of the seven countries.
Market share adopted for the operator in the model (High)	The market share adopted for the operator in an Irish cost model would reflect the average market share of Irish operators rather than individual operators' allocation. The presence of 4 mobile network operators in the market implies a relatively smaller market share than in countries with fewer operators which could lead to a lower pure LRIC cost of termination as discussed in Figure 3.1.	May lead to termination cost being **lower** in Ireland than the average of the seven countries.
Population density (High)	Ireland is characterised by a mix of dense, urban areas (where the pure LRIC cost of termination would be high) and rural areas (where the pure LRIC cost of termination would be low). The resulting effect of the mix between urban and rural depends on the level of coverage provided (if there is limited rural coverage, then the contribution from rural areas would be lower) as well as the distribution of traffic between urban and rural areas which will only be known once the data collection process part of the cost model development starts.	**Not obvious** whether it would lead to termination cost being higher or lower in Ireland than the average of the seven countries.
Topography (High)	Relatively flat topography appears quite similar to the other countries presented in Annex B.	**Would probably not** lead to termination cost being different from the average of the seven countries.
Extent of network coverage (High)	2G network coverage in Ireland appears quite similar to the other countries presented in Annex B so this would not lead to differences in 2G pure LRIC cost of termination compared to other countries.	May lead to termination cost being **higher** in Ireland than the

Characteristic	How Irish value compares to other countries	Expected impact on the pure LRIC cost of termination in Ireland
	3G network coverage in Ireland appears quite low compared to the other countries presented in Annex B which could lead to a higher 3G pure LRIC cost of termination as discussed in Figure 3.1. The resulting effect of the mix between 2G and 3G would depend on 2G/3G mix of voice traffic (see below)	average of the seven countries.
Subscriber penetration (High)	Ireland's subscriber penetration is at the level of most of the other countries (with France and Portugal being exceptions).	**Would probably not** lead to termination cost being different from the average of the seven countries.
Voice usage (High)	Voice usage in Ireland appears quite high compared to the other countries presented in Annex B which could lead to a higher pure LRIC cost of termination as discussed in Figure 3.1.	May lead to termination cost being **higher** in Ireland than the average of the seven countries
Amount of mobile broadband data traffic (Low)	Mobile broadband data usage in Ireland appears quite high compared to the other countries. However the impact on pure LRIC is expected to be low as discussed in Figure 3.1.	**Would probably not** lead to termination cost being different from the average of the seven countries.
Radio deployment costs (High)	Radio deployment costs in Ireland will only be known once the data collection process part of the cost model development starts. As a consequence it is not possible at this stage to assess whether radio deployment costs would be higher in Ireland compared to the other countries presented in Annex B	**Not obvious** whether it would lead to termination cost being higher or lower in Ireland than the average of the seven countries.
2G/3G mix of voice traffic (High)	The 2G/3G mix of voice traffic in Ireland will only be known once the data collection process part of the cost model development starts.	**Not obvious** whether it would lead to termination cost being higher or lower in Ireland than the average of the seven countries.
Switching network topology and costs (Low)	Switching network topology and costs in Ireland will only be known once the data collection process part of the cost model development starts. As a consequence it is not	**Would probably not** lead to termination cost

Characteristic	How Irish value compares to other countries	Expected impact on the pure LRIC cost of termination in Ireland
	possible at this stage to assess whether Switching network costs would be higher in Ireland compared to the other countries presented in Annex B. We note however that the impact on pure LRIC is expected to be low as discussed in Figure 3.1.	being different from the average of the seven countries.
Backhaul technologies (Low)	Backhaul technologies in Ireland will only be known once the data collection process part of the cost model development starts. As a consequence it is not possible at this stage to assess whether backhaul costs would be higher in Ireland compared to the other countries presented in Annex B. We note however that the impact on pure LRIC is expected to be low as discussed in Figure 3.1.	**Would probably not** lead to termination cost being different from the average of the seven countries.
WACC (High)	The WACC to be used in the model will probably only be known once the modelling part of the cost model development starts. As a consequence it is not possible at this stage to assess whether the cost of capital would be higher in Ireland compared to the other countries presented in Annex B	**Not obvious** whether it would lead to termination cost being higher or lower in Ireland than the average of the seven countries.
Duration (Low)	The duration of the model will only be known once the modelling part of the cost model development starts. We note however that the impact on pure LRIC is expected to be low as discussed in Figure 3.1.	**Would probably not** lead to termination cost being different from the average of the seven countries.

