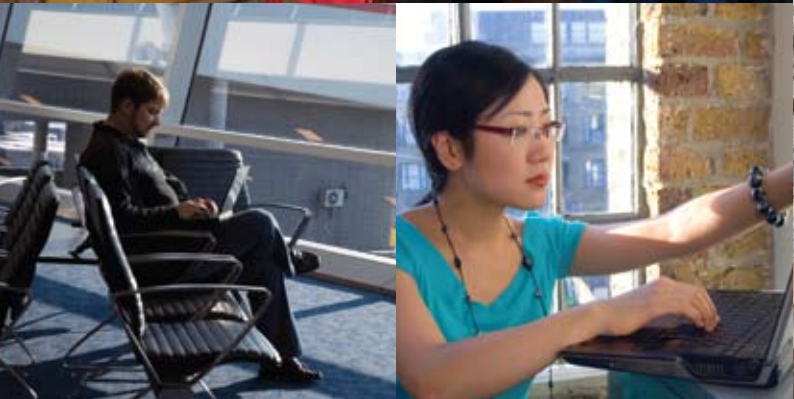




The setting of mobile termination rates: Best practice in cost modelling



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1.0 Introduction and Executive Summary

1.1 Executive Summary

This report was commissioned by the GSM Association (GSMA) and undertaken by PricewaterhouseCoopers (PwC) to examine best practice cost modelling in the context of regulating mobile termination rates (MTRs).

The setting of regulated MTRs¹ is a complex and involved task which is likely to require detailed costing analysis and careful consideration of the welfare and competition effects of regulatory intervention.

Hundred of billions of minutes are terminated on mobile networks every year, so it is no surprise that the issue of MTRs has attracted considerable attention from various interested parties including governments, consumer bodies and the media. This has resulted in National Regulatory Authorities (NRAs), operators, and in many cases the courts, devoting considerable effort to answering the fundamental question – how much should an operator be allowed to charge for terminating a call on its network.

Given the complexity of the analysis required to answer that question, it is not surprising that NRAs and operators have considered and developed a wide variety of approaches and analytical frameworks without a real consensus emerging across the industry, although certain areas of common practice have emerged as highlighted in this paper. The debate about MTRs will continue for many years to come, and there is a move in certain quarters, especially at a European Community level, to develop a consensus regarding how MTRs should be calculated, in the hope that this will drive a harmonisation of rates across Europe.

This paper seeks to highlight the key issues that NRAs and operators should consider both with respect to how to estimate the cost of terminating a call on a network and how the calculated cost should feed into a pricing decision. In detailing the key issues, where relevant, we provide our opinion as to what we believe constitutes best practice, although in many cases, best practice will be determined by the particulars of the country in which termination rates are being assessed.

We hope this paper will contribute to a constructive debate around the principles that should be followed when setting termination rates, and will provide NRAs and operators with guidelines as to how they should go about assessing MTRs. The setting of MTRs is best achieved in a transparent consultative

process that includes the NRA, operators and other interested stakeholders. This paper will be most applicable at the start of such a consultation, and will provide a framework for discussing the key issues that need to be covered before MTRs can be set; it can never be a substitute for effective consultation and considered decision-making.

1.2 Key findings

The setting of regulated MTRs has attracted enormous attention in both developed and developing countries, and many different approaches and methodologies have been developed for this purpose. We have surveyed operators to give context to this report and the survey responses support our view that the industry is a long way from achieving a consensus regarding how termination rates should be set.

Our analysis of the key issues highlights the complexity of the issues that need to be considered, and in some cases, the lack of clear best-practice either in terms of theory or application. However, there are some areas where best practice has emerged including:

- The use of a hybrid model,
- The use of economic depreciation,
- The use of a forward looking model incorporating historic data as a sense check,
- Allocation of costs between services based on routing factors,
- Networks are assumed to be efficient in competitive markets,
- MTRs should be based on the technologies in use, e.g. 2G migrating to 3G, and
- Cuts in MTRs need to be passed on to the end user if they are to have the desired effect.

There are some publicly available cost models, notably the World Bank model and the COSITU model that have been used, especially in the developing world, to provide NRAs and operators with cost estimates. We believe these models are not appropriately specified and should not be relied upon for the purposes of setting MTRs.

We believe the best way to set MTRs is to engage in a detailed consultative process, with sufficient time given to consider all the key issues that are discussed in this paper.

¹ In a calling party pays world. Under a receiving party pay regime call termination ceases to be a bottleneck.

2.0 Background and Methodology

2.1 Purpose of the Study

PwC has been commissioned by the GSMA to write a report on best practice cost modelling in the context of regulating MTRs. In recent years, NRAs in many countries, especially in the developed world have undertaken cost modelling exercises in order to set efficient MTRs. The level of MTRs in the developing world, where mobile penetration has outstripped fixed line penetration, is attracting more attention and regulators are now considering what steps should be taken in order to regulate MTRs appropriately. This paper is intended to serve as a guide to best practice cost modelling and how such modelling should be used to set appropriate prices for terminating calls on operators' networks. The report sets out some of the key issues that should be considered when embarking on a cost-modelling exercise. In some cases we provide our opinion as to what we believe modelling best-practice is. In other cases, we provide an explanation of the various options available, and under what circumstances the different options are more or less appropriate.

2.2 Approach

We have used the following sources of information in compiling this report:

- 1 Our experience of working with mobile operators and regulators in over 20 countries in the context of setting cost-based MTRs;
- 2 Publicly available information on the websites of NRAs and network operators;
- 3 The responses to a survey that was distributed to mobile network operators as part of this study; and
- 4 The generic cost models that have been developed and used to inform mobile termination rates, especially in the developing world.

Much of the best-practice cost modelling and price setting has been established in the developed world. Whilst many of the issues and methodologies can be relevant in the developing world, there are also further considerations which should be taken into account. In this paper we set out our view as to what best practice cost modelling and price setting entails, and how it might differ in the developing world due to additional factors and constraints that are not observed in the developed world, especially with regards to the costs and efforts associated with different types of solutions.

2.3 Regulatory context

2.3.1 Termination as an enduring bottleneck

There is a distinct trend among NRAs to judge mobile termination on each operator's network to be a monopoly service requiring regulation. In the EC regulation has been administered under the common regulatory framework for electronic communications networks and services, with all NRAs required to perform a market analysis of *Voice call termination on individual mobile networks* (Market 16).

Notwithstanding the specifics of the legislative and regulatory environments, mobile call termination has been a main focus for NRAs' work regulating mobile operators and in most cases has been judged to be the only area of mobile operations requiring *ex ante* price regulation.

There are some circumstances where the case for *ex ante* price regulation of mobile termination falls away, e.g. under receiving party pays regimes where mobile users bear some or all of the cost of receiving calls. In this case, and where there is effective competition for customers and mobile originated calls, termination charges will also be competed.

However, receiving party pays regimes are not the norm and have become less common over recent years. This study specifically focuses on cost modelling and its application to *ex ante* price regulation under calling party pay regimes.

² NRAs have also used international benchmarking to set MTRs. We briefly discuss the role of benchmarking in section 3.

2.3.2 SMP/dominance found on individual networks

Regulators have generally concluded that call termination on each individual mobile network is a separate market and each operator of those networks enjoys significant market power (SMP)/dominance³ of that market. Consequently, NRAs have imposed remedies on the operators to ameliorate or prevent market distortions resulting from the presence of market power. Remedies have included a variety of obligations such as requirements to interconnect, transparency of interconnection arrangements and various reporting requirements, but most importantly a requirement to set cost-oriented prices for call termination.

2.3.3 Remedy of cost-orientation

The most important and intrusive remedy applied by NRAs in regulating call termination markets is the imposition of cost-orientated pricing. Typically, NRAs intervening in price setting aim to replicate prices that a competitive market would produce. The components of such an efficient price are:

- (a) incremental cost (practical proxy for marginal cost)
- (b) contribution to fixed and common costs (required to ensure full cost recovery and maintain investment incentives)
- (c) externality adjustment (discussed further at section 4.2)

The implications and practicalities of this remedy form the basis for this study. In this study we look at the key questions that need to be answered when setting cost-based prices. At a high level each NRA must form a view as to what cost is and how that cost information should be used to set mobile termination rates.

2.3.4 Balance between market regulation and market stimulation

The imposition of cost-based pricing has typically occurred in mature or maturing mobile markets where demand for mobile services is long-established and operators have completed or nearly completed building out their coverage networks. In this paper we will explore the issues NRAs should take into account in the context of mobile markets that are in the early stages of development, including the delicate balance that needs to be struck between market regulation and market stimulation.

³ The purpose of this paper is not to examine different regulatory regimes. As such, terms such as SMP and dominance, which have slightly different connotations, are used in a general sense and not with respect to any specific regulatory or legal definition.

3.0 Best practice modelling

3.1 Overview

This section sets out the most important issues that NRAs must consider when embarking on a cost modelling exercise. There is not always a ‘correct’ methodology, and each of the options will typically have strengths and weaknesses. It is important for the NRA to understand these strengths and weaknesses and adopt the approach which is most applicable given the specifics of their local market conditions, including data availability and the time and resources available.

3.2 Cost modelling or international benchmarking

In setting MTRs, NRAs have usually followed one of two approaches: cost-modelling or international benchmarking⁴. This paper does not consider how international benchmarking studies should be performed or their possible application in the setting of regulated MTRs. It is our view that relying on international benchmarking for setting MTRs is fraught with difficulties⁵, and as such should be used only as a last-choice and then preferably only as an interim solution, when the difficulties of performing a properly specified cost-modelling exercise prove too challenging. Therefore, this paper adopts the presumption that cost-modelling is superior to international benchmarking – a view endorsed by the actions of most NRAs that have set MTRs, and by the comments of the European Commission with respect to NRAs that have used international benchmarking to set MTRs, e.g. as demonstrated by the Commission’s comments on the Portuguese decision that relied on benchmarking:

The Commission considers that a cost orientation obligation is a robust method for price control in mobile call termination markets where the level of the mobile termination rates is based on the costs of an efficient operator. The Commission notes that ICP-ANACOM has not yet implemented cost orientation as was envisaged during its first notification (PT/2004/0129) but that its implementation is a priority for 2008. Given the importance of regulating mobile termination rates effectively and in a consistent manner, the Commission encourages ICP-ANACOM to work in close co-operation with the European Regulators Group and the Commission to arrive at a coherent approach on this matter across the EU, and to revisit an analysis in light of a common European approach as soon as this has been established.

Much of the best-practice cost modelling and price setting has been established in the developed world. Whilst many of the issues and methodologies can be relevant in the developing world, there are also further considerations which should be taken into account. In this paper we set out our view as to what best practice cost modelling and price setting entails, and how it might differ in the developing world due to additional factors and constraints that are not observed in the developed world, especially with regards to the costs and efforts associated with different types of solutions.

3.3 Types of cost model

Before discussing the main cost modelling issues, set out below are high-level schematics showing the different types of cost model that regulators and operators have used in informing the level of MTRs. The choices around types of cost model can be broken down into three key questions:

- 1 Should the model be top-down, bottom-up or a combination of the two (a hybrid model)?
- 2 Should the model calculate average costs or incremental costs?
- 3 Should the model use historic cost valuations and straight-line depreciation or should adjustments be made to reflect economic or current cost asset valuations and alternative depreciation methodologies?

Whilst models can be constructed to reflect all of the different combinations of the above options, presented opposite are the main types of model that operators and NRAs have typically adopted.

⁴ International benchmarking has also been used as a sense-check to verify the outputs of a cost-modelling exercise, but in such cases it is the cost-modelling that is ultimately used to set MTRs.

⁵ Even where all termination rates in a sample are cost-based and were the result of similar cost-modelling processes, we would still expect cost differences between countries as a result of a number of factors, including geography, disposable income, access to power, security requirements, need to deploy backhaul satellite links, access to wholesale backbone products, availability of site-sharing, etc.

Option 1 – Top down FAC/HC

Figure 1 shows a schematic of the most straightforward type of cost model. Costs are taken directly from the operator's accounting records and are allocated to services using service demand and allocation rules. In this type of model, there is no distinction between incremental costs and fixed and common costs – the average cost approach.

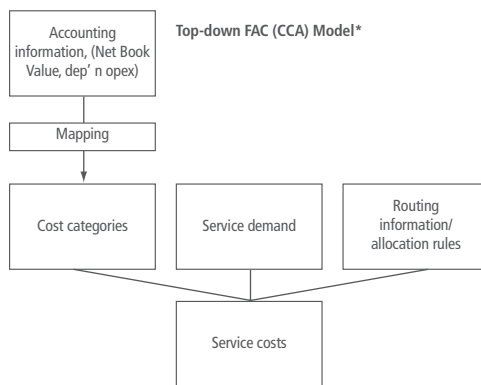


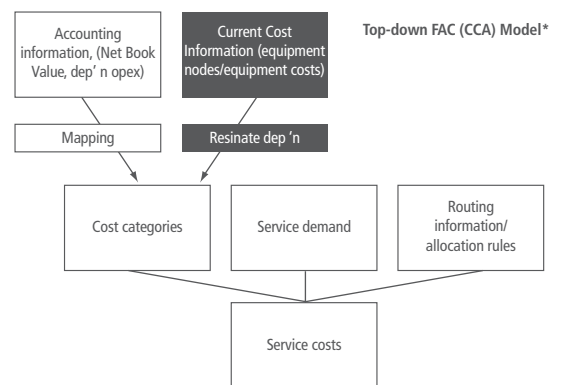
Figure 1 – Top down FAC (HCA) model schematic

If an NRA or operator relies on this approach, it is effectively making three key implicit assumptions:

- 1 The level of historic investment remains relevant for the setting of prices; and
- 2 The distinction between, on the one hand, marginal (or incremental) cost and, on the other hand, fixed common and joint costs, is not relevant for the setting of prices
- 3 Accounting depreciation is a reasonable method for scheduling recovery of capital costs.

Option 2 – Top down FAC/(Current Cost valuation)⁶

Figure 2 shows an additional element to the FAC (HCA) model. In this model, further information relating to the current value of assets is collected and analysed. This allows different types of depreciation, e.g. Current Cost Accounting (CCA) and annuity-based depreciation, to be considered. If annuity-based depreciation is used, information regarding the future expected asset price changes will also be required.



*Depending on what current cost information is gathered.

Figure 2 – Top down FAC (CCA) model schematic

⁶ We use the term current valuation in the broad sense to capture different types of valuation/depreciation methodologies that require a revaluation of assets, including annuity-based methods, but not the proxy for economic depreciation methods that require historical and forecast demand and other inputs.

Option 3 – Top down LRIC/(Current Cost valuation) Model

Figure 3 shows an additional element to the FAC (Current Cost valuation) model. In this model, cost volume relationships (CVRs) are used to differentiate between, on the one hand, incremental costs and on the other hand, fixed, common and joint costs. The model will typically be constructed to allocate the fixed, common and joint costs to the increments or services once the incremental costs have been allocated.

