Conceptual approach for the upgraded incremental cost model for wholesale mobile voice call termination

Paper for the Norwegian mobile telecoms industry

1 December 2009

Post- og teletilsynet

Contents

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1 Introduction

Analysys Mason Limited (‘Analysys Mason’) has been commissioned by the Norwegian Post and Telecommunications Authority (‘NPT’) to perform an upgrade of the mobile network incremental cost calculation model originally developed in 2006 (the ‘original model’), in order to take into account recent market developments and prepare a cost-based justification for NPT’s future wholesale mobile termination rate regulation.

Since the development and application of NPT’s existing mobile termination cost model, there have been a number of significant changes in the Norwegian mobile market. In particular:

- 3G networks and services have been established for Telenor and NetCom
- Tele2/Network Norway have launched a joint network infrastructure company (Mobile Norway)
- MVNOs are now offering wholesale mobile termination (at a regulated rate).

In order to assess the potential requirement for further regulation of mobile termination, NPT requires a detailed understanding of the costs associated with the new market situation in Norway. This is to be accomplished by carrying out a set of upgrades and modifications to NPT’s original mobile cost model to incorporate the evolution of the mobile market as well as 3G deployments and services.

The conceptual design applied to the original model and the response from NPT following comments during the consultation process in 2006, along with model documentation, can be found on NPT’s website.[1] NPT issued a final cost model to both Telenor and NetCom in 2006 and has access to the original combined operator model. These materials form the starting point of the current cost modelling work, supplemented by additional activities completed so far in 2009:

- collection of updated demand, network and cost data from Telenor and NetCom

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1 See http://www.npt.no/lric

- implementation of the third network operator in the model, based on the approach of an efficient national 2G+3G business
- extension of the network design algorithm in the model to accommodate next-generation mobile network equipment
- further upgrading of the cost model to calculate additional results, such as MVNO costs, and LRIC versus LRAIC+ costs.

1.1 Project timetable

Analysys Mason and NPT commenced the project to upgrade the incremental cost model in February 2009 with a workshop for the Norwegian mobile industry, followed by a data collection period. Following the receipt of data, Analysys Mason and NPT have worked to incorporate this material into a draft upgraded model. This paper was originally issued as one of three documents, which were provided to the mobile operators in Norway as the *draft model consultation*.

The other two documents of this consultation were:

- the draft upgraded cost model (provided in separate confidential versions to each operator; NPT retains the full confidential model internally)
- documentation of the draft upgraded cost model.

The consultation period ran from 15 June 2009 to 7 September 2009. This paper now includes the relevant conceptual aspects of the operators' submissions, and NPT conclusions.

1.2 Scope of conceptual discussion

In 2006, NPT developed its original mobile cost model through a process involving industry input and a number of consultation stages. The *original cost model* (in its 'final v4' form) was subsequently applied in NPT's proposed remedies to Telenor and NetCom in Market 16 (wholesale mobile termination), which were later upheld by the Norwegian Ministry of Transport and Communications.

This document now sets out the concepts applied in the *revised upgraded cost model (v6),* which will underpin NPT's price regulation of all operators with Significant Market Power in Market 7 (wholesale mobile termination) from 2011 onwards. As such, this model may ultimately apply to any or all of:

- Telenor
- NetCom
- Tele2
- Network Norway
- MVNOs offering mobile termination, such as TDC and Ventelo.

The conceptual issues to be addressed in this document are classified in terms of four *modelling dimensions*: operator, technology, service and implementation, as shown in Figure 1.1.