The analysis presented in Figure 3.2 shows that there are:

- Factors that may lead to termination cost being **higher** in Ireland than the average of the seven countries (two factors: extent of network coverage, voice usage)
- Factors that may lead to termination cost being **lower** in Ireland than the average of the seven countries (one factor: market share)
- Factors for which it is **not obvious** at this stage whether they may lead to termination cost being higher or lower in Ireland than the average of the seven countries (five factors: population density, spectrum allocations, 2G/3G traffic mix, radio deployment costs, WACC)
- Factors that **would probably not** lead to termination cost being different from the average of the seven countries (seven factors: spectrum fees, topography, subscriber penetration, mobile broadband usage, switching network topology and costs, backhaul technologies, and model duration).

Our conclusion from analysing these factors is that many cannot be fully assessed until such time as ComReg carries out its own modelling, and therefore there is little certainty about an exact Irish cost model result until it has been modelled explicitly.

3.3 Would a benchmark-based approach be likely to result in MTRs which would materially differ from the outcome of a cost model developed for Ireland?

Figure 3.3 below shows the pure LRIC results for cost per minute in seven EU Member States that have developed public bottom-up LRIC models, and two member states that have developed models and published cost results but not made the models transparent.

Figure 3.3: Pure LRIC results for cost per minute in nine EU Member States that have developed bottom-up LRIC models [Source: Analysys Mason, 2012]

Pure LRIC results[19]	DK	FR	NL	PT	ES	SE	UK	BE	IT
Pure LRIC in 2012	1.11	0.46	1.23	1.34	0.76[20]	1.08	1.10	1.07	
Pure LRIC in 2013	1.02	0.40	1.23	1.33	0.78[20]	0.97	1.08		0.98
Pure LRIC in 2014	0.94	0.58	1.23	1.33	0.80[20]	0.95	1.06		

Despite the variety of country and model characteristics described in Annex B, it can be observed that the bottom-up pure LRIC MTRs based on these models are within a limited range around 1 eurocent per minute:

- the range goes from 0.46 eurocents to 1.34 eurocents in 2012, from 0.40 eurocents to 1.33 eurocents in 2013, and from 0.58 eurocents to 1.33 eurocents in 2014
- the mean is 1.02 eurocents in 2012, 0.97 eurocents in 2013 and 0.98 eurocents in 2014.

The analysis presented in Figure 3.3 shows that Ireland has broadly similar characteristics to other Member States (i.e. Ireland's values are typically between the lowest and highest values of other Member States). It is therefore our opinion that if ComReg carried out a detailed bottom-up pure LRIC modelling exercise, the result would not be likely to fall out of the range of the mobile termination costs calculated by the seven Member States discussed in this report.

19 In EUR cents per minute, nominal terms, using the inflation forecast of the model

20 An inflation rate of 2% per annum from 2010 has been assumed as no mention to inflation is made anywhere in the model.

4 Conclusion

The EC Recommendation on the regulatory treatment of FTRs and MTRs in the EU[21] allows NRAs to apply alternative methodologies to pure bottom-up LRIC modelling to set termination rates until 1 July 2014. The EC provides further guidance on how the benchmark should be constructed as the average of specific rates. The results of our assessment, based on economic and legal criteria, as well as the consistency with the EC Recommendation, indicate that it is reasonable for ComReg to adopt a benchmarking approach for setting MTRs in Ireland for the next regulatory period, until 1 July 2014. After this date, it is not clear whether a benchmarking approach would still be appropriate, and under what conditions. However, as ComReg intends to develop its own pure bottom-up LRIC model by 1 July 2014, the uncertainty of the possibility of using a benchmarking approach for setting MTRs in Ireland later than that date should not constitute a disadvantage to this method.