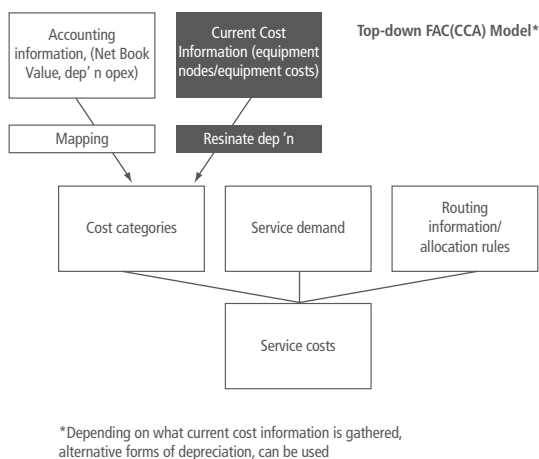


Figure 3 – Top-down LRIC (CCA) model schematic

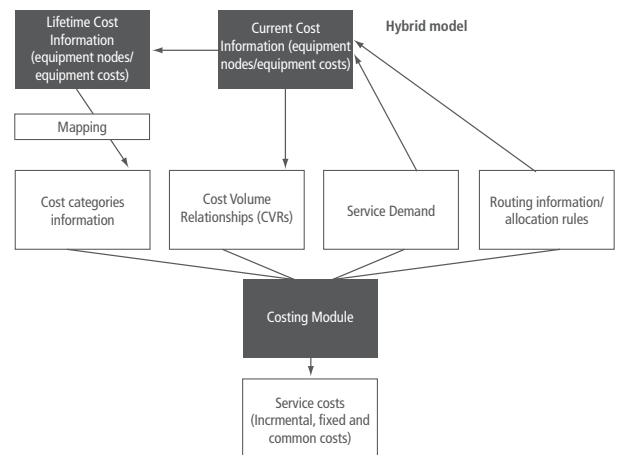
If a NRA relies on this type of model the NRA has additionally removed the assumption that the distinction between, on the one hand, average cost and, on the other hand, fixed common and joint costs, is not relevant for the setting of prices.

Option 4 – Bottom-up model

Figure 4 shows a schematic for a bottom-up model. A bottom-up model will require a wide variety of information which will allow the model to produce outputs for different types of costing (average or incremental) and different methods of valuation and depreciation. In our experience, the most common type of bottom-up model used by regulators is one which distinguishes between incremental costs and fixed, common and joint costs, and uses an economic depreciation methodology. A bottom-up model will include network dimensioning rules to estimate the size of the network for different levels of demand and network/service quality. The network design rules can either be hypothetical based on industry benchmarks or based on operator-specific data. This allows different levels of efficiency

to be considered within the context of the bottom-up model.

The network dimensioning rules and quality assumptions can also be used to generate the cost volume relationships which are used to distinguish between incremental costs and fixed, common and joint costs.



*A bottom-up model can either be a FAC model, or if CVRs are used can be a LRIC model. The costing model can calculate annual depreciation under a variety of methods including HCA, CCA, annuity and cash-flow based depreciation.

Figure 4 – Bottom-up model schematic

If a NRA relies on a bottom-up incremental cost model with economic depreciation, the NRA has removed all the implicit assumptions that were noted in relation to the FAC/HCA model. However, the use of a bottom-up model can introduce new elements of uncertainty and complexity. In section 3.4, we provide some more details on these and other key modelling decisions, and where relevant, provide our opinion as to which is best practice, or under which circumstances different options are preferable.

Option 5 – A hybrid model

A hybrid model is effectively an extension to the bottom-up model in which outputs (annual network size and implied annual investment and operating costs) from the model are compared with an operator's actual data. Where material differences are observed changes can be made to the model inputs or algorithms to enhance the robustness and predictive quality of the model.

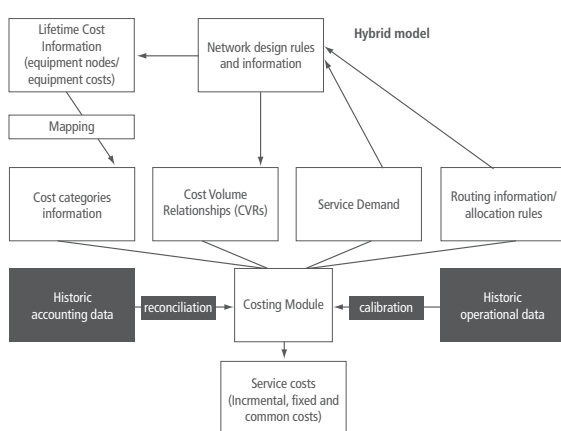


Figure 5 – Hybrid model schematic

An NRA will typically rely on a hybrid model if it is concerned that a pure bottom-up model will produce results that are not necessarily consistent with the real-world constraints that mobile network operators face.

3.4 Important modelling issues

The section below builds on the previous section and also details a number of specific issues which need to be considered when building a model to set MTRs.

3.4.1 Average v incremental

According to economic theory, in competitive markets the price of a service or product will equal the marginal cost of providing that product or service. In the telecoms industry, it has long been recognised that the short-run marginal cost of a call minute is not a relevant measure cost as the vast majority of call minutes generate almost no marginal costs until a point is reached when e.g. further investment in the network or an additional member of staff is required. For that minute, the marginal cost will be exceptionally high. For that reason, NRAs have sought to find a pragmatic

solution which, on the one hand recognises that an average cost approach does not fully reflect principles of cost causality⁷, and on the other hand is more practical than marginal costing.

The solution that NRAs have adopted is incremental costing and more specifically long-run incremental costing (LRIC). LRIC modelling distinguishes between the costs that are incremental and the costs that are fixed common and joint. Incremental costs are typically lower than average costs in the presence of economies of scale and/or scope, but the sum of all the incremental costs will not equal the total cost in the event that there are fixed common and joint costs. In order to ensure full recovery of cost, a methodology for recovering the fixed, common and joint costs needs to be implemented. Fixed, common and joint costs are discussed further in section 3.4.15.

In estimating incremental costs, it is crucial that: the increments are appropriately defined, the cost categories are sufficiently granular and the cost-volume relationships are sufficiently robust. These are complex tasks that should not be under-estimated. It is our view that if each of these tasks can be performed, then an incremental cost approach offers superior costing information and insight into the economics of a mobile operator than an average cost approach. For this superior information to be translated into superior MTR price setting requires an understanding of how the fixed common and joint costs are to be recovered across different products and services (including mobile termination). This is discussed in more detail in section 3.4.15. In our view the additional effort and cost that is associated with a LRIC model compared to an average cost model is justified if either the incremental cost allocation is significantly different, in relative terms, from the average cost allocation, or fixed common and joint costs are material, and their treatment is more developed than the simple Equi-Proportionate Mark-Up (EPMU)⁸ approach.

⁷ An average cost approach can be inconsistent with cost causality. For example, if an asset group is used by two services, one uses 80% of the asset group's capacity and the other uses 20%, an average cost approach will assume that cost should be allocated in the ratio 80:20 without considering whether the structure of the asset group means that the cost of providing 80% capacity are significantly different (on a unit basis) to providing 20% capacity.

⁸ EPMU is the simplest mark-up whereby the fixed common and joint costs are allocated in proportion to the incremental costs.

3.4.2 Top down, bottom up, hybrid

A top down model is based on actual accounting data from the operator(s) and replicates the existing network and cost structure. The strengths of this approach are that:

- the data is usually accessible and reliable
- the model will reflect the reality of costs
- the model does not explicitly have to try to capture all the difficulties of deploying a mobile network in the real world

The weaknesses of the approach are that:

- it is difficult to identify and deal with any inefficiencies within the operator
- it is hard to model a hypothetical operator under this approach
- the model relies heavily on data provided by the operator(s), which presents a risk of misinterpretation and inconsistencies between operators

A bottom up model uses network design algorithms and demand assumptions to replicate the network which would be built by an efficient operator.

The strengths of this approach are:

- An efficient and/or hypothetical operator can be modelled
- The model does not have to depend on data from individual operators, as benchmarks⁹, common network design rules and averages of operator data can be used
- A sophisticated model running multiple demand and market evolution scenarios is relatively easy to construct

The main weaknesses of a bottom-up model are:

- There is a risk that a bottom-up model will over-optimize the network design rules and set an efficiency standard that is unachievable in the real world
- Given that a bottom-up model effectively starts from a blank piece of paper, there is a risk that relevant costs will be omitted from the model
- The model requires extensive data, not all of which is easily available and as such assumptions are often required, resulting in doubts over the robustness of the model outputs

It is also possible to build a hybrid model, where the results of a bottom up model are checked against top-down financial and operating data. The checks are usually performed in two steps: firstly a calibration step against historic operational data to determine whether the model can accurately predict how big the network should be for a given level of demand. Secondly, the hybrid model incorporates historical accounting data for a reconciliation step to check if the model can accurately predict how much should have been invested in order to build the appropriately sized network at different points in time.

A hybrid model works best when the historic cost and operational data are used to validate the assumptions, algorithms and relationships in the model, such that a greater degree of reliance can be placed on the forward-looking elements in the model. There is an assumption that, to a certain degree, what held true in the past will hold true in the future, but this is an effective means of producing model outputs that take into account future demand and equipment price scenarios, whilst setting an efficiency standard that is known to be achievable in the real world.

In our opinion, the hybrid model is the optimal solution as it provides a view on the likely costs of the network going forward, has been tested against actual performance in the past, and has flexibility to allow detailed scenario and sensitivity modelling to be performed. In the event that a NRA wants to choose a single approach, we do not believe that either a top-down or bottom-up approach is inherently superior. A NRA must consider many of the other issues such as whether a hypothetical operator or actual operator is modelled, whether the model should be historic or forward-looking and only after those issues are clarified can a NRA determine whether a top-down or bottom-up model represents the best solution.

⁹ Benchmarks in this sense are acceptable in that they are used to fill in gaps in inputs where actual operator data is unavailable. This is different to using benchmarks for the setting of termination rates.

3.4.3 Valuation/depreciation methods

The cost of an operator's asset base can be divided into two elements – the opportunity cost of the investment ("the cost of capital") and the depreciation of the asset base. In order to determine the level of these costs, a valuation or depreciation methodology is used in a model. There are several valuation/depreciation methodologies which could be used and it is not uncommon for a single model to contain more than one valuation/depreciation methodology, with alternative results produced.

Historic Cost Accounting (HCA) depreciation methodologies only consider the capitalised purchase price of an asset which is then depreciated its useful life. The most common form of HCA depreciation is straight line, whereby the annual depreciation charge is the purchase price divided by the useful life. Alternative methods such as declining balance methods may also be used.

A return on capital is then added to the accounting depreciation to give the total capital costs (return of and on capital). This is calculated as the opening written down value of assets multiplied by the cost of capital (WACC). This ensures that the present value of cost recovery at the time of investment is equal to the investment, thereby giving investors a fair return. HCA straight line depreciation is the methodology usually used in statutory financial statements, while HCA declining balance depreciation is frequently used for tax purposes.

The table on the right shows how the extra return is required to ensure full cost recovery. If the cost is set as just the depreciation, an operator will invest 100 for an asset, but in present value terms will only expect to achieve cost recovery of 79. Under such circumstances the operator will not invest in the asset. However, when a return on capital is included in the allowable cost recovery, the present value of cost recovery is equal to the investment in the asset. Under such circumstances, the operator will invest in the asset knowing that there will be sufficient cost recovery to cover the cost of the asset and to provide investors with their required return on investment.

Asset	100
Life	4
WACC	10%

	Yr1	Yr2	Yr3	Yr4
Depreciation	25	25	25	25
Present Value	79			

	Yr1	Yr2	Yr3	Yr4
Depreciation	25	25	25	25
NBV x WACC	10	7.5	5	2.5
Total Cost	35	32.5	30	27.5
Present Value	100			

Table 1 - Illustration of cost recovery under HCA depreciation

Current Cost Accounting (CCA) depreciation methodologies involve taking the current cost of the asset and the useful economic life at the valuation date. The Current Cost of an asset is determined by looking at the cost of purchasing the equivalent asset now. A number of adjustments are required to the historic cost depreciation in order to calculate the current cost depreciation. Holding gains or losses must be recognised as well as supplemental depreciation to reflect the fact that the asset has changed value in the period in question, and backlog depreciation to reflect the fact the asset was being depreciated in the past assuming a different asset price would hold for the rest of its useful life, which is no longer deemed to be the case.

The current cost depreciation method described above is an approach known as Financial Capital Maintenance (FCM). Under this approach, the net present value of cost recovery will equate to the value of the asset, thereby ensuring an operator gets a fair return on its investment. An alternative approach is Operational Capital Maintenance, whereby unrealised holding gains/losses and backlog depreciation are not included in the allowable cost. As a result the capital costs recognised in any period will not represent the change in economic value of the asset. If, for example, an asset is increasing in value the operator will recover (in present value terms) more than its investment, and the reverse is true if the asset is going down in price. The deviation from economic principles and the discrepancy between investment and present value of cost recovery means the OCM approach is almost never used.

Economic depreciation

Economic depreciation can be defined as the depreciation methodology that will result in the written-down value of an asset¹⁰ at any point in time being equal to the net present value of the cash flows it will generate in the future. This outcome would be expected in the event that there is perfect competition in the equipment market as well as the market in which the output of the asset is consumed.

Whilst the hypothetical world of perfect competition is not observed in reality, many NRAs have adopted a proxy for economic depreciation in the setting of MTRs. A common form of economic depreciation is based on the methodology developed by Oftel and Analysys Consulting for the bottom-up cost model that supported the setting of UK MTRs in 2002. This proxy for economic depreciation recovers costs over the lifetime of the network according to the profile of demand and equipment price changes, subject to the constraint that the present value of the investment over the life of the network is equal to the present value of cost recovery over the same period. By adopting a network lifetime approach to cost recovery, there is a possibility that the full cost of an asset is not recovered until after the asset has been decommissioned where the output of future generations of the asset is higher because it inherits the higher utilisation of its ancestors. This is not consistent with a fully contestable market where a new entrant could enter the market and reach efficient scale immediately. However, it has been argued that this approach strikes a balance between perfect competitive standard and the realities of an effectively competitive market with some barriers to entry.

An alternative proxy for economic depreciation is annuity-based depreciation. A flat annuity-based depreciation methodology will result in the cost recovery for an asset, i.e. the depreciation plus the return on capital, being equal in every period of the asset's life. This is a sensible outcome when output, operating costs and equipment prices are stable. In the event that equipment prices are expected to change over the life of the asset, a tilt can be applied to the formula to ensure that the cost recovery in any period is equal to the cost recovery that a new entrant would seek having purchased a new asset¹¹.

Summary of cost recovery methods

We have used a simple example to show the different cost recovery profiles that are observed for a single asset that has a useful life of ten years and whose price increases by 5% per annum and where outputs increase as set out in figure 6.

The graphs below show the cost recovery profiles under HCA, FCM, Flat Annuity, Tilted Annuity and Economic depreciation as well as the unit cost. It should be noted that for simplicity, we show an economic depreciation profile that only takes into account the demand for the asset over its life. This is to show the impact economic depreciation has on unit costs. In practice, we would expect to an economic depreciation methodology to also reflect the extent to which the asset's replacement cost changes over its life.

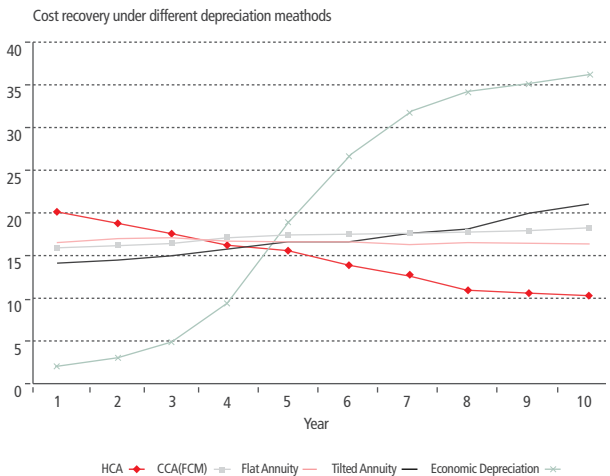


Figure 6 – Cost recovery under different depreciation methods

¹⁰ As with the HCA approach, this is true once the return of capital (opening written down asset value x cost of capital) is included in the total allowable cost recovery.