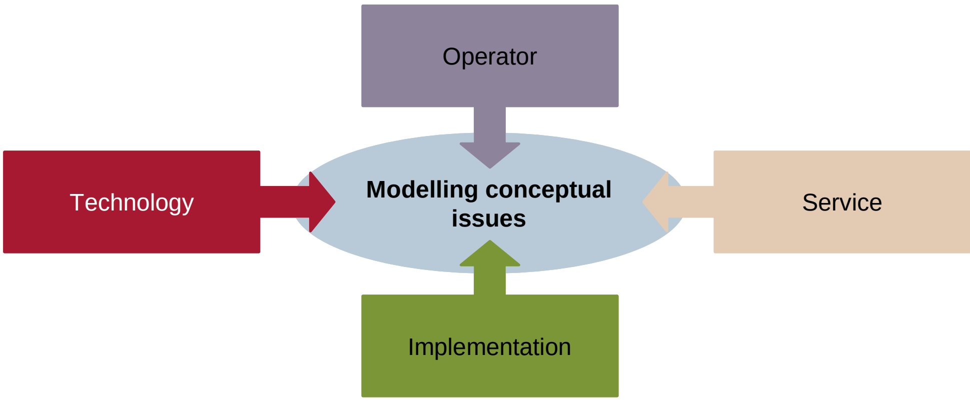

Figure 1.1: Framework for classifying conceptual issues [Source: Analysys Mason]

Operator The characteristics of the theoretical operator that is used as the basis for the model represent a significant conceptual decision with clear costing implications:

- What **structural implementation** of the model should be used?
- What **type** of operator should be modelled – actual operators, or a hypothetical new entrant to the market?
- What is the **size** of the operator(s) being modelled – actual size, average size, or some other hypothetical operator?

Technology

The nature of the network to be modelled depends on the following conceptual choices:

- What **radio technology standard** should be deployed?
- How should **technology generations** be treated: in particular, the effects and existence of migration and other proxies for technology evolution?
- Over time, what is the **extension and quality of network coverage?**
- What is the appropriate **transmission network** type and topology?
- What is the appropriate way to define the number of **network nodes** (radio sites, RSO[2], MSO[3]) and the level of collocation at these nodes?
- What level of **input costs** would be incurred for network elements?
- What **scope of business** do the modelled costs support?
- What is the nature of the **spectrum allocated** to the modelled operator (amount, band and fees paid)?

Service

Within the service dimension, the scope of the services being examined needs to be determined:

- What **service set** does the modelled operator support?
- Are costs calculated at the **wholesale** or **retail** level?

Implementation

A number of implementation issues must be defined to produce a final cost model result:

- What is the **weighted average cost of capital** (WACC) for the modelled operator?
- What **depreciation** method should be applied to annual expenditures?
- What **increments** should be costed?

2 Remote switching offices, containing only BSCs (and no MSCs).

3 Main switching office, containing one or more MSCs (plus various other network switches).

- What **year**(s) should results be calculated for?
- What **mark-up mechanism** should be applied to costs common to the increments?

NPT does not intend to reach a conclusion on *pricing* issues within the process of updating the LRIC model. NPT believes that it would be most appropriate to address pricing issues in a separate process, in conjunction with the market and remedy analyses for Market 7. This will allow all parties to focus on the cost modelling within the current process of updating the model.

1.3 Summary of revised and unchanged conceptual issues from the original model specification

The original model was developed from 17 Recommendations. In the table below we highlight where the principle proposed for the draft upgraded cost model has been revised (and a brief summary of the revision) or where the principle from the original modelling approach is unchanged.

Three principles have been materially revised for the upgraded model, relating to the current status of the market (number of players, inclusion of UMTS and treatment of technologies). In addition, one principle must now accommodate the latest Recommendation of the European Commission (EC) in the area of mobile termination costing; finally, one revision is to re-calculate the WACC.

1. Structural implementation	Unchanged: the upgraded model will be bottom-up and reconciled.
2. Type of operator	**Revised: the approach of actual-operator costing has been extended to *repeat* the actual costing of incumbents Telenor and NetCom, and to *include* a calculation of the costs of a third network operator in Norway. Actual MVNOs will also be included.**
3. Size of operator	Unchanged: the actual size of the incumbent operators in the market will be modelled, assuming long-term convergence in scale. For the third operator, a reasonably efficient size will be

	forecast.
4. Radio technology standard	**Revised: the model will be upgraded to include explicit costing of the Norwegian UMTS networks, including UMTS900 in the long term, but excluding data-focused overlays such as LTE.**
5. Technology generations	**Revised: along with Principle 4 above, the migration of voice and data to UMTS will be modelled. The rate of voice migration today is slower than forecast in the original model, and so actual historical migration will be included along with an updated forecast.**
6. Extension and quality of coverage	Unchanged: for Telenor and NetCom, actual coverage levels will be implemented (updated with latest information), along with a converging forecast of planned total coverage (for both GSM and UMTS). For the third operator, a projection of national coverage will be applied.
7. Transmission network	Unchanged: the model will apply actual transmission networks, ensuring an efficient, modern and standardised approach.
8. Network nodes	Unchanged: the model will adopt actual designs with scorched-node calibration of radio sites.
9. Input costs	Unchanged: actual/average equipment unit costs will be applied.
10. Spectrum situation	Unchanged: actual spectrum allocations will be reflected.
11. Service set	Unchanged: actual voice and data services will be included (updated to reflect UMTS low-speed and high-speed data services).
12. Wholesale or retail	Unchanged: retailing costs will be excluded from the wholesale cost of termination.