Furthermore, as presented in Section 3 and Annex B, due to the varying characteristics of the EU Member States that have developed transparent bottom-up LRIC models in terms of their telecoms market (subscriber penetration, traffic per subscriber, number of operators, etc.) and the modelled operator (switching topology, equipment unit costs, etc.), MTR cost results range from 0.46 eurocents to 1.34 eurocents in 2012, from 0.40 eurocents to 1.33 eurocents in 2012 and from 0.58 eurocents to 1.33 eurocents in 2014. In our opinion, Ireland does not contain characteristics that would make the result of a cost model for Ireland significantly different from the range of results obtained in other European countries.

Ultimately, it requires a degree of technical knowledge to identify precisely the right cost model result in the situation where an NRA publishes a detailed cost model. On the other hand, it is straightforward to refer to the rates (prices) notified by NRAs in their communications with the EC. We therefore conclude that the benchmarking approach proposed by ComReg (i.e. a simple average benchmark based on the notified rates (prices) from NRAs in other Members States) would be, subject to the uncertainty discussed above, suitable to reflect the pure LRIC incurred by an Irish mobile operator in the provision of termination to a third party in the period to 1 July 2014. The notified mobile termination rates (prices) based on pure-LRIC models proposed by a number of EU countries are shown in Figure 4.1.

Figure 4.1: Proposed rates (prices) based on pure LRIC models [Source: ComReg, 2012]

Proposed rate	DK	FR	NL	PT	ES	SE	UK	BE	IT
EUR, cents per minute	1.07	0.80		1.27	1.09		0.83[22]	1.08	0.98

[21] COMMISSION RECOMMENDATION of 7 May 2009 on the Regulatory Treatment of Fixed and Mobile Termination Rates in the EU (2009/396/EC). Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:124:0067:0074:EN:PDF.

[22] We note that the UK figure is still in 2008/09 currency before the adjustment for UK inflation

Annex A The EC's opinion on benchmarking approaches for setting termination rates, based on recent decisions

As discussed in section 2.3 of the report, the use of benchmarking for setting MTRs in Ireland until 1 July 2014 is consistent with the EC Recommendation provided its outcome does not exceed the average of the termination rates set by NRAs implementing a bottom-up LRIC model, as described in the Recommendation.

The EC recently issued several 'Serious Doubts' and 'Comments' letters with respect to the use of benchmarking for setting MTRs. We review here four of these letters issued in 2012 to the NRAs of Estonia (in April 2012), Slovakia (in April 2012), Bulgaria (in May 2012) and Greece (in July 2012) before summarising the conclusion that can be drawn from them on the EC's opinion on the way a benchmarking approach should be designed.

A.1 Estonia

The EC provided a range of comments on the notification from the Estonian NRA, the Estonian Competition Authority (ECA), concerning the third review of the markets for voice call termination on individual mobile networks in Estonia. They relate to the process of setting MTRs and the definition of a benchmark, and reiterate the objective of MTRs set at cost.

The Framework Directive requires the regulator to carry out a national consultation before publishing its proposed termination rate

The ECA proposed to publish MTRs on its website "*not earlier than three months but not later than two months before the beginning of the relevant period [and] adopt these MTRs by way of so-called interim decisions, which will not be consulted at national or EU level, but will be communicated to the Commission, BEREC and the other NRAs*". The EC indicated that this process does not comply with EU legislation: "*as setting of price caps has a significant impact on the mobile termination market, interested parties should get an opportunity to comment on the draft measure, therefore Article 6 of the Framework Directive obliges ECA to first carry out a national consultation*."