¹¹ This form of tilted-annuity calculation, where only equipment price changes are captured, is the one that is most commonly applied in practice. The calculation can be adapted to capture all of the cash flow effects relating to the asset, i.e. changes in demand and changes in operating costs.

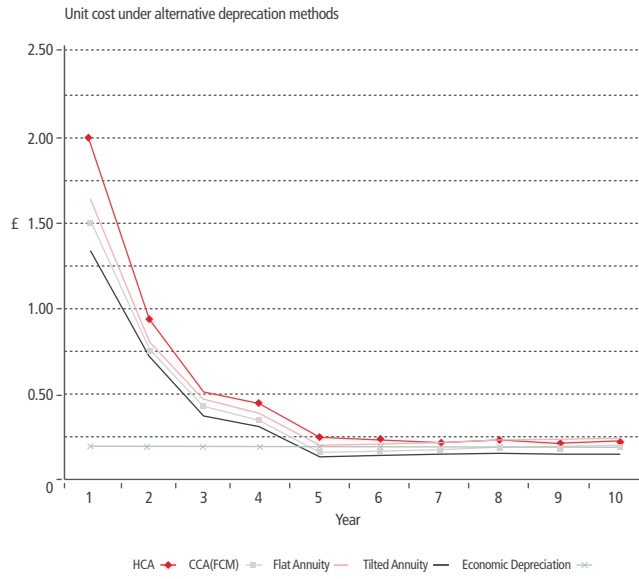


Figure 7 – Unit cost under alternative depreciation methods

UEL (years)	10
WACC	10%
Price trend	5%
Investment	£100

Year	1	2	3	4	5	6	7	8	9	10
Demand (million minutes)	10	20	40	80	160	240	280	300	310	320
Year	1	2	3	4	5	6	7	8	9	10
HCA dephn	£10	£10	£10	£10	£10	£10	£10	£10	£10	£10
Capital cost	£10	£9	£8	£7	£6	£5	£4	£3	£2	£1
Total cost	£20	£19	£18	£17	£16	£15	£14	£13	£12	£11
Unit cost	£2.00	£0.95	£0.45	£0.21	£0.10	£0.06	£0.05	£0.04	£0.04	£0.03
NVP	£100									
Year	1	2	3	4	5	6	7	8	9	10
FCM depreciation charge	£11	£12	£13	£14	£15	£17	£18	£20	£21	£23
Holding Gain/Loss	-£5	-£5	-£6	-£6	-£6	-£6	-£7	-£7	-£7	-£8
Cost capital	£10	£9	£9	£8	£7	£6	£5	£4	£3	£2
Total cost	£16	£16	£16	£16	£16	£17	£17	£17	£17	£17
Unit cost	£1.55	£0.79	£0.40	£0.20	£0.10	£0.07	£0.06	£0.06	£0.05	£0.05
NPV	£100									
Year	1	2	3	4	5	6	7	8	9	10
Flat Annuity	£16	£16	£16	£16	£16	£16	£16	£16	£16	£16
Unit cost	£1.63	£0.81	£0.41	£0.20	£0.10	£0.07	£0.06	£0.05	£0.05	£0.05
NPV	£100									
Year	1	2	3	4	5	6	7	8	9	10
Economic depreciation	£13	£14	£15	£16	£16	£17	£18	£19	£20	£21
Unit cost	£1.34	£0.71	£0.37	£0.19	£0.10	£0.07	£0.06	£0.06	£0.06	£0.07
NPV	£100									
Year	1	2	3	4	5	6	7	8	9	10
Economic depreciation	£1	£2	£5	£9	£18	£27	£32	£34	£35	£36
Unit cost	£0.11	£0.11	£0.11	£0.11	£0.11	£0.11	£0.11	£0.11	£0.11	£0.11
NPV	£100									

Table 2 – Illustration of cost recovery and unit costs under different depreciation methods

In our opinion, there is no single method of capital cost recovery that can be considered best practice in all circumstance. In principle, a proper articulation of economic depreciation taking into account, inter alia, output levels over time, capital input price in(de)flation, operating cost expenditure over time is to be preferred. However, the associated informational difficulties may argue for the application of a simpler proxy. We believe that HCA is the least likely to provide an appropriate time-series of cost recovery and should only be used if a top-down model is being used and there are strong reasons to suspect that a revaluation of the assets and a move to an alternative depreciation methodology will not lead to materially different costs. In the event that demand for mobile services, or at least those being considered in the cost model, has been, or is expected to be fairly stable, a move to annuity-based or current cost accounting methods can yield results that are broadly similar to an economic depreciation approach. Under these circumstances, the decision not to implement economic depreciation can be appropriate. However, in countries where explosive growth in demand for mobile services, including voice, has been observed or is likely to be observed, economic depreciation is likely to provide a cost-recovery profile that is most consistent with how a rational company would seek to recover costs in a competitive market.

3.4.4 Historic v forward-looking

Models can be populated with historic data,¹³ forward looking data or a combination of the two. The advantage of historic data is that it is not subject to forecast uncertainty, and can be gathered relatively quickly. The main shortcoming of historic data is that it is not necessarily relevant for the period over which prices will be regulated. The shortcoming can be overcome in a number of ways:

- A NRA can conclude that the likely changes in unit cost over time are not sufficient to justify the more expensive and time-consuming gathering of forecast data;
- A NRA can use the outputs of a historic cost model as the starting point for setting regulated MTRs, but build assumptions about how cost will change over time into the final price determination. At the simplest level this can be an adjustment to reflect the expected changes in demand over the forecast period combined with the expected level of capital investment over that period (including investments in new technologies). A more sophisticated method will take into account any expected efficiency gains in that period; or

- A NRA can accept that the modelled cost based on prior periods is likely to exceed the current cost. However the NRA can allow the operators to earn economic profits on their regulated services. This can be either because those excess profits will be competed away in the provision of services where competitive pressures are working strongly, or because the NRA expects the operators to use the excess profits to fund network expansion/technology refresh.

A forward-looking model will forecast the expected cost for the regulated price period, whereas a pure historic model will not predict how costs will change over time and therefore there will be a lag between the observed cost and its application to prices. A forward-looking model will have the desirable feature of matching the time period of forecasting with the time period of regulation. However, as noted above, such a model is more complex to build, has more onerous data requirements, and is likely to take longer to populate than a historic model. Additionally, there is significant forecast risk inherent in a forward-looking model, including uncertainty regarding future demand, take-up of new services, capital equipment and operating cost price-trends and capital investment requirements.

A model that incorporates both historic and forward-looking data can help overcome problems with forecast uncertainty if appropriately specified trend analysis is used to sense-check the forecast assumptions. However, such a model will add to the model complexity rather than reduce it and any sense checks will only be meaningful in the event that the past is considered a good indicator of the future. Nonetheless, given the materiality of the issue of setting MTRs, it is our view that a forward-looking model, with the inclusion of historic data as a sense-check, is the optimal type of model for informing regulated MTRs. However, we are also aware that this is a more costly and time-consuming solution to implement. Models populated with historic data are also relevant in the context of setting MTRs, as long as NRAs have considered how the observed cost is likely to change going forward, and what impact that should have on setting a regulated price for MTRs.

¹³ The issue of historic data v forward-looking data should not be confused with Historic Cost Accounting and Current Cost Accounting. Even under a historic period approach, current cost accounting can be used, e.g. in 2007 an NRA can use the results for the year ended 31/12/2006, but restated to reflect the current cost of equipment during that period. Likewise, a forward-looking model can reflect the level of cost that is likely to be observed in a future period, under the Historic Cost Accounting convention.

3.4.5 Single year v multi-year

Any number of years may be covered by the model. A single year model has the advantage of being simple and does not necessarily require forward-looking assumptions, which can be difficult and unreliable. As it is unlikely that an NRA will carry out a cost modelling exercise each year, the results of a single-year model will have to be applied to multiple years, perhaps using an assumed percentage reduction each year. This is a weakness of the single year approach because the use of a single-year as the anchor point for multi-year regulated prices is less thorough than having a model which covers all years for which regulated prices are being set.

A multi-year model is necessarily more complex and requires more assumptions as well as potentially less robust assumptions. A multi-year model does have several advantages as it allows MTRs to be calculated for, and applied to, multiple years, allows a multi year depreciation methodology – such as economic depreciation – to be applied and permits alternative network developments to be modelled.

Ultimately, the number of years in the model should match the regulatory decision. If cost-based MTRs are being set for a number of years, then a multi-year model should be used. If a cost-based MTR is only being set for one year, then a single-year model can be built, as long as that decision is not inconsistent with other modelling decisions, e.g. a lifetime economic depreciation approach.

3.4.6 Which services

If the model is being constructed with the sole purpose of determining the cost of mobile termination, it will still need to model other services in order to correctly allocate the cost between the services. This also allows for sensitivities involving altering the percentage of cost allocated to MTRs. In our opinion, it is not possible to build a meaningful model without considering at the very least all of the main network services, namely; call termination, call origination (including a distinction between on-net and off-net calls) and value added/ data services. This is necessary to ensure a robust allocation of cost between the different services. For operators/ markets with more developed services, it might be necessary to split the value added/ data services into further categories to ensure a more robust allocation of costs between services.

Depending on the method adopted for allocating general business overheads and retail costs, there might be a need to model a subscription service or

event. Without modelling a subscription service it is difficult to allocate the general business costs which are common across both wholesale and retail services. By incorporating the retail costs in the model, and allocating them to a subscription service, it is possible to allocate the general business costs across both retail and wholesale services. Some NRAs have chosen not to incorporate a subscription service but have allowed a proportion of general business costs to be allocated to wholesale services, with the proportion being determined by analysis exogenous to the model.

3.4.7 Allocation of costs between services

The most appropriate way of allocating costs between services is to use consumption or routing factors. Routing factors will allow network costs to be allocated according to both the level of demand for a service and the extent to which that service uses the cost element in question. The simplest example is with respect to mobile base stations.

1 Total base station cost	500				
2 Base station routing factor		Incoming	Outgoing	On-net	Total
3 Total minutes		1	1	2	
4 Route-factored minutes (1x2)		100	50	150	
5 Cost allocation (=4/sum(4) x1)		100	50	300	450
6 Cost per minute (=5/3)		1.11	56	333	500
		1.11	1.11	2.22	

Table 3 – Example of allocating costs between services

The table shows that on-net calls are allocated more cost per minute than incoming or outgoing calls because an on-net call requires two radio network legs to fulfil the call, whereas incoming or outgoing calls only require one.

Based on models that have been constructed using routing factors, it is common for an incoming call to be more costly than an outgoing call to another network. This is because there are some network elements that are used exclusively for terminating calls (or messages), e.g. the HLR and the location processing elements in the MSCs. Additionally, as a result of typical handover regimes, a call to a mobile network will be handed over to that mobile network at the nearest point of interconnect, resulting in the mobile network using more of its core network, especially transmission, to terminate calls than to originate calls¹⁴.

¹⁴ This is always true for a comparison of incoming calls to outgoing calls to other mobile networks. It is possible that outgoing calls to fixed networks are handled on a far-end handover basis and will also use more of the mobile network's core transmission and switching.

3.4.8 Level of efficiency

In the development of regulation in the fixed industry, it was generally assumed that operators were not fully efficient and were able to become more efficient. Operators might have been inefficient because of, for example:

- use of outdated assets
- inefficient processes
- excess capacity
- unnecessary investment, often referred to as gold-plating of the network

This raises the question of the extent to which operators should be allowed to recover their costs. If regulation allowed operators to recover all their costs, regardless of whether they were efficiently occurred or not, there would be no incentive for operators to reduce inefficiencies. Consumers would be paying for the inefficiencies, implying that consumer welfare would not be maximised. In a competitive market, there is a natural pressure on players to reduce their inefficiencies in order to retain the ability to price competitively. Regulation is intended both to create the effect of competition in a market and to promote consumer welfare. Neither of these aims is served by allowing operators to recover inefficiently occurred costs.

For this reason, where there is a concern that an operator is inefficient, best practice modelling entails that those inefficiencies are not fully recoverable. The mechanism for implementing this principle varies. In a top down model, the seemingly obvious approach would be to identify which of an operator's costs are inefficiently incurred and remove them from the model. In reality there is rarely, if ever, a simple way of distinguishing between an operator's inefficiently and efficiently occurred costs.

If a bottom up model is of a hypothetical operator model is used, then no inefficiencies should be incorporated in the model unless the network design rules incorporate inefficiencies.

In the mobile industry, *a priori* concerns over inefficiencies are rare. Unlike the fixed industry, the mobile industry has predominantly developed in a competitive environment, and even when operators could have incentive to charge above competitive levels for individual services, there is little evidence to suggest that operators also have any incentive to deploy inefficient networks or processes. In our opinion, where mobile networks have been developed in a competitive environment, the NRAs starting position should be to assume that the network operators are efficient, and no adjustments should be required to their observed costs.

In the developing world, it is more common for a single mobile network to have been established originally, with competition only arriving at a later date. Under such circumstances, it is not so clear cut that the incumbent mobile network will have developed efficiently. In this case, NRAs should seek to establish whether inefficiencies are likely.

In order to do this, they should look at some of the historic drivers of inefficiencies, e.g. rate of return regulation, and state ownership, and determine whether those conditions are present, and if they are, the NRA would have more reason to conduct an efficiency study to determine whether any inefficiencies need to be removed from regulated prices. Alternatively, the NRA can set prices based on the new entrant competitive operator as long as that operator has reached sufficient scale.

Therefore, the issue of efficiency might have more relevance in the developing world for the time being, but given the ever increasing levels of competition combined with increased ownership of operators by profit-seeking multinational groups, we do not believe that operators will be able to sustain any material levels of inefficiency in the medium to long term.

3.4.9 New technologies and services

A number of options are possible regarding which technologies to model. These include:

- 2G network only
- 2G/2.5G
- 2G/2.5G/3G
- 3G only

In many European jurisdictions, NRAs have concluded that they can ignore investment in 3G networks on the basis that operators would only invest in 3G if it is a cheaper technology and therefore, by only considering 2G and 2.5G networks, there is no risk that the operators will under-recover cost.

In the developed world, we expect this approach to slowly unwind as more NRAs follow Ofcom's approach and explicitly model the costs of 3G rather than rely on sweeping assumptions. We also believe that 2G networks are likely to remain in service over the medium and longer term, that NRAs will rarely consider a 3G only model for setting MTRs.

Whilst we agree that there is an *a priori* view that at scale 3G networks should be cheaper (per unit of traffic) than 2G/2.5G networks, this is not always going to be the case, especially in jurisdictions where there were expensive 3G spectrum auctions, or the 3G licence included more onerous coverage obligations than under the 2G licence. 3G network investment has been predicated on the take-up of new bandwidth intensive services. There is still enormous uncertainty regarding the demand for those services, and even if the demand does materialise, the timing of the take-up of new services can impact the timing of cost recovery – potentially leading to higher unit costs in the short to medium term¹⁵. Additionally, there are short-run costs of running two networks in parallel, migrating customers from one network to the other, and then decommissioning the obsolete network equipment. These transitional but unavoidable costs should not be ignored when setting MTRs.

In the developing world where there has been little development of 3G networks to date, we do not believe this to be a significant modelling issue, and NRAs will rightly focus on the current 2G technologies that are used to provide mobile services, although there will be some countries where 3G is being deployed in the absence of xDSL technology. In such an event, it will be important to understand which network is being used for mobile termination and the extent to which network

elements are being used to support both voice and data services.

In our opinion, whether in the developed or developing world, NRAs should ideally base MTRs on the technology /ies that is/are used to deliver the service. In the event that more than one technology is deployed, then a cost model should include both technologies, and to the extent that it is a forward-looking model, sensible assumptions should be made regarding asset lifetimes and the migration of traffic to the newer technology. In the very early stages of a new technology, it can be acceptable for an operator to ignore the newer technology, as long as the costs being incurred are immaterial and the new technology is not expected to be widely used in delivering the regulated service in the period of regulation¹⁶.

3.4.10 Actual operator models v hypothetical operator models

Models vary as to the nature of the operator(s) modelled. Some models aim to replicate the actual operators in a market and some employ a "hypothetical" operator construct. Under the first approach, the model is designed to incorporate real data about an operator, such as market share, network traffic and coverage information. Alternatively a "hypothetical" operator construct, where the parameters used in the model are not those of any particular operator. Under this approach, there is considerable flexibility and the hypothetical operator may take any number of forms, although it will typically be constructed in accordance with certain guiding principles. For example, the guiding principal might be to construct an "average" operator, which would then be based on the actual operators in the model. Another common approach is to model a new entrant into the market (irrespective of whether a new entrant to the market is actually anticipated).

Advantages of actual operator models

- Captures differences between individual operators
- Allows operator-specific termination costs to be calculated

Advantages of hypothetical operator models

- Flexibility
- Model does not have to contain confidential operator data and can be populated with dummy data for public release
- Need only model a single operator to apply to all actual market operators

¹⁵ This is especially the case where accounting based depreciation is used and there is a requirement to meet near term coverage obligations that are not justified from a demand perspective.

¹⁶ For example, where a 3G network is only expected to account for a very small proportion of an operator's total terminating traffic in the period of regulation.

In deciding on a particular approach, a NRA should be mindful of whether there is an expectation that there are fundamental cost differences between the different operators, and whether or not these differences could be quantified in a hypothetical model. If there are differences which cannot be easily be quantified in a hypothetical model, it is our opinion that individual operator models should be built to ensure that the NRA reduces the risk of setting a termination rate that is unachievable for one or more of the operators in the market. An example of this is considered in the next section with respect to spectrum.

3.4.11 Spectrum

It is often argued that the biggest source of enduring cost differences between operators is spectrum allocations. These differences can relate to the quantity or type of spectrum or both. It is generally accepted that operators with lower frequency spectrum (e.g. 900 MHz) can achieve the same level of coverage as an operator with higher frequency spectrum (e.g. 1800 MHz) with fewer cell sites due to the propagation characteristics of radio waves. As such, where operators build networks with areas that are coverage constrained, rather than capacity constrained, it is expected that the lower frequency operators will have fewer sites and ceteris paribus lower costs.

An additional difference relates to radio wave propagation characteristics in densely populated built-up areas. It is generally accepted that lower frequency spectrum is better able to penetrate dense materials such as buildings. As such, in capacity constrained areas, where in-building coverage is important, the lower frequency operators will be able to provide the same level of service, in terms of availability and quality, as higher frequency operators, but with fewer cells.

Based on the two differences noted above, there is an a priori expectation that ceteris paribus lower frequency operators will have lower costs than higher frequency operators. There are however a number of reasons why this might not be the case, including:

- If spectrum is auctioned efficiently, in theory, the cost savings from lower frequency spectrum should be bid away in the auction process through higher payments for lower frequency, until the cost differential is removed.
- Lower frequency operators might have less spectrum than higher frequency operators. Under these circumstances, the operator with

more spectrum will have to deploy less sites to meet capacity requirements, and the observed costs of the higher frequency operator could be higher or lower depending on the balance of capacity-constrained and coverage-constrained areas in the network.

- It has often been the case in Europe that 900 MHz operators were the early entrants into the mobile market. As such, they didn't benefit from the learning effects that later entrants were able to benefit from, and therefore their networks might be less optimal. This raises a separate set of questions regarding efficiency standards, but in terms of observed operator-specific costs, could be a reason for cost differentials between the operators.

Clearly, the issue of spectrum will be specific to each country, and each NRA must determine the effect actual spectrum allocations are likely to have on the operators' actual costs and by extension, the most appropriate modelling approach, e.g. with respect to a hypothetical v actual operator approach.

3.4.12 Cost of capital

All LRIC cost models include a cost of capital figure. It is used to calculate the fair return on investment that an operator requires. The actual figure used must be appropriate to the market and operator(s) in question. Small changes in the cost of capital number can have a significant impact on the level of MTR calculated by the model. Given that the cost of capital is usually one of the most material single inputs in a cost model considerable care should be taken in determining the appropriate cost of capital number to be used. The cost of capital should take into consideration the riskiness of the operators' investments as well as other economic effects such as country risk. A CAPM approach is most common and advised.

The cost of capital applied must match the cash flows which are being considered in the model. Typically a cost model will use pre-tax cash flows, and therefore a pre-tax cost of capital would be required. A detailed description of best practice Cost of Capital analysis is outside the scope of this report.

3.4.13 Licence fees

It is typical for governments to issue licences to mobile operators which allow the operators to offer mobile services. A number of different fee structures are in place for licences. In some instances a single licence fee is payable, whereas in some case an annual fee is payable. The charges may be fixed by the issuing institution or may be determined by other means, for example by auction.

The treatment of licence fees in cost models is an area of ongoing debate and there is considerable variation between models. There are numerous ways in which licence fees can be handled in a cost model. They may be:

- recovered across all services
- recovered across specific services
- excluded from the model

Where licence fees are included in the model, the value used may be either based on actual fees paid or may be a “fair value” estimate. An example of the former would be the use of the average value paid by operators in a licence auction process, and an example of the latter would be the result of a discounted cash flow calculation of the value of the services which a licence allows an operator to offer or a benchmark valuation against other similar licences that have been purchased, e.g. on a price per MHz per population basis.

In our opinion, general licence fees are typically a common cost for the whole business and should be recovered in the same way as general business overheads. Licence fees that specifically relate to spectrum can be recovered in the same way as other radio network assets. Licence fees typically are included at historic cost. We believe that there is a certain amount of circularity in revaluing the value of licences upwards and arriving at a higher MTR. However, if regulators are minded not to allow an upward revaluation of licence fees, there should also be an a priori expectation that licence fees won't be revalued below their historic cost.

3.4.14 Retail costs

Some models include direct retail costs and some exclude them on the basis that they are not relevant to the costs of a wholesale service. Here we are considering retail costs which are specifically retail, e.g. sales and marketing, dealer commissions etc., and not common or overhead costs such as accounting, legal and human resources. Direct retail costs are also different from operating wholesale business processes costs, (wholesale billing, wholesale customer management, wholesale credit

management, etc.). Operating wholesale business processes costs are direct network services costs and they have to be considered in the dimensioning process of the LRIC model. As a basic principle, retail costs should be allocated to the retail services they are directly related to as these would not be incurred by a wholesale operator. In our opinion, they should not be recovered through MTRs in the first instance. However, some retail costs can ultimately be allocated to MTRs through a network externality calculation¹⁷. This is covered in more detail in section 4.1.

3.4.15 Fixed common cost definition

There are two broad categories of fixed common costs:

- 1 General overhead costs which are incurred to support all functions and activities. Examples include head office buildings (fixed assets) and finance, HR and senior management salaries (opex). A proportion of these common costs may be fixed.
- 2 Some network costs which are invariant with respect to demand in the long-run and so are fixed and common across all network services. This is similar to, but not exactly the same as, the coverage network.

The key questions for regulators to answer on this topic are:

- Which costs are fixed and common?
- Is the level of fixed and common cost material?¹⁸
- If the fixed and common costs are material, how should those costs be recovered?

Even where fixed and common costs have been estimated as a significant proportion of total costs, regulators have nearly always adopted an equi-proportionate mark-up (EPMU) for the recovery of those fixed and common costs. The main alternative to EPMU that operators have argued for is Ramsey pricing, which recovers the fixed and common costs in inverse proportion to the super elasticity of demand of the services modelled.

¹⁷ In some instances NRAs might choose to allocate some retail costs to network services instead of performing a network externality calculation.

¹⁸ If fixed and common costs are not material the mark-up methodology will not have a material impact on the cost of termination.

The theoretical basis for Ramsey pricing as the method of ensuring full cost recovery while minimising the distortion to consumption compared to marginal cost pricing are nearly universally accepted. However, it has seldom if ever been operationalised by NRAs for the following reasons:

- 1 The informational difficulties associated with estimating elasticity's of demand make Ramsey pricing too difficult to implement; or,
- 2 The prevailing structure of prices in the mobile market is not consistent with the assumptions underpinning Ramsey pricing, e.g. that all services are priced in accordance with Ramsey principles¹⁹.

In our opinion, the level of fixed and common costs is likely to be material for most mobile networks, especially those that provide significant coverage in rural areas. We recognise the difficulties of implementing Ramsey pricing, but also believe that adopting an EPMU approach implies that the issue of fixed common cost recovery has not been given due consideration.

The growth of data services on mobile networks and the associated economies of scope, especially on UMTS networks, means the issue of fixed common and joint cost recovery is becoming increasingly important. This points to the need for further work by NRAs and operators to develop a methodology that is superior to EPMU to avoid large allocative inefficiencies.

We believe that without significant further efforts from the industry and regulators, especially with respect to the estimation of demand elasticities, to overcome the perceived difficulties of implementing Ramsey pricing, EPMU, despite its shortcomings, will remain the default method adopted by nearly all regulators.

As noted above, we believe scale and scope economies are present for mobile network operators, and there will be costs that are fixed and common across a number of services, including mobile termination. Under such circumstances, pricing all services at marginal cost (or incremental cost as a proxy) will result in the fixed and common costs not being recovered. Therefore, the pricing of some or all of these services needs to move away from the first-best principle of marginal costing to a second best which includes an allocation of the fixed and common costs.

In our opinion the allocation of fixed and common costs is best achieved through a Ramsey framework (with an appropriate adjustment for externalities, as explained in section 4.1). In the absence of a Ramsey framework for setting prices, NRAs need to form an opinion on the appropriate mark-up regime to ensure that fixed and common costs are not left unrecovered.

¹⁹ Even if unregulated prices are not consistent with Ramsey principles, it is almost certain that they will not be consistent with the implicit assumptions of an EPMU approach. As such, adopting an EPMU approach can be criticised in that it is also inconsistent with how prices are set for unregulated services.

4.0 The setting of mobile termination rates

The previous section set out some of the key issues that NRAs and operators need to consider in arriving at their estimates of the cost of providing the MT service. This section sets out the further issues that NRAs and operators should consider in arriving at the price of that service.

The key issues are:

- 1 Should the final price include an allowance for the network externality?
- 2 Should the final price be above cost to encourage the operator(s) to invest further in their networks?
- 3 Should the final price be above currently observed cost to reflect future network roll-out into less profitable areas?
- 4 How long should NRAs allow operators to transition from market [current] prices to cost-based prices?
- 5 Should termination rates be symmetrical or asymmetrical and if asymmetrical, for how long?
- 6 Should NRAs ensure that all cuts in MTRs are passed on to consumers by mandating an equivalent cut in the retail cost of calling a mobile phone, especially from a fixed network?

The above issues reflect four different types of consideration:

- Is there a difference between the observed cost and the expected cost going forward? (2, 3)
- Should there be a difference between cost and price in the short to medium term? (4, 5)
- Should there be a difference between cost and price in the long term? (1, potentially 5)
- Is there a need for an additional regulatory mechanism to ensure consumer benefits from the MTR regulation? (6)

In unregulated competitive markets the prices of goods and services should, over time, equal the marginal cost of production²⁰ including a reasonable return on capital²¹. If a market is not regarded as competitive, such as in the case of individual operator mobile termination, a regulator may intervene to ensure that prices are set to maximise consumer welfare in the long term. The 'long term' is somewhat ambiguous but the guiding principle is to ensure that the market players are incentivised to continue developing infrastructure and investing. This is one of the reasons why a regulator would include adjustments to the basic costs of mobile termination. The following sections cover some of the areas and options that are considered by operators and regulators.

4.1 Network Externality

The previous section set out the various issues relating to how the costs of the different services provided by mobile operators should be assessed. However, if NRAs set regulated prices equal to or with reference to costs alone this may not result in economically efficient (welfare maximising) prices for consumers. Having estimated the costs of the different services, NRAs must determine whether it is in the interests of consumers to take account of externalities and their impact on the efficient level of prices for mobile terminating services.

"An externality is an effect (i.e. a cost or a benefit) that impacts on a third party by a decision (i.e. to consume or produce) taken by another party. Since this cost (or benefit) does not affect the party that makes the decision, the latter does not, in general, take account of this cost/benefit in his decision."²²

A common type of externality discussed in relation to mobile networks is the 'network externality'. In the mobile market it is often argued, especially in developing countries where mobile penetration is rising rapidly, that if a mobile network acquires a new customer then there is a marginal social benefit conferred on the entire network comprising a 'private benefit' and a 'public' or 'external' benefit'.

There is an external benefit to existing mobile subscribers and callers to mobile subscribers as there are more people to communicate with. This is in addition to the private benefit that the new subscriber themselves experiences. Therefore a new customer may confer a positive external benefit on the communications (mobile and fixed) sector. When a potential new subscriber makes a decision to join a mobile network they do not necessarily take into account the external benefit they may create. They base their acquisition decision on their private benefit alone. Therefore there may be subscribers who do not choose to subscribe at a given price because the private benefit to them is too low, whereas if they were to take into account the external benefit of their subscription they would subscribe. These subscribers require a subsidy to incentivise them to join the network and to realise the full social benefit of their acquisition.

²⁰ Where in the long-run all costs are variable under conditions of perfect competition

²¹ What level of return of capital is 'reasonable' is one of the questions which needs to be answered by individual NRAs. See comments in previous section.

²² Source: ITU, 24-28 January 2005

In the presence of externalities, and assuming a policy desire to account for externalities within the sector, consumer welfare will be improved through the application of an externality adjustment to prices. This operates by changing the balance of prices across all mobile services. For example, instead of setting the price for all mobile services equal to their cost, the price for some services is set below cost and this shortfall is subsidised through increasing the level of prices for other services. This change in the structure of prices affects consumers' behaviour, takes into account externalities and maximises overall welfare.

An operator could argue to offer prices at a discount or offer subsidies, for example on handsets or even to engage in strong marketing activities, to increase the size of the market and boost welfare. If prices were set at marginal cost there could be too few subscribers to mobile networks and therefore the welfare of society would not be maximised²³. In effect, an operator could argue to include some contribution to customer acquisition, retention and/or maintenance costs or general subscriber-related retail costs in the mobile termination rate. This would ensure that there is an incentive to attract new customers and maintain existing customers which in turn increase social welfare. The existing customers benefit and so it could be justified that they pay towards this benefit.

While many operators in developed countries have recognised the theoretical validity of the network externalities argument, many have chosen not to apply an externality surcharge. This is partially due to the complexities involved in calculating the optimal mark-up²⁴, but principally because developed countries have high mobile penetration (usually >90%), meaning that the number of potential new mobile subscribers is much smaller, and a larger proportion of these non-subscribers are highly price-insensitive and thus unlikely to be marginal non-subscribers²⁵. This reasoning is less likely to hold in developing countries where mobile penetration is significantly lower.