The benchmark needs to follow strict guidelines

NRAs must adhere to the following EC guidelines when using benchmarks to set MTRs:

- The benchmark needs to be based on bottom-up LRIC models developed in other countries, without including LRAIC+ cost models.
- The benchmark needs to be based on forward-looking rates and not on rates currently used (at the time the benchmark is calculated) to set

termination in other countries. It should therefore consider the termination rates announced for the future by other countries for the period in which they will apply, to avoid creating a time-lag between the termination rates applicable in other countries and the termination rates calculated with a benchmark (that is, a benchmark to be applied in the period between 1 January 2013 and 31 December 2013 should be based on termination rates determined for the same period in other countries, not on termination rates applied in these countries at the time the benchmark is calculated).

- The regulator needs to explain "*why the chosen benchmarking approach would comply with the […] policy objectives and principles [set in EU legislation]*", such as being in line with the Regulatory Framework and resulting in cost-efficient rates.

- The benchmark should only include EU countries, as "*the Commission finds it inappropriate to benchmark against non EU-countries since they are not subject to the Regulatory Framework*."

The EC reiterates the objective of termination rates set at cost

The EC explains that if the ECA does not use forward-looking MTRs in its benchmark, Estonian operators will be regulated above costs and thus unduly benefit from these rates over their counterparts in other EU countries whose MTRs are regulated at cost. These termination rates set above costs create "*asymmetries in mobile termination rates within the EU [which] not only distort and restrict competition but have a significant detrimental effect on the development of the internal market*", the development of which is a goal of Article 8(2) and (3) of the Framework Directive.

A.2 Slovakia

The comments from the EC to the Slovakian NRA, Telekomunikačý úrad Slovenskej republiky (TÚSR), were similar to some of the comments the EC made to the ECA. They restated the following requirements for the use of a benchmark to set termination rates:

- The benchmark needs to be based on pure bottom-up LRIC models only, without including bottom-up LRAIC models (referred to as 'bottom-up LRIC plus models' in this letter).

- Rates used for the benchmark "*should represent the cost efficient target rates at the end of the respective glide paths*", that is, these rates should be forward-looking rather than historical.

A.3 Bulgaria

The comments from the EC to the Bulgarian NRA, the Communications Regulation Commission (CRC), detailed additional requirements for the use of a benchmark to set termination rates. The EC comments were as follows:

- Benchmarking should be based on the termination rate calculated in other countries, not on the rate of decline, as starting points can be different. In this case, benchmarking the rate of decline rather than the rate itself would maintain a discrepancy between the rates used as reference for the benchmark and the rate calculated with the benchmark, which would not be justified.

- The benchmark needs to consider a large enough set of countries and be revised if the set of relevant countries significantly increases. This requirement was raised from just one country being included in the benchmark used by the CRC, as at the time the benchmark was calculated only one country, the Netherlands, had built a bottom-up LRIC model for setting fixed termination rates (FTR).

A.4 Greece

The comments from the EC to the Greek NRA, the Hellenic Telecommunications & Post Commission (EETT), provided further insights on the use of benchmarking to set termination rates. The EC comments indicate the following additional requirements:

- The benchmark has to be based on termination rates implemented in EU countries, not on termination rates notified to the commission by NRAs in their draft decisions, as these may be different from the rates actually implemented. An NRA calculating a benchmark should therefore refer to the final decisions published by the other NRAs or by the Body of European Regulators for Electronic Communications (BEREC).

- The glide path adopted should fully reflect pure bottom-up LRIC rates from 1 January 2013, not later. This confirms the initial date to adopt termination rates based on pure LRIC as set in the EC Recommendation (which establishes 31 December 2012 instead of 1 January 2013).