In practice, the network externality will be a balance between the social welfare gains from increased subscribers compared to the social welfare gains of increased usage. Depending on the relative demand elasticities, there is the possibility that the externality calculation will reduce the efficient cost of calls (including or specifically terminating calls) and increase the cost of access/subscription. The issue of externalities has been widely considered by NRAs and where externalities have been included, they have typically increased termination rates rather than reduce them.

The following sections consider some examples where regulators permitted network externalities to be included in the mobile termination rate.

UK: Competition Commission/Ofcom

In the UK, the issue of mobile termination rates has been reviewed on numerous occasions, starting with Oftel in the late 1990s, followed by the Competition Commission in 2001 and more recently Ofcom. In all of these decisions, the network externality has been considered in great detail, and the conclusion has been that it is appropriate to include an allowance for the network externality in the mobile termination rate.

Ofcom has continued to apply a mark-up for network externalities and in the most recent review of mobile termination rates states:

“In the presence of a network externality, not enough consumers may choose to become mobile subscribers from the perspective of society as a whole. To the extent that not all of the network externality is internalised, social welfare can be increased by providing a subsidy to some of those consumers who are not willing to pay the full price of subscription.”

²³ A GSMA study on the impact of mobile network growth, based on the methodology developed by Len Waverman showed that a 10% increase in mobile penetration results in an annual GDP rise of 1.2% (www.gsmworld.com/tax).

²⁴ Whilst calculating externalities is complex, the same can be said for many other elements of costing and price-setting and as such is not in itself sufficient justification for ignoring externalities.

²⁵ However, Ofcom's empirical study concluded that 34% of UK subscribers are marginal

In this review, Ofcom has allowed an externality surcharge of 0.3ppm. This is 5.8% of the total termination charge of 5.1ppm (for 2G/3G operators).

As noted above, the purpose of this paper is not to prescribe a method for calculating the network externality. A very detailed discussion of the methods of estimating the network externality can be found on Ofcom's website²⁶.

Subsequent to the Competition Commission's decision in 2002/03, some other NRAs chose to rely, in one way or another, on the work performed by the Commission. These are briefly explained below.

Greek decision

In Greece, EETT completed a review of mobile termination rates shortly after the Competition Commission completed its review in the UK. EETT agreed with the Competition Commission's conclusion that a network externality should be included in the mobile termination rate and used the same model as the Competition Commission, updated with Greek inputs, to estimate the value of the externality.

Italian decision

In Italy, Agcom has recognised the need for a network externality, but is also aware of the difficulties of collecting the right data for a sufficiently robust estimation of its value. In order to get round this problem, Agcom's decision on MTRs states that where data is problematic, the network externality can be based on other countries which display similar characteristics in terms of mobile market size, penetration and number of operators²⁷.

Israeli decision²⁸

The Ministry of Communication commissioned Analysys Consulting to calculate the appropriate MTRs in Israel. In the decision document, the conclusion is reached that the network externality is relevant, but using the UK model with Israeli-specific inputs, the externality was immaterial in the context of the estimated cost-based MTRs.

Implications for developing countries

Developing countries are in many ways very different from Europe. However, that does not mean that the experience from Europe is not relevant. In Europe, mobile operators initially entered a market with high fixed line penetration. The mobile markets have not been a substitute for fixed lines and as the markets develop 'convergence' is the key phrase between fixed and mobile. In many developing countries this is not the case. Fixed line penetration tends to be low and new subscribers are more likely to take up a mobile service or a fixed wireless service. Therefore, people may be contactable on a mobile phone only.

The service offering and usage may also be significantly different. Voice call usage may be low, particularly for low income users who may only use their mobile for incoming calls. There is also evidence of 'flashing'. That is, a subscriber would ring another mobile but hang up before the call is completed. The receiver would then know that the caller wanted their attention which is the only point of the 'flashing'. It's even cheaper than sending a "please call me" SMS. The frequency of 'flashing' in Africa is such that a number of African operators, notably Celtel, have introduced free 'Call me back' text messages, a restricted number of which can be sent each day²⁹.

There is a social benefit to increasing the number of mobile users even if the incremental users have a very low usage and the priority for owning a mobile is to receive calls. More people are able to communicate and are contactable. These low income incremental customers are most likely to be pre-paid users but they still generate some retail, fixed and common costs. How are these costs to be recovered if the subscriber does not make any calls? There could be a justification for including a surcharge to the cost-based mobile termination rate to ensure that mobile operators cover the costs of increasing the mobile subscriber base and increasing social welfare.

26 http://www.ofcom.org.uk/consult/condocs/mobile_call_termination/wmvct/annexd/

27 Refer -page 5, paragraph 25 of Allegato A1 (page 101 in pdf document) in the following link http://circa.europa.eu/Public/irc/info/ecctf/library?l=/italia/adopted_measures/it20050316/mkt_16pdf/_IT_1.0_&a=d

28 http://www.moc.gov.il/new/documents/about/analysis_10.2.05.pdf

29 For example, Celtel Nigeria offers personal customers up to ten free 'call me back' messages per day: <http://www.ng.celtel.com/en/personal-plans/user-guide/index.html>

4.2 Network expansion objectives

In developing countries, and even in developed countries where mobile markets are expanding, there is an argument that the mobile termination rate should be above the estimated cost of terminating a call on the existing sized network. Mobile termination rates at cost could restrict the roll-out of networks. A network operator may have a reduced incentive to expand their network to some rural areas, road, train lines etc. The costs of building could be very expensive and the usage in these areas may not be enough to justify the cost³⁰. However, it is not obviously the case that high MTRs are necessary to encourage network expansion. The incentives to invest will be a function of a number of factors, of which MTRs is one. It should also be noted that NRAs might find it difficult to ensure that above-cost MTRs are actually used for the intended purpose. NRAs will need to determine a method for policing such a scheme, which might prove costly.

As in the network externality section, considering the costs of acquiring and maintaining customers, welfare will be maximised if the networks are expanded. The costs associated with the expansion to low usage areas could be partly recovered through the mobile termination charge as all mobile and fixed customers benefit from the increase subscriber base and network coverage.

Options to consider:

- Explicit surcharge on MTR for funding network expansion;
- Explicit inclusion of network expansion costs within the base cost model. If using a bottom-up model then the regulators/operators must be careful not to include network expansion in the base costs and also add a surcharge;
- Glide-path to cost-orientated rates allows time for operators to expand networks;
- Asymmetry in mobile termination rates may be reasonable for new entrants or for a lagging mobile operator to allow them time to build a network to compete effectively; and
- New technologies. For example, asymmetry in termination rates between 2G and 3G termination to allow 3G new entrants to compete with the established operators while they build out an enhanced network.

CASE STUDY: MALAYSIA

Malaysia uses mobile termination rates as a means to compensate operators' costs for rolling out their mobile network in areas that are mandated by the Government. Essentially, the Government has mandated national coverage or roll-out obligations through Time 1 and Time 2 requirements³¹.

According to the Report on Public Inquiry of Access Pricing, issued by the regulator MCMC in November 2005, the expenditure incurred in meeting the roll-out obligations are regarded as unavoidable costs that should be included in the LRIC calculation once incurred. As a result, the mobile termination rates have (gradually) increased annually between 2006 and 2008, reflecting the increased roll-out obligations.

4.3 Investment incentives

It is possible that a cost-based termination rate distorts an operator's investment incentives, such that it curtails its network roll-out into less profitable areas. Set out below is a simple example that demonstrates how this effect might occur. Assume that a new mobile operator (NewCo) is entering Country A and has to build out a mobile network. Country A is 400km sq and it is 50% cities and 50% countryside. Building a mobile network is cheaper in the cities as some infrastructure is already in place and there are fewer problems caused by the terrain [and presumably more customers / and revenues per \$ of investment] . NewCo will naturally build the network out to the high value areas first, even if it intends to eventually cover the whole country.

Suppose the regulator imposes cost based termination rates once all the cities have been covered. As the network is new, we assume that all NewCo's investment is efficient. We make the following additional assumptions:

- The average useful life is 15 years – HCA depreciation is used.³²
- Demand for services is constant within a geotype, with Cities having double the demand per sq km compared to the Countryside
- Half of the asset base is recovered over mobile termination services

³⁰ The differences in coverage between operators might be an exogenous cost factor that can be reflected in asymmetric termination rates. This is considered more in section 4.4.

³¹ Malaysia Communications & Multimedia Commission (MCMC), Report on a Public Inquiry on Access Pricing (November 2005), (<http://www.mcmc.gov.my/Admin/FactsAndFigures/PublicEnquiryReport>)

³² Although we have not included the capital cost in these calculations, this would result in a proportional mark-up on all costs. It would not affect the relative levels.

The table below shows that if a cost based MTR is set after coverage of the cities has been achieved then the rate will be £0.021. However as it is more expensive to build a network covering the countryside, if this rate is applied as the network expands then NewCo would be unable to recover its investment. The MTR required in order to achieve full cost recovery is £0.042 once the countryside is completely covered.

Geotype	Cost per sq km	Total cost	Recovered through MTRs	Depreciation in year	Total demand	MTR
Cities	£500,00	£100,000,000	£50,000,000	3,333,333	160,000,000	£0.021
Countryside	£1,000,000	£200,000,000	£100,000,000	6,666,667	80,000,000	£0.083
Total	£750,000	£300,000,000	£150,000,000	10,000,000	240,000,000	£0.042

Table 4 - Example of incentives created through cost based MTRs

With these incentives, NewCo will choose not to invest in a network in the Countryside as the low MTR will only permit under-recovery of investment costs.

If MTRs are set too low, NewCo will have to recover the additional costs of servicing the Countryside through higher prices for other services. In the table below we show the impact of recovering the cost not correctly recovered through MTRs through other services.

We assume the following:

- The network is built out over the entire country
- The MTR is set at the cost based price for cities: £0.021
- Total demand for other services is the same as total demand for termination services³³

Scenario	Cost not recovered through MTRs	Depreciation in year	Total demand	Cost per minute
Cost based MTRs	£150,000,000	£10,000,000	240,000,000	£0.042
MTRs at cost price for cities	£225,000,000	£15,000,000	240,000,000	£0.063
Uplift due to MTRs below cost:				50%

Table 5 – Uplift in price of other services required due to MTRs below cost

³³ In this example we have made the simplifying assumption that the route factors are such that the demand in terms of effective minutes in the same for all services.

This shows that the cost per minute for other services would need to increase by 50% to recoup the revenue lost through incorrect pricing of termination services. In this example we have made the simplifying assumption that the route factors are such that the demand in terms of effective minutes in the same for all services.

As we assume that it is beneficial for Country A to have a larger network as more people will be connected, the regulator should ensure that network expansion is not halted by MTRs which are too low to ensure a reasonable return on investment. We assume that there are no economies of scale to be gained, so the numbers above will be an overestimate, however these will not be sufficient to counterbalance the 50% uplift required in these of other services.

This simple example demonstrates that regulators may choose to set MTRs above the previously determined cost of termination to ensure that network expansion and investment will continue and to ensure that operators are not forced to raise prices for other services in order to recoup the full value of their investment.

4.4 Symmetrical v asymmetrical rates

The issue of symmetrical (or asymmetrical) termination rates has caused much debate between operators and NRAs. Presently, we observe symmetrical termination rates in some markets and asymmetrical termination rates in other markets. No definitive pattern has emerged in terms of symmetry v asymmetry per se, although there has been a clear trend towards more symmetrical termination rates over the last few years (particularly when we look at the members of the European Union). This is largely a result of the extension of MTR regulation to all mobile operators rather than just the larger operators recognising that termination of calls on each network is a separate market and each operator has a monopoly of termination to its customers.

Economic theory suggests that under perfect competition, different operators offering the same service will charge the same price. With regulators often attempting to mimic competitive outcomes when regulating MTRs, there can be an expectation that a single market rate will prevail. However, with respect to MTRs, conditions of perfect competition are not fully met, e.g. where termination on each network is deemed to be a separate market. As a consequence, the issue of symmetrical or asymmetrical termination rates cannot be resolved quickly with reference to economic theory.

In principle, the EC is in favour of symmetrical termination rates. The ERG has recently published a common position on MTR symmetry³⁴. The key conclusion reached is:

“Termination rates should normally be symmetric and asymmetry, acceptable in some cases, requires an adequate justification.”³⁵

In our opinion, NRAs should not come to any conclusions about the relative costs of different operators without performing the appropriate level of analysis. This will include analysing all the market and cost information that a NRA will gather during the process of regulating MTRs. Only then will a NRA be in a position to form view on whether symmetrical or asymmetrical termination rates are appropriate.

4.5 Glide path

A glide path refers to a regulated price control where regulators require operators to reduce prices over time rather than mandate an immediate move to the cost-orientated level. This allows operators time to plan for the decreased revenue from mobile termination charges, and offers stability rather than a one-off shock if the difference between the existing MTR and the cost-orientated MTR is great. There are a number of options available. These are listed below going from the gradual to the immediate:

- Glide path from current prices to cost-orientated or benchmark prices
- One-off step change then glide path to cost-orientated or benchmark prices
- Immediate move to cost-orientated / benchmark prices

NHH in Hungary reduced asymmetry in a one-off step and then glided to cost-based tariffs. The highest MTR was only allowed to be 20% higher than the lowest in the market at the time of the first cut. Thereafter the decision required all operators to glide to a single cost-based tariff.

Glide paths are frequently used to reduce asymmetries in MTRs at the same time as approaching cost-orientation prices. In mature markets, MTRs are usually symmetrical. Having a glide path can be seen as a way to allow smaller and/or less efficient operators time to grow their market share or improve efficiency so they are able to complete effectively once the MTRs are at a cost-orientated level.

³⁴ http://www.erg.eu.int/doc/publications/erg_07_83_mtr_ftr_cp_12_03_08.pdf

³⁵ In section 3.2 of the ERG's document they also state "In any case, regulators should bear in mind that asymmetric regulation is sustainable only on a transitional period".

The optimal length of a glide path is a matter of debate. Regulators have generally set glide paths of between one and three years. The UK has previously used four year charge control periods during which the MTRs glide to the cost-orientated rate. Spain has had a three year glide path. The European Commission has stated on a number of occasions³⁶ that while it supports the use of glide paths, these should be as short as possible and in many cases has encouraged NRAs to revise glide paths which are over two years long.

A glide path may also be a consideration in a developing market. The cost based termination may be too low to encourage network expansion and development in new services. If the objective of the glide path is to allow for network investment, it is possible that the optimal glide path length would be longer than in developed countries.

4.6 Pass-through of termination rate cuts

The primary purpose of regulating MTRs should be to increase consumer welfare³⁷. If it is deemed necessary to cut MTRs, social welfare will not be maximised unless these cuts are passed through to consumers. If there is effective competition in the retail market for mobile telephony, MTR cuts should be passed through to consumers.

As mobile subscribers' decisions are influenced by the retail prices there is a tendency for mobile operators to compete at this level and the result is that termination revenues are shared between mobile operators. A reduction in the mobile termination rates will be passed onto the mobile subscriber. However, if there is a monopoly in the fixed market there is little incentive for a fixed operator to pass on any reduction in mobile termination costs to their own subscribers as there is not sufficient competition in retail fixed to mobile calls.

If there is limited pass-through of the termination rate cuts to the consumer, the perceived benefit to social welfare will not materialise. Therefore, there may be a need to regulate the fixed to mobile retail prices to ensure that fixed line customers receive the benefit of a reduction in mobile call termination. If the fixed retail calls to mobile are regulated, for example, as part of a price cap bundle there may not be a visible reduction, and regulators will need to be careful to ensure that the MTR cuts result in the desired effects on the market.

4.7 Price-setting process

Whilst the purpose of this paper is not to determine the process a NRA should follow in setting mobile termination rates, we believe the issues contained herein demonstrate the complexity of the issue and we briefly describe below the type of process a NRA should follow.

We believe NRAs should always adopt an open consultative approach when embarking on a rate-setting process. The exact nature of the process will differ from country to country, but we believe the fundamental features of an open, consultative approach are:

- Full transparency of models, subject to data confidentiality concerns, and associated documentation
- Sufficient time allocated for the process
- Consideration of different methodologies
- Effective consultation including responding to and, where appropriate, acting on comments received from interested parties
- Very clear decision making including detailed explanation of the basis for the decisions

Whilst it is impossible that all parties will ultimately be in agreement about the NRA's decision, in the absence of the above, there is a stronger likelihood that the NRA's decision will be challenged leading to more regulatory uncertainty.

³⁶ For example in comments to the Greek NRA, EETT, the Commission encourages the NRA to impose a shorter glide path to cost-based prices than the two years announced in the notification – case SG-Greffe (2006) D/203020

³⁷ This assumes that the level determined by the NRA is a socially optimal one, and has taken into account both the costing and pricing issues that have been set out in this document.

5.0 Critique of existing cost models

5.1 Overview

In this section we review two publicly available cost models which are widely used in the developing world; the World Bank Model and the COSITU model. Both of these were designed for use in developing countries, particularly in Africa. We give some background to the model development and comment on the ease of use of the model, the depreciation methodologies used the model structure and the model outputs.

5.2 World Bank model

5.2.1 Background/Overview

The World Bank model³⁸ was developed by the World Bank Global Information and Communication Technologies Department with assistance from BIPA SA³⁹ in 2003 for use by NRAs in developing countries across Sub-Saharan Africa. Their stated expectation is that the model would be adapted by individual NRAs to suit their specific requirements.

The model calculates interconnection rates for both Fixed and Mobile services. The interconnection costs for fixed and mobile are calculated from completely separate inputs. The model is a bottom-up LRIC model which is designed for small networks as is common in Africa.

As stated in the model documentation, a large amount of information is required in order to populate the model. The user is required to enter information on traffic demand, network topology, and cost elements among other things. It is not immediately clear what the source of this information will be.

The demand assumptions required are current usage and annual growth rate. It appears from our attempts to run the model that that network assumptions in terms of quantities are supposed to come from operators and that network assumptions in terms of costs are supposed to be forward looking, efficient costs. A base case for this would be to use the unit cost information provided by the relevant operators, however this may not be an efficient level of cost.

5.2.2 Ease of use

Extensive documentation is provided with the model which explains basic cost-modelling principles and contains a user guide. The user guide necessarily assumes a certain level of telecoms knowledge, and is clearly written to be understood by telecoms practitioners.

The model is built in Microsoft Excel and is well structured, with input cells clearly marked. Upon opening the model, the user is presented with a menu with buttons linking to each of the assumptions and output sheets. The model language can be set to English or French. There are a number of visual basic macros in the model which relate to the reset function, the language function and the economic depreciation calculation.⁴⁰

³⁸ The model and documentation is available from the World Bank website: http://publications.worldbank.org/ecommerce/catalog/product?item_id=2984189

³⁹ The authors are Paul Numba Um (WBI), Laurent Gille (ENST), Lucile Simon (BIPA SA) and Christophe Rudelle (BIPA SA).

⁴⁰ The 'phi' function

As with all cost models a large amount of information is needed to fully populate the model. The model contains default parameters for a number of areas, such as routing factors, however alternative parameters may be entered if available.

5.2.3 Model structure

The model structure for the fixed network is shown in the diagram below⁴¹, taken from the model documentation. The structure for the mobile network is very similar. This shows how the demand, network and cost assumptions flow through into network sizing and cost per service. The model structure for the mobile network is essentially the same, but with all the hypotheses being entered on one sheet.

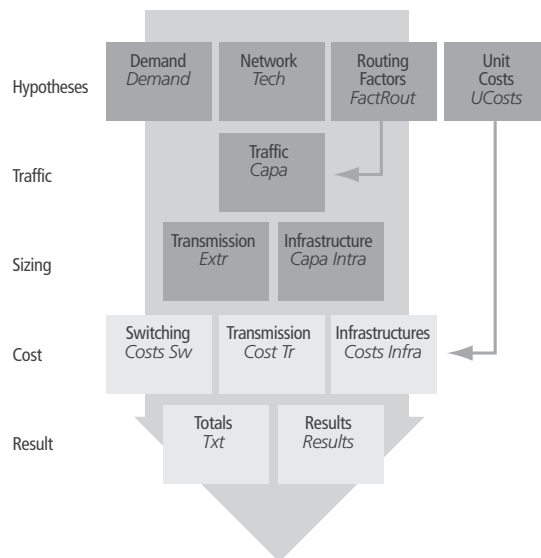


Figure 8 – COSITU model structure

5.2.4 Costs included/cost allocation rules

The model distinguishes between incremental and common costs. Common costs are calculated as a percentage uplift on top of the incremental cost per network element. This means that these percentages will need to be cross-checked against actual data to avoid over/under recovery of common costs. The documentation suggests that the NRAs perform benchmarking studies on an appropriate level of uplift.

A key issue here is that the NRAs may fail to correctly distinguish between incremental and fixed costs. This can lead to incorrect cost recovery.

5.2.5 Depreciation methodology

The model considers Economic Costs rather than Accounting Costs. The Economic Cost is defined as the current cost of the most efficient asset to perform the service required – in essence an MEA approach.

The model uses economic depreciation, which is a multi-year depreciation methodology; however only one set of outputs are produced. The depreciation methodology used in the model uses the current cost of the network assets (or modern equivalent) as the investment cost which is converted to an Average Annual Economic Cost of investment using the ‘phi’ formula, which is defined within the model. This formula is a function of the cost of capital and the useful economic life of the asset and is such that the Initial investment cost divided by phi results in the average annual economic cost. If this annual cost is recovered in each year of the assets life then this results in full cost recovery when discounted at the WACC. An example using a WACC of 10% and a UEL of five years is given below.

International investment (Year 0)	£100
WACC	10%
Price trend	0%
UEL	5
Phi (UEL, 1+WACC)	3.37
Annual payment (investment/phi)	£26.38

Year	0	1	2	3	4	5
Annual payment		£26.38	£26.38	£26.38	£26.38	£26.38
NPV (WACC, payment stream)	£100.00					

Table 6 – World Bank model cost recovery illustration with constant asset prices

41 Source: World Bank model documentation, pg 32

This example calculation shows a flat annuity. The model also allows for changes in equipment prices over time. While this avoids the front loading of cost associated with HCA depreciation, it does not take into account the changes in the demand profile over time.

An example of the same asset but with a price trend where the cost of the asset decreases by 5% each year is shown below.

International investment (Year 0)	£100
WACC	10%
Price trend	-5%
Discount rate (1+WACC)*(1-Price trend)	116%
UEL	5
Phi (UEL, Discount rate)	3.31
Annual payment (investment/phi)	£30.19

Year	0	1	2	3	4	5
Annual payment		£30.19	£30.19	£30.19	£30.19	£30.19
NPV (WACC, payment stream)	£114.43					

Table 7 – World Bank model cost recovery illustration with trending asset prices

This shows that under or over cost recovery occurs once the price of the asset is changing. This is a serious weakness of the model as the majority of telecoms equipment does experience a significant change over time. This is akin to the OCM approach, although not mathematically identical, as discussed in section 3.4.3.

5.2.6 Model Outputs

Outputs produced by the model are unit costs (per minute) for each type of node and link, interconnection cost per minute,⁴² in Euros and local currency, for the interconnection services listed below:

Fixed	Mobile
Local level	Originating
Single transit	Terminating
Double transit	
Transit	
Transit international	

Table 8 - World Bank model outputs

It should be noted that the route factors for the mobile network include on-net, off-net and fixed to mobile calls. The default values of these route factors do not take into account the relative usage of each of these services. The user can calculate new route factors offline and input them into the model. If one of a set of route factors eg usage of nodes (MSC, BSC, BTS) are entered then the entire set must be entered manually.

SMS services and value add services are not included in the model. This is a serious weakness in given the growth of these services in recent years – some network costs should be recovered over these services rather than over voice termination and origination.

Time of day adjustments (peak/off-peak/weekend rates) can be applied if desired.

The model can automatically produce sensitivities for the following inputs:

- Traffic at peak hours as % total traffic
- Total length of trenches
- Total staff
- Average annual cost of employee
- Market surcharge ratio
- Gearing level

⁴² Calculated as Unit cost * Route factor

The user can compare the original output to the sensitised level and keep the result of the sensitivities as the new base case if required.

5.2.7 Conclusion

While the World Bank model is reasonably easy to use, a certain level of technical knowledge is required in order to understand the model. The model can be useful in promoting a detailed discussion about the types of data which would be required for the LRIC cost modelling process, and the areas which should be considered. However, as discussed above, the model has weaknesses in relation to the depreciation calculation, the route factor calculations and the services included. For this reason, we would recommend that NRAs build their own cost models which can be tailored to the specific needs of their jurisdiction and which can take into account the factors listed in section 3.

5.3 COSITU model

5.3.1 Background/Overview

The COSITU model was developed by the International Telecommunications Union (“ITU”) to assist regulators and operators in developing countries in the setting of interconnection rates. The model was initially designed for fixed-networks. The latest update⁴³, released in 2004, incorporates an option for both fixed and mobile networks, however the mobile features are very limited. The majority of the model is the same for both fixed and mobile networks.

According to information published on their website⁴⁴, ITU are planning to upgrade the COSITU model in 2007, although as of January 2008 this hasn’t happened. The upgrade will potentially include options to calculate interconnection rates for VoIP calls, as well as an expansion of the model’s mobile capability. Our critique of the COSITU model is therefore limited to the 2004 version.

The COSITU model is a single year, Fully Allocated Cost (“FAC”) model. The model allocates the cost of the network to the interconnection services based on cost allocation rules. There is the option to apply an “adjustment for current costs” when calculating Net Fixed Assets, however we do not believe the methodology applied is consistent with best practice. This is discussed in more detail in the ‘Depreciation methodology’ section below.

ITU provides training courses for regulators in developing countries to introduce the COSITU model. The software is available to these organisations at an 80% discount and the feature which allows costs to be benchmarked against others in the region is only available to these users.

As with any model, the outputs are only as good as the inputs. There is naturally a large amount of information which needs to be inputted into the model. It is essential that these inputs undergo a full quality review in order to ensure that the model output is realistic.

5.3.2 Ease of use

The model is built in Access using Windows Graphical User Interface and requires the data to be entered in a specific sequence. There are often fixed sequences of windows which a user has to navigate in order to adjust a parameter/input. This can make the process rather unwieldy. The software automatically saves any changes the user makes.

5.3.3 Costs included/cost allocation rules

The costs considered in the model may be divided into network elements and other costs. These are listed below.

Network elements	Other costs
International Transmission	Capital costs
International Switching	Other Common Costs
National Switching	Inefficient Costs
Access Network	

Table 9 - COSITU model network elements and other cost categories

⁴³ Edition 2004, Version 1.0 – Service Pack 2. Available from <http://www.itu.int/ITU-D/finance/COSITU/index.html>

⁴⁴ http://www.itu.int/ITU-D/finance/work-cost-tariffs/events/tariff-seminars/havana-07/doc_0_carmen_en.PDF

The user is required to input information on Net Book Values, Asset Lives and Annual Depreciation charges for the network elements listed above. Data for each of the network elements can be entered at this level or with each category broken down into Telecommunications Equipment, Energy Equipment, Buildings and Other Investments. We feel that this is still very high level and yet NRAs may find it difficult to determine the appropriate allocations. For instance, if a building is used for both national and international switching, which cost category should it be allocated to?

If it is not possible to get a sufficiently robust allocation of fixed asset costs, the model has the facility to download benchmark percentage splits from the COSITU server for Net Fixed Assets and Amortisation. These are based on a weighted average of the percentage splits for similar countries. Unfortunately this server has been out of action since early 2006 and there is no indication of whether this facility will be re-instated.

It is necessary to input operational costs in two distinct sheets. Some operational data such as employee costs are entered on the Cost Elements page and some, such as advertising and billing on the Direct, Indirect, Common and Special costs page. Care will need to be taken that cost are not duplicated or excluded.

A thorough review of the data will be required in order to correctly ascertain which costs fall in which categories. There is also the possibility that some opex will be inadvertently excluded if it does not fall within one of the categories above. It is therefore important that the costs which go into the model are reconciled to the total opex in the accounting systems.

5.3.4 Depreciation methodology

The user is required to enter the yearly depreciation⁴⁵ charge, the accounting asset life and the expected asset life. This depreciation charge will be calculated outside the model and will most likely be taken from accounting records. The model will adjust the accounting depreciation in proportion to the change in useful life.⁴⁶ This adjustment is done by scaling the depreciation in proportion to the useful life. This implied that the user will have used HCA straight line depreciation, as is common in accounting records.

Depreciation charges and useful lives are entered for each of the following categories: International Transmission, International Switch, National Transmission, National Switch, Network Access and Other.

The model will perform what is called an Adjustment for Current Costs. The current cost adjustment formula used in the model is as below:

$$ACC = AMO \cdot \left[\frac{(1+8)^{D/2}}{(1-\epsilon)^{D/2}} - 1 \right]$$

where:

ACC	is the adjustment current costs
AMO	is the amortization allowance
8	is the average annual growth rate in the price of equipment ⁴
ε	is the average annual rate of currency depreciation
D	is the amortization period

AMO is equivalent to HCA depreciation. Although called an adjustment for current costs, this adjustment does not result in current cost depreciation, nor is full cost recovery guaranteed. This is demonstrated in the example below using a WACC of 10%, a useful life of 5 years and a price trend of 6%. There is no cost of capital in the formula.

⁴⁵ Referred to as amortisation throughout the COSITU model

⁴⁶ For example, if the annual depreciation charge is £10 with a 10 year life, the charge would be £5 if the actual life was 20 years.

Investment (year 0),1	£100
WACC	10%
UEL	5
HCA depn	£20
AMO	£20
δ	6%
ε	0%
D	5
ACC	£3

Year	1	2	3	4	5
HCA depn (AMO)	£20	£20	£20	£20	£20
ACC	£3	£3	£3	£3	£3
Amortisation after ACC	£23	£23	£23	£23	£23

NPV depn charges	£87.70
-------------------------	---------------

Table 10 - COSITU current cost adjustment calculation illustration

The model includes capital costs separately from the amortisation calculations, (calculated as WACC*total capital), however debt and equity are individual inputs and there is no check that the funding is equal to the asset base.

As demonstrated by the example above, and given that the cost of capital is a separate input, the chance of correct cost recovery is low. The model is highly likely to under-recover or over recover the investment cost. The fact that the cost of capital is calculated separately and plays no part in the depreciation calculations is a serious weakness of the model, given that the purpose of cost models is to allow full recovery of reasonably incurred costs.

5.3.5 Model Outputs

The outputs of the model are cost oriented (if access deficit is non-zero) or cost based (if access deficit is zero) unit tariffs for the services below. The unit profit or loss for each service is also shown.