The requirement to adopt bottom-up LRIC rates from 1 January 2013 is more restrictive than the leniency granted to Spain to set termination rates based on pure LRIC from 1 July 2013.[23] The EC indicated it approved the introduction of MTRs based on a bottom-up LRIC methodology as of 1 July 2013 instead of 1 January 2013 in Spain "*(i) given that the revised measures set a level of rates which tend towards the pure BU LRIC rates which are to be implemented by 31 December 2012 by all NRAs, (ii) due to the fact that pure BU-LRIC rates will be achieved much earlier than under the*

[23] European Commission (30 April 2012), *Commission decision concerning Case ES/2012/1314: Voice call termination on individual mobile networks in Spain; Comments pursuant to Article 7(3) of Directive 2002/21/EC*. Available at https://circabc.europa.eu/d/d/workspace/SpacesStore/f44aee40-b8a9-41ea-8677-f4f368368cac/ES-2012-1314%20Acte(1)_EN%2Bdate%2Bcote%2Bsg.pdf.

previously notified draft measure, and (iii) due to the fact that the proposed measure now strikes an appropriate balance between the increased consumer welfare on one hand and the risk of disruptive impacts on the sector (through too short a glide-path) on the other hand."

A.5 Implications of these case studies for setting MTRs based on benchmarks

These cases provide guidance on the EC's opinion regarding the way a benchmarking approach should be designed:

- It should include a large enough number of countries, and up to all relevant EU countries[24].
- It should only consider EU countries, as non-EU countries are not subject to the Regulatory Framework.
- It should only consider countries which have developed a pure bottom-up LRIC model, as this is the cost methodology set out in the Recommendation.
- It should be based on forward-looking rates; that is, rates for a defined (target) period in the future should be based on rates published for the same period in the countries benchmarked, not on the rates in these countries at the time the benchmark is calculated[25].
- It should be based on the target cost result in the final pricing decision published by NRAs whose rates (calculated from a pure LRIC model) are used to calculate the benchmark value.
- The glide path adopted should fully reflect pure bottom-up LRIC rates from 1 January 2013, not later, unless it is duly justified, as in the case of Spain.

24 The EC did not expressly indicate the minimum number of countries that they would recommend (in the Estonian case described above, 12 countries were used in the benchmark, 15 in the Slovakian case, and 7 in the Greek case and none of these countries was criticised for the size of the sample used in its benchmark) and indicated that that number could change over time with the number of countries having developed a pure bottom-up LRIC model. There is therefore no "magic number" and the EC seems to recommend NRAs that choose a benchmark-based approach to take into account the best evidence available at the time of the decision.

25 The Estonian case is the clearest on the definition of 'forward-looking' when it states that "*the Commission believes that calculations of price limits that are to be applied in the future should be based on forward-looking termination rates which will be applied in the relevant Member States in the same period*". The Slovakian case refers to the Estonian case when explaining which rates should be used for benchmarking.

Annex B Values of characteristics that can affect MTRs in a number of Member States

Figure B.1: Values of the main characteristics influencing the pure LRIC of termination in models built for NRAs[26] [Source: Analysys Mason, 2012]

Characteristics	Ireland	Denmark	France	Netherlands	Portugal	Spain	Sweden	UK
Exchange rate used for local currency conversion, if not EUR	n/a	DKK1 = EUR0.13406 Average rate in 2006, year used in the model for amounts in real terms	n/a	n/a	n/a	n/a	SEK1 = EUR0.10483 Average rate in 2010, year used in the model for amounts in real terms	GBP1 = EUR1.25929 Average rate in 2008, year used in the model for amounts in real terms
Version of the model	n/a	5.0vF	Release 5	Final (20 April 2010)	anexo1_modeloCcusteio LRICpuro v1.1	Model v47.8 (Final)	"10-8320-pts-mobil-lric-final-model" and "10-8320-Kostnadsresultat-110621"	Release version 4
Spectrum fees (in 2012 EUR)	Multi-band (800MHz, 900MHz and 1800MHz) auction taking place in September 2012	Annual 2G licence fees (in 2012): 1 920 881 3G licence fees: 163 784 131 (of which 25% is paid in	2100MHz auction fee: 841 723 032 (paid in 2001) Annual licensing fees (in 2012, 2G; 3G):	900MHz licence fees: 274 289 719 (paid in 2004, 2019, 2034 and 2049) 1800MHz licence fees:	2100MHz licence fees: 126 651 267 (paid in 2004, 2019 and 2034) Annual licensing fees	900MHz licence fees: 81 200 110 (paid in 2000), 33 833 379 (paid in 2005 and 2020), 56 388 965	800MHz auction fee: 7 091 562 2600MHz auction fee: 2 997 113 Licensing fees to PTS	2100MHz: auction fee: 819 797 170 (paid in 2004) Annual licensing fees (in 2012, 2G; 3G):

[26] Belgium and Italy are not shown in this table because they do not have transparent pure LRIC cost models. The only relevant characteristics which can be determined for these countries are:

- Population density: Belgium - 365, Italy - 207
- Topography: Belgium - flat coastal plains in northwest, central rolling hills, rugged mountains of Ardennes Forest in southeast; Italy - mostly rugged and mountainous; some plains, coastal lowlands

Characteristics	Ireland	Denmark	France	Netherlands	Portugal	Spain	Sweden	UK
		2010, and an extra 7.5% each year until 2020) Annual spectrum usage fees (in 2012, 2G; 3G): 419 001; 227 714	67 187 850; 39 503 455	197 655 044 (paid in 2004, 2019, 2034 and 2049) 2100MHz licence fees: 156 043 456 (paid in 2004, 2019, 2034 and 2049) Annual licensing/numbering fees in 2012): 530 604	(in 2012, 2G; 3G): 3 710 969; 6 412 534	(paid in 2012 when refarming), 58,644,524 (paid in 2015) 1800MHz: licence fees: 159 492 200 (paid in 2000 and 2025) 2100MHz licence fees: 169 180 509 (paid in 2002 and 2022)	(yearly): EUR9959	253 006 012; 0
Spectrum allocation	Multi-band (800MHz, 900MHz and 1800MHz) auction taking place in September 2012	900MHz: 2×8.8 1800MHz: 2×18.8 2100MHz: 2×15	900MHz: 2×7.5 to 2×12.4 (changes by geotype) 1800MHz: 2×23.8 2100MHz: 2×15	900MHz: 2×11.3 1800MHz: 2×19 with termination, 2x11.5 without termination 2100MHz: 2×10	900MHz: 2×8 1800MHz: 2×6 2100MHz: 2×20	900MHz: 2×20.4 (entirely used for GSM until 2011, 2×10 refarmed for UMTS from 2012) 1800MHz: 2×44.64 2100MHz: 2×42	900MHz: 2×7.2 1800MHz: 2×23 2100MHz: 2×15 800MHz: 2×10 2600MHz: 2×20	900MHz: 0 1800MHz: 2×30 2100MHz: 2×10
Market share adopted for the operator in the model	n/a	25%	33.3%	33.3%	25.8% (in 2012) Hypothetical new entrant	30% (as the three main operators control 90% of	GSM: 50.0% UMTS: 40.5% HSPA: 40.8% LTE: 32.7%	23.8% (in 2012)

Characteristics	Ireland	Denmark	France	Netherlands	Portugal	Spain	Sweden	UK
					starting in 2006	the market)		
Population density[27]	65 inhabitants per square kilometre	132 inhabitants per square kilometre	119 inhabitants per square kilometre	494 inhabitants per square kilometre	115 inhabitants per square kilometre	93 inhabitants per square kilometre	23 inhabitants per square kilometre	260 inhabitants per square kilometre
Topography[28]	"Mostly level to rolling interior plain surrounded by rugged hills and low mountains; sea cliffs on west coast"	"Low and flat to gently rolling plains"	"Mostly flat plains or gently rolling hills in north and west; remainder is mountainous, especially Pyrenees in south, Alps in east"	"Mostly coastal lowland and reclaimed land (polders); some hills in southeast"	"Mountainous north of the Tagus River, rolling plains in south"	"Large, flat to dissected plateau surrounded by rugged hills; Pyrenees Mountains in north"	"Mostly flat or gently rolling lowlands; mountains in west"	"Mostly rugged hills and low mountains; level to rolling plains in east and southeast"
Extent of network coverage (population covered in 2012)	2G: 99+%[29] 3G: 90% to 96%[30]	Area covered rather than population covered: 2G: 98.1% 3G: 82.6%	2G: 98.4% 3G: 97.4%	2G: 99.9% 3G: 97.0% (the scenario used for costing uses an indoor coverage of 2G: 99.1% and 3G: 85.2%, with reduced	GSM: 99.0% UMTS: 87.2%	GSM/GPRS: 99.5% EDGE: 80.0% UMTS: 93.0% HSPA: 93.0%	GSM: 99.6% UMTS: 98.8% HSPA: 94.0% LTE: 25.0%	2G: 98.1% 3G: 91.5%