Basic telephone services	Transit Services	Basic telephone services
Urban	International to International	National Incoming Single
Interurban	International to Subregional	National Incoming Double
International Outgoing	Subregional to International	National Outgoing
International Incoming	Subregional to Subregional	National to National
Subregional Outgoing		International to National
Subregional Incoming		National to International

Table 11 - COSITU model outputs

The model includes capital costs separately from the amortisation calculations, (calculated as WACC*total capital), however debt and equity are individual inputs and there is no check that the funding is equal to the asset base.

As demonstrated by the example above, and given that the cost of capital is a separate input, the chance of correct cost recovery is low. The model is highly likely to under-recover or over recover the investment cost. The fact that the cost of capital is calculated separately and plays no part in the depreciation calculations is a serious weakness of the model, given that the purpose of cost models is to allow full recovery of reasonably incurred costs.

5.3.5 Model Outputs

The outputs of the model are cost oriented (if access deficit is non-zero) or cost based (if access deficit is zero) unit tariffs for the services below. The unit profit or loss for each service is also shown.

Outputs are given for these services regardless of whether the network being modelled is a fixed line or mobile network. No explanation is given in the model documentation regarding how these outputs should be interpreted if a mobile network is being modelled. This highlights how the model is not at all suitable for use in calculating mobile termination rates.

5.3.6 Benchmarking capability

One of the useful features of the COSITU model highlighted in the documentation is the benchmarking capability. The software should be able to download both a standard distribution of the fixed assets and benchmark interconnection rates. The fixed asset distribution is for use when total fixed assets are known but it is not possible to split the costs between the categories due to deficiencies in available accounting information or otherwise. The tariff benchmarking allows the user to assess the reasonableness of the model output against similar countries. The tariff data is collected by ITU and stored on their server.

It appears that this feature is no longer available as the ITU server has been non-operational since 2006. These facilities are only available to Telecommunications Regulators and ITU members so PwC would have been unable to access or comment on the content even if the server was working.

5.3.7 Conclusion

The COSITU model is difficult to use and it would take some time to get familiar with it. It has clearly been built for fixed line networks with the mobile module as a small addition. The cost categories are high level and it is unclear whether operators will be able to provide a split of their costs in the manner required. Cost recovery is not automatic and it is not obvious how the model outputs should be interpreted in relation to a mobile network.

As a result, we do not feel that the COSITU model should be used in the setting of mobile termination rates. NRAs would achieve more reliable results by building their own cost model which can be tailored to the specifics of the national market in question.

6.0 Operator survey

6.1 Survey methodology

We constructed our survey in conjunction with the GSMA working group. The survey was distributed to GSMA members and we thank those who have found the time to respond.

The purpose of the survey was to establish the state of regulation in a range of countries, specifically in regard to MTRs. As with the rest of this paper, the survey focused on the details of cost modelling, the regulatory regime currently in place and any changes anticipated in the future.

The questions were designed to determine whether clear trends have emerged with respect to how cost models are being developed, and how those models are being used to set MTRs. The next section sets out the survey responses along with our commentary and clarifications.

6.2 Survey responses

6.2.1 Model background

We received 29 responses to our operator survey, 12 of which were from developed countries with the remaining 17 from developing countries. The developed countries were principally European and the developing countries principally African although we did receive responses from other parts of the world. Where we have received multiple responses from more than one country we have amalgamated the results so that each country is only counted once. As a result our sample size is 27 countries.

Has your NRA developed a cost model itself or has your NRA directed you to develop your own model?

The majority of respondents have built their own cost model as shown in the chart below. In a number of African countries this was not explicitly requested by the regulator, however the regulator was beginning to look at the issue of MTRs and the operators felt it was necessary to increase their knowledge of cost models. A large number of respondents used the publicly available cost model from the World Bank which they populated with data relevant to their network.

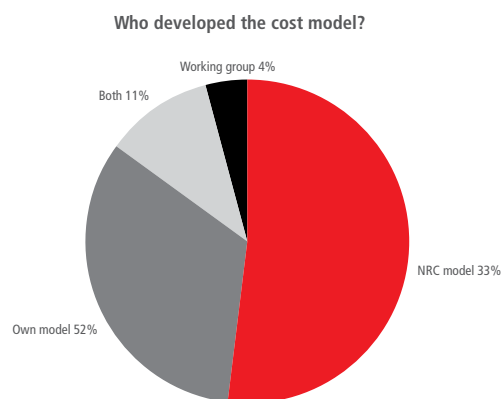


Chart 1 – Cost model developers

When was the most recent model built?

Where a response was provided, the cost model was almost always completed in 2006 and 2007 with a number of respondents stating that they or the NRA was likely to update the model in the future.

Why did the regulator decide regulation was necessary?

The list of reasons why the regulator decided to regulate MTRs is varied, as shown in the chart below.

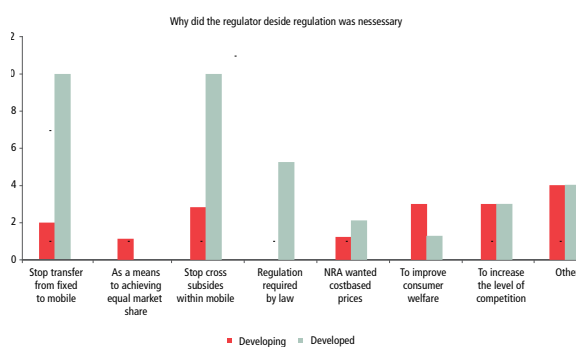


Chart 2 – Reasons for regulation

6.2.2 Key modelling decisions

What cost standard is used in the model?

As shown in the chart below, a clear majority of operators are currently using LRIC models. Some of the respondents have commented that the model which is currently used in price setting is FAC/FDC however there is work in progress on a new LRIC based cost model.

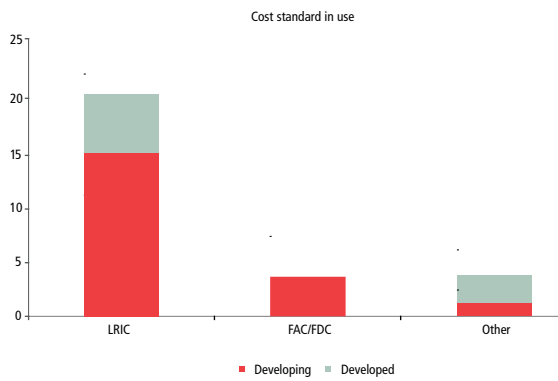


Chart 3 – Costing standard in use

What is the type of model?

By far the most common type of model is a hybrid model, although there are still a few countries in which other methods are used. Again, some respondents have commented that although the current model may be either top-down or bottom-up, a new hybrid model is currently in development.

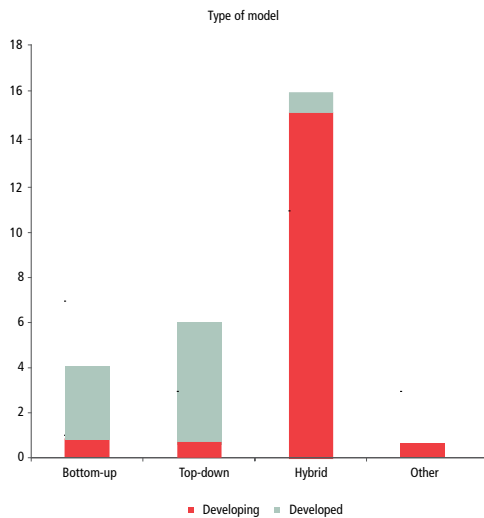


Chart 4 – Type of model in use

Is a hypothetical operator modelled or are actual operators modelled?

In the majority of countries cost modelling involves modelling a hypothetical operator. The answers to this question will have been influenced by the wide use of the World Bank model which is a hypothetical operator model. Where a hypothetical operator was modelled the operator was defined as an efficient operator in all but two countries.

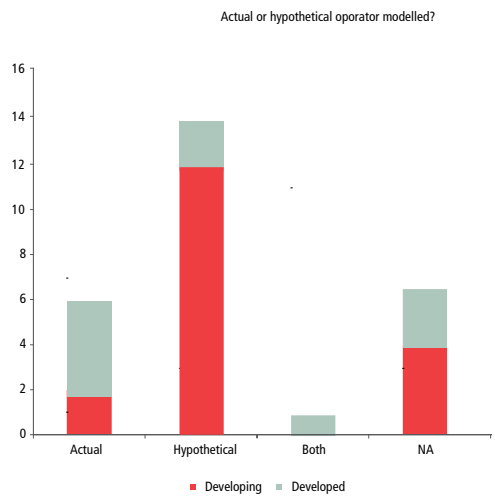


Chart 5 – Actual or hypothetical operator

What time period does the model cover?

The majority of the respondents had forward looking models:

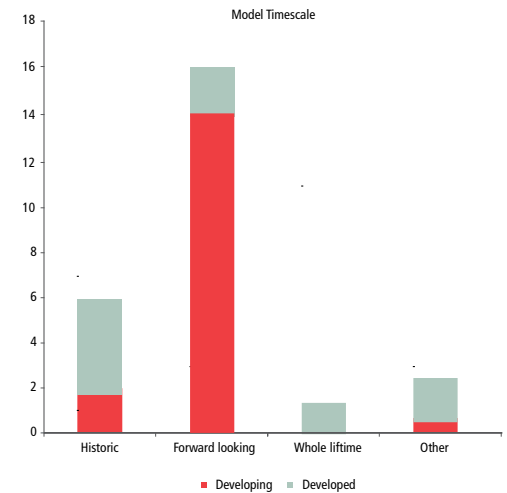


Chart 6 – Model time period

What time period does the model provide an output for?

The majority of models were single year models (World Bank model is single year):

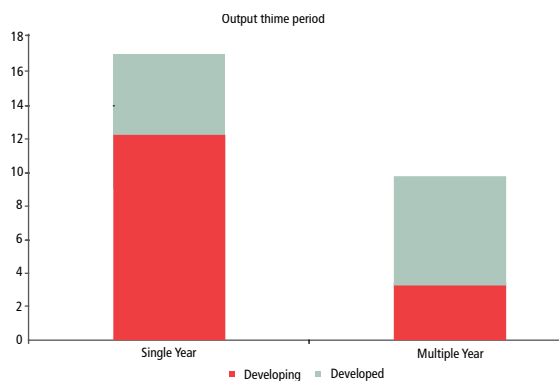


Chart 7 – Model output period

What services are modelled?

The majority of respondents stated that all services including data are included in the model. This was all but one of the respondents from developed countries. In this case there is a working group of operators and the NRA who are developing a new model which will model all services including data.

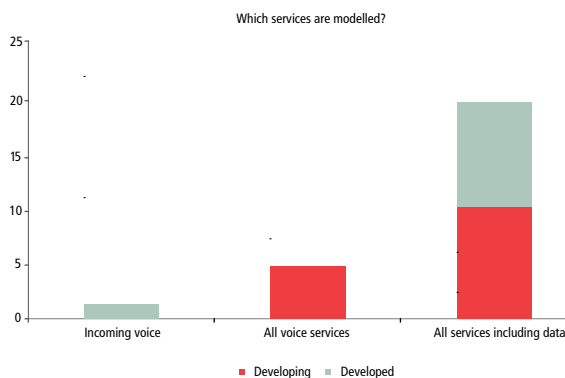


Chart 8 – Services modelled

Which valuation/depreciation methodology is used?

The most frequently used depreciation methodology among our respondents was economic depreciation, followed by the tilted annuity approach. As with the question relating to the time period of the model, the responses to this question will have been influenced by the wide use of the World Bank model, although in our opinion, the World Bank model does not deploy economic depreciation as we have defined it in section 3.4.3.

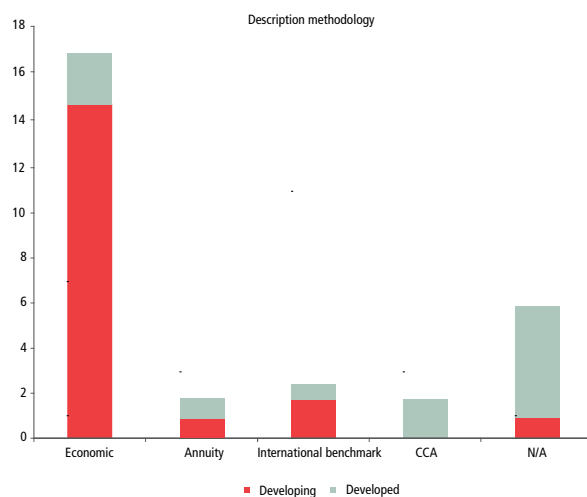


Chart 9 – Depreciation methodology

Are efficiency adjustments included in the model?

Efficiency adjustments are present in the majority of countries and appear to be more prevalent in developing countries. (75% of developing countries' models have efficiency adjustments compared to 18% of developed country models.)

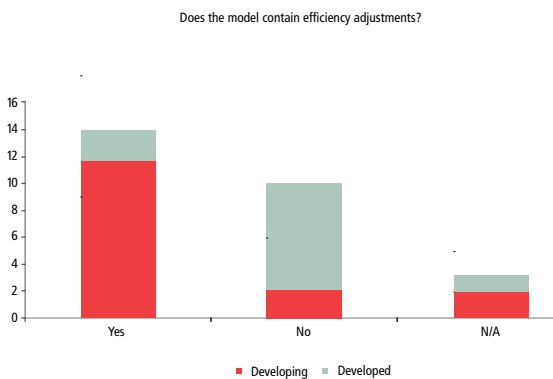


Chart 10 – Efficiency adjustments

What technologies are included in the model?

The chart below shows the technologies modelled GSM, GPRS and EDGE are unsurprisingly the most common technologies modelled.

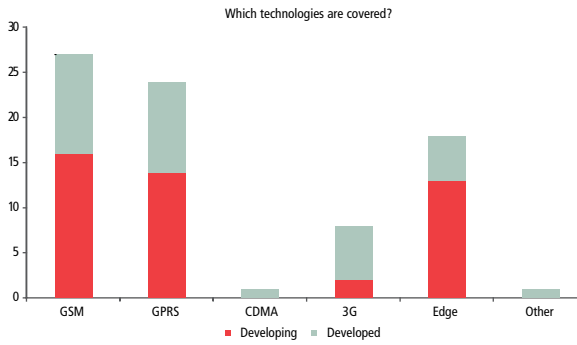


Chart 11 – Technologies included

What is the cost of capital included in the model?

The cost of capital is an area where it is difficult to compare responses, as the figure could be pre or post tax and in real or nominal terms. The majority of countries (15 of 27) had a cost of capital expressed in nominal, post-tax terms. The average cost of capital for developed countries appears to be slightly lower than that of developing countries as expected. A table of the vital statistics is given below. Please note that no adjustment has been made to correct for real/nominal and pre/post tax differences.

	Developed Countries	Developing Countries
Average	14%	17%
Max	25%	40%
Min	9%	10%
Range	16%	30%

Are direct retail costs included in the model?

In the majority of countries, direct retail costs are not included in the model.

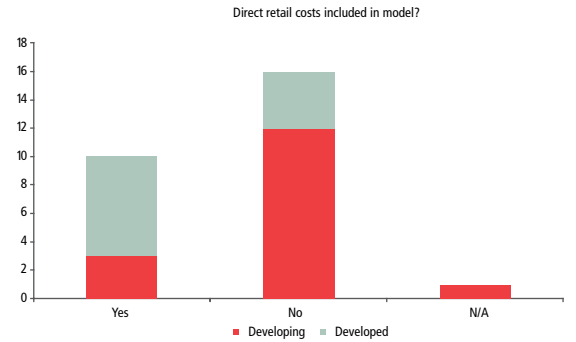


Chart 12 – Direct retail costs

If yes, are any direct retail costs allocated to mobile termination?