27 Calculated from the area provided by the CIA World Factbook ("Field listing: area", the "land" category was used) and the population from Eurostat (see footnotes 15 and 16 for links to the sources).

28 Uses the "Field listing: terrain" category of the CIA World Factbook. Available at: https://www.cia.gov/library/publications/the-world-factbook/fields/2125.html.

29 Meteor and O2 announce values of respectively 99% and 99.6% population coverage on their website, and coverage maps for Vodafone and Three look very similar (http://www.meteor.ie/plans/coverage; http://www.o2online.ie/wps/wcm/connect/O2/Home/Shop/O2+Network+Coverage+checker; http://www.vodafone.ie/coverage; http://www.three.ie/products_services/coverage/index.html)

30 O2 announces 90.5% mobile broadband coverage (http://www.o2online.ie/wps/wcm/connect/O2/Home/Shop/Broadband/Coverage+checker/), Vodafone's and Three's mobile broadband coverage seem more extensive (same links as in the previous footnote). Three claims 96% population coverage on its website (http://www.three.ie/products_services/broadband/index.html)

Characteristics	Ireland	Denmark	France	Netherlands	Portugal	Spain	Sweden	UK
				cell radii compared to outdoor coverage)				
Subscribers penetration (year average in 2012)	[confidential]	Voice: 129% Data-only: 14%	Voice: 93% (of which 2G: 40%; 3G: 53%) Data-only: 6%	130% (of which voice-only: 1%; voice and data: 129%)	Voice (and low-speed data): 155% High-speed data: 27%	128% (of which GSM: 55%; UMTS: 73%)	As a proportion of the 2009 population: Voice: 117%; Handset data: 74% Data-only: 23%	Voice: 124% (of which 2G: 55%; 3G: 69%) Data-only: 13%
Voice usage (by subscriber in minutes in 2012)	[confidential]	Outgoing: 84 On-net: 55 Incoming: 66	Outgoing: 92 On-net: 77 Incoming: 77	Outgoing: 55 On-net: 39 Incoming: 48	Outgoing: 27 On-net: 73 Incoming: 35	Outgoing: 55 On-net: 56 Incoming: 52	Outgoing: 99 On-net: 91 Incoming: 78	Outgoing: 101 On-net: 56 Incoming: 74
Amount of mobile broadband data traffic (by subscriber in Mbytes in 2012)	[confidential]	2G: 7 3G: 428	2G handset: 2 3G handset: 63 Data-only: 830	Voice and data subscriber: 41 (of which 2% GPRS, 5% R99, 93% HSPA)	Low-speed data: 0.2 High-speed data: 1,100	GSM: 5.9 UMTS: 28 HSPA: 298	Handset data: 100 Data-only: 4,000	2G handset: 1.4 3G handset: 42 Data-only: 1,042
Radio deployment costs (2012 unit prices in EUR, nominal): capex; opex BTS and NodeB unit costs are for macro-cell equipment	n/a	Macro site (own): 103 573 to 106 418; 5735 Macro site (third-party): 82 327 to 84 983; 2308 BTS (2 to 3 sectors): 22	Macro site: 136 705; 15 832 BTS (1 to 3 sectors): 6606 to 14 689; 1128 to 2339 NodeB: 22 135; 2193	Macro site (own): 95 724 to 118 247; 10 612 to 21 224 Macro site (third-party): 56 308 to 78 831; 4245 to 15 918 BTS: 31 892;	Macro site (own): 160 203; 8262 Macro site (third-party): 101 947; 7081 BTS (1 to 3 sectors): 24 780 to 49 561; 2123	Macro site (tower): 93 655 to 121 751; 6862 to 18 010 Macro site (rooftop): 49 596 to 64 475; 7807 to 20 745 BTS: 22 389;	Macro site (own): 78 391 to 93 644; 5534 to 8854 Macro site (third-party): 35 632 to 49 885; 4427 to 7747 BTS: 18 825;	Macro site: 101 780; 10 417 BTS (1 to 3 sectors): 55 994 to 75 552; 5579 to 6419 NodeB: 74 112; 8389

Characteristics	Ireland	Denmark	France	Netherlands	Portugal	Spain	Sweden	UK
		351 to 25986; 1908 to 2222 NodeB: 6575; 323		3388 NodeB: 24 116; 2656	NodeB: 49 561; 4721	4368 NodeB: 23 622; 4384	2234 NodeB: 9682; 1195	
2G/3G mix of voice traffic (in 2012)	n/a	2G: 56% 3G: 44%	2G: 53% 3G: 47%	2G: 65% 3G: 35%	2G: 64% 3G: 36%	2G: 50% 3G: 50%	2G: 45% 3G: 55%	2G: 45% 3G: 55% (same proportion as 2G to 3G subscribers)
Switching network topology (in 2012)	n/a	3 main switching sites, IP core-core links on 10GE (2100km)	30 switching sites, IP-MPLS optic fibre core transmission (6751km dark fibre, 2234km lambdas)	7 core transmission sites on a national backbone fibre ring (437km), 6 regional backbones fibre rings (total of 2003km)	4 switching sites with MSS and MGW, 8 core transmission sites linked by a self-provided national backbone ring	20 MSC-MGW sites	Modern MSS-MGW pairs in each of three major cities ATM/SDH/PDH for voice and Ethernet for data transmission for RNC-core and core-core links	30 switching sites, 2Mbit/s links for core transmission
Backhaul technologies	n/a	LMA: 41% leased lines, 59% microwave	LMA (changes by geotype): 38% to 46% leased lines, 32% to 59% microwave, 0% to 16% DSL, 0% to 6% fibre	LMA (changes by geotype and for 2G/3G): 0% to 22% leased lines (100% for micro/indoor sites), 67% to 100% microwave,	LMA (changes by geotype): 15% to 28% leased lines (100% for micro sites), 5% to 70% microwave, 2% to 80% fibre (slight	LMA: 22% leased lines, 78% microwave	LMA: 10% leased, 90% microwave/self-provided (100% leased for urban micro sites), ATM/SDH/PDH for GSM only sites, Ethernet	LMA: 100% microwave; from 2009, sites requiring more than 3.5 2 Mbit/s circuits (determined by geotype) use Ethernet rather than standard

Characteristics	Ireland	Denmark	France	Netherlands	Portugal	Spain	Sweden	UK
				0% to 20% fibre, 0% to 2% collocation	differences between 2G and 3G sites)		for UMTS, LTE and multi-technology sites	microwave links (0% Ethernet in 2012)
WACC (real terms)	n/a	4.41%	10.17%	8.45%	9.19%	10.87% no mention to inflation is made anywhere in the model	7.30%	6.20%
Duration	n/a	1992-2041 (the generic operator starts deploying its network in 2010; the 2G network is shutdown in 2019, the 3G network is shutdown in 2029)	1990–2016 (the generic operator starts deploying its network in 1993)	2004-2053	2001–2050 (the generic operator starts in 2004)	2000–2049 (model runs over the 2000–2029 period)	2008–2035 (model built to run until 2058 if desired)	1990–2021 (the generic operator starts in 1993; cost calculations extended to 2040)