Where retail costs are included, a proportion is generally allocated to MTRs.

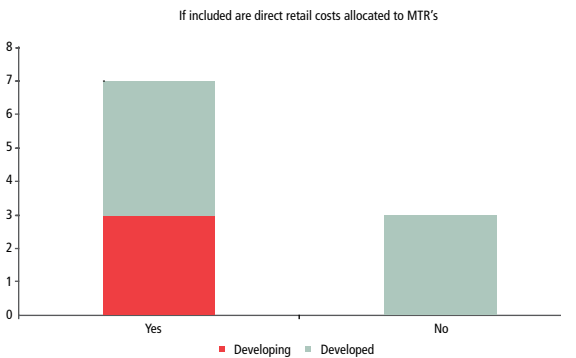


Chart 13 – Allocation of direct retail costs

Does the model include Fixed Common Costs?

Fixed common costs are almost always included in the model.

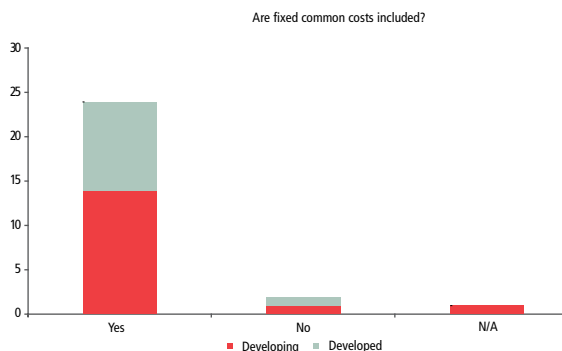


Chart 14 – Inclusion of fixed common costs

How are Fixed Common Costs treated in the model?

Where fixed common costs are included in the model, the most likely allocation method is an Equi-proportional mark-up based on a percentage of direct costs.

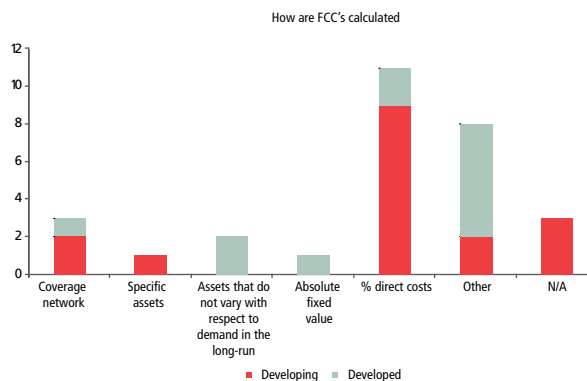


Chart 15 – Treatment of fixed common costs

Did the regulator consider using Ramsey pricing to allocate FCC?

Ramsey pricing does not seem to have been considered by the NRAs in the countries we have responses from. Only one respondent reported that Ramsey pricing had been considered by their NRA.

Are up-front licence fee costs included in the model?

All of our respondents from developed countries stated that up-front licence fees were included in the model, compared to just over half those from developing countries. Some operators stated that the upfront fees were either fully amortised or that no up-front fee was payable.



Chart 16 – Inclusion of un-front licence fee costs

Are up-front licence fees recovered in full?

Where up-front licence fees were included in the model, a majority of operators said they were fully recovered or that they didn't know. This suggests that the operators in question are populating generic or NRA models which they do not fully understand. A number of operators commented that the licence fee was often recovered through the fixed common costs allocation.

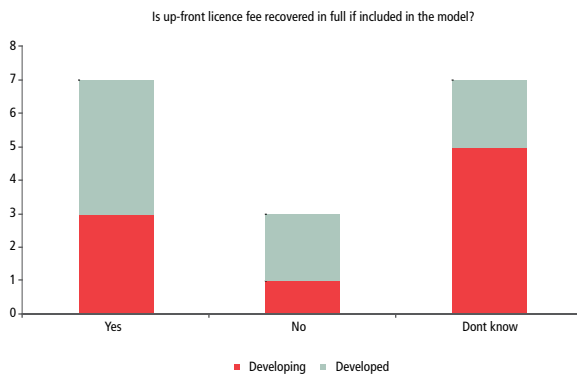


Chart 17 – Recovery of up-front licence fees

What valuation methodology is used for licence fees?

All but one of the respondents stated that the valuation method used for the licence was the historic cost which they had paid. The exception was the UK, where the NRA has considered a range of scenarios using different licence valuations.

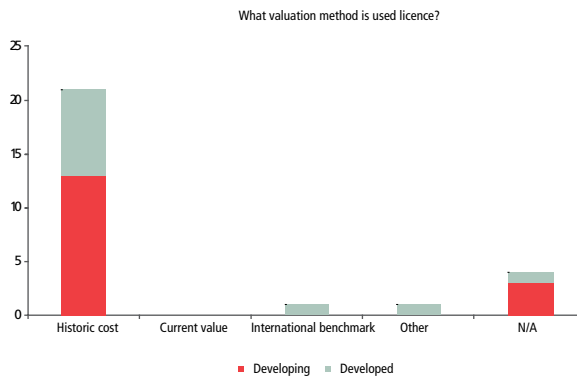


Chart 18 – Up-front licence valuation methodology

Are ongoing licence fees included in the model?

As with up-front licence fees, all of the developed country respondents stated that ongoing licence fees were included in the model whereas the majority of developing country operators stated that they were not.

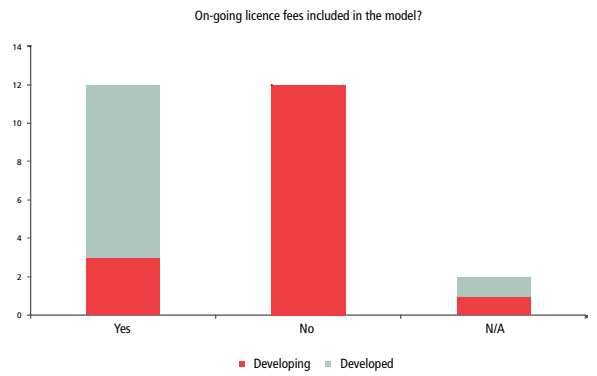


Chart 19 – Inclusion of ongoing licence fees

What valuation methodology is used for ongoing licence fees?

Unlike up-front licence fees, it is much more common for ongoing licence fees to be valued using international benchmarking, particularly in developing countries:

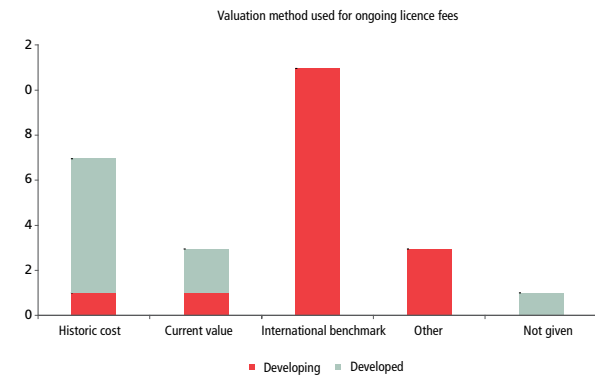


Chart 20 – Ongoing licence fee valuation methodology

Is there a network externality calculation in the model?

As shown in the chart below, it is rare for a network externality uplift to be included within the model. On a proportional basis, the externality uplift appears to be more likely to be present in developing countries. Of the four countries where a network externality was included in the model, this was thrice through an explicit calculation and once implicitly through the allocation of some subscriber acquisition costs to MTRs.

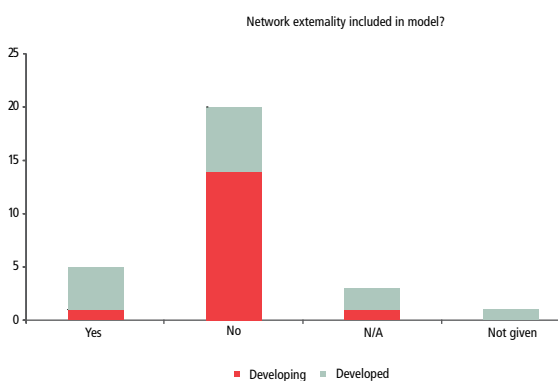


Chart 21 – Inclusion of network externality

6.2.3 The setting of mobile termination rates

Has a glide path or a one-off change been applied to mobile termination rates?

From the responses we received, it appears that a one-off cut in MTRs is the most common outcome. A large number of respondents said that this question was not applicable as the regulator has not yet reached a decision on MTRs. In these cases the cost modelling process is frequently underway at the moment.

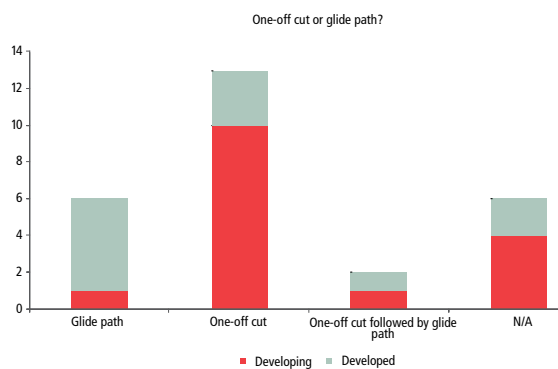


Chart 22 – Path of mobile termination rates

How long (in years) is the glide path?

Where a glide path was imposed, this was over a period of 3 or 4 years, although this may be the length of the timeframe considered by the NRA rather than the full length of the glide path. For example, in the UK, Ofcom set an initial glide path for the period 2003 – 2007 and has recently set a new glide path for the period 2007 – 2010.

Has the NRA regulated the retail cost of calls to mobile to ensure pass-through of mobile termination rate cuts? If not, is such regulation planned for the future?

In most countries the NRA has chosen not to regulate the retail mobile markets, however several respondents stated that this is something the regulator was considering for the future.

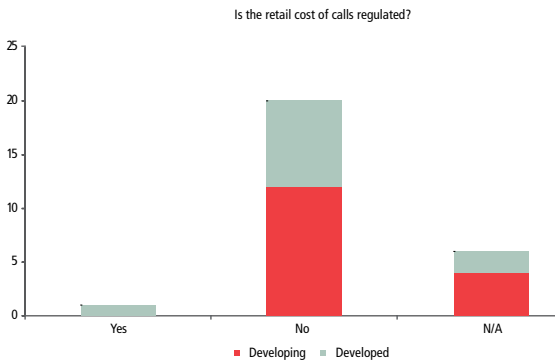


Chart 23 – Current regulation of retail call costs

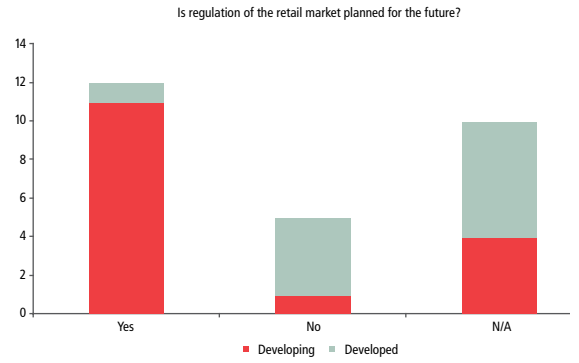


Chart 24 – Future regulation of retail call costs

Have symmetrical or asymmetrical rates been applied in the market?

In the majority of countries MTRs are symmetrical. Interestingly, two thirds of developed country respondents said MTRs were asymmetric compared with 13% of developing country respondents.

If asymmetrical, will this continue beyond the current regulatory time frame?

In developing countries where rates are asymmetric they will stay asymmetric throughout the current regulatory period, whereas asymmetric rates will converge in some developed countries.

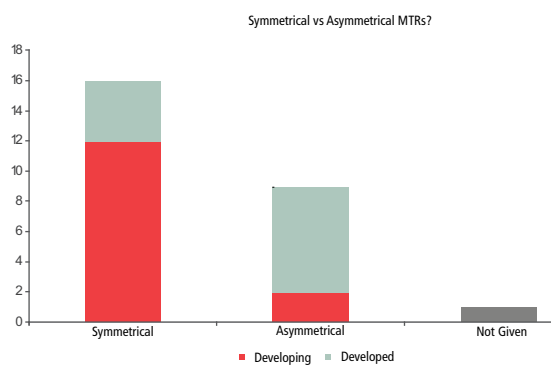


Chart 25 – Application of symmetrical vs. asymmetrical MTRs

Have NRAs allowed an uplift to mobile termination to contribute to the costs of network expansion?

None of the operators who responded to our survey said that a network expansion surcharge was explicitly included in MTRs, although one operator said that there was a de facto acceptance of the practice.

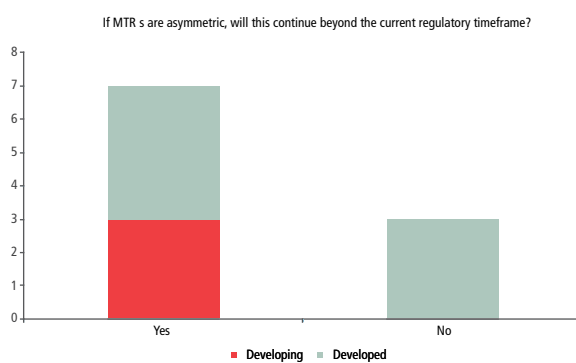


Chart 26 – Convergence of asymmetric rates

7.0 Conclusion

7.1 Regulation comes in many shapes and forms

The survey responses show that the regulation of MTRs has been done for a variety of reasons in a variety of ways producing a variety of outcomes. Some of the NRA's decisions have been the result of detailed analysis whilst others have merely relied on off-the-shelf costing packages to set the MTRs. There is little evidence from the industry that the need for regulating MTRs will disappear in the near to medium term so it is in the interests of the industry and also the wider economy that NRAs make correct decisions regarding the setting of MTRs.

7.2 Many issues in modelling and price-setting – consultation is key

This paper has demonstrated that MTRs are the function of numerous inter-related complex factors, and there is no "correct" answer as to how MTRs should be set. However, it is clear that there are incorrect decisions that can easily be taken and NRAs and operators must be mindful of the many pitfalls that lie in wait when embarking on a MTR price-setting exercise. Therefore it is imperative that NRAs consult, that operators fully engage in the consultation and that the final decision is transparent, understood and supported with rigorous analysis and reasoning.

This paper has highlighted areas of best practice, and their adoption will enhance the harmonisation of cost modelling and price setting for MTRs. These areas of best practice include:

- The use of a hybrid model,
- The use of economic depreciation,
- The use of a forward looking model incorporating historic data as a sense check,
- Allocation of costs between services based on routing factors,
- Networks are assumed to be efficient in competitive markets,
- MTRs should be based on the technologies in use, e.g. 2G migrating to 3G, and
- Cuts in MTR need to be passed on to the end user if they are to have the desired effect.

7.3 Change takes time

The transition from existing rates to cost-oriented rates can have a big impact on the structure of prices for all mobile services. It is surprising that NRAs in the developing world have often chosen to initiate a one-off price cut in order to arrive at cost-based MTRs. This is counter to the experience in Europe where operators have been given time to adjust their prices before cost-orientation is achieved. Given the risks detailed in this paper of setting MTRs based on cost when networks are still expanding into rural areas, we believe NRAs in developing countries should carefully consider how they set MTRs and over what time period they do it.



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