13. WACC	**Revised: updated WACC value to be applied.**
14. Method of depreciation	Unchanged: the model will apply the same economic depreciation calculation as in the original calculation.
15. Increments	**Revised: we will re-apply the LRAIC+ method from the previous model, but we will also include a "pure" LRIC approach as now recommended by the EC.**
16. Year(s) of results	Unchanged: the upgraded model will repeat the same full-time series from the original model.
17. Mark-up mechanism	Unchanged: we will apply an equal proportionate mark-up for common costs in the LRAIC+ approach.

1.4 General comments of industry parties to the consultation

A number of operators submitted comments to NPT on the *pricing principles* for wholesale mobile voice call termination. These comments are not reproduced in full in this document. A number of general modelling comments related to process and approach, rather than comments regarding a specific conceptual principle were also submitted.

1.5 NPT response on process, the applicability of NPT's modelling approach and pricing issues

Telenor and NetCom have submitted comments regarding the process that NPT has chosen for updating and extending the LRIC model. In particular, the operators are arguing that there should have been a separate consultation on the conceptual approach for the update and extension *prior* to the consultation on the draft model.

NetCom argues that it is unlikely that comments regarding conceptual issues will be taken into account when such issues have not been subject to a separate consultation. Telenor refers to several aspects of the draft model (e.g. the modelling of a third network operator and the inclusion of UMTS), which in their view implies that the draft model is in reality a *new* model. Consequently, in both NetCom's and Telenor's opinion, there should have been an initial consultation on the conceptual approach.

NPT has set up the process of updating the LRIC model with one major aim in mind: to secure a transparent process with as much involvement of the industry parties as possible. NPT considered it important that all operators should have a comprehensive understanding of how the existing model would be upgraded and what new functionalities would be added. Demonstrating how the proposed principles would play out in practice by sharing a draft version of the model with industry as early as possible was seen as an efficient way to achieve this. Furthermore, the purpose of having two sets of bilateral meetings with the operators, one during the consultation period and one immediately after, was to ensure that the operators were able to make informed comments on the conceptual design *as well as* on the implementation of the proposed principles in the model. Therefore, NPT maintains that conceptual issues have been open for consultation to the same extent as the actual inputs and calculations in the model.

NPT also maintains that it is more appropriate to view this project as an update and extension of the previous LRIC model than the development of a new model.

The concepts of a third network operator and traffic migration from 2G to 3G were present within the previous model. NPT does not consider that adding specific cost calculations for a new network operator and for UMTS technology is equivalent to introducing fundamentally new modelling principles. With regard to the pure LRIC calculation, NPT again considered that it would make the conceptual issues more tangible if the operators were issued with a draft model that demonstrates how the calculation works. As for the other conceptual issues, the question of how the pure LRIC calculation should be applied, has been open for consultation within the process.

Telenor argues that since NPT proposes to model a third entrant operator that does not directly reflect the operations of Tele2 and Network Norway, whereas NetCom and Telenor will be modelled as actual operators, NPT will not have a sound basis for comparing cost differences between the operators. To the same effect, NetCom argues that since termination rates according to the EC

Recommendation[4] would be symmetric, choosing various cost models for various operators is inappropriate.

NPT has carefully selected an approach to modelling the Norwegian network operators and the MVNOs, which is able to support the regulation of termination rates in the next regulation period. The current approach provides NPT with a comprehensive understanding of the cost of termination that the different mobile operators are facing. It allows for a comparison of the development in costs between NetCom and Telenor by applying the same actual operator costing as in 2006. NPT also believes that it is relevant to compare the results of the current model for the established network operators with the results for the third entrant operator as long as the costing base for the third entrant operator is reasonable and representative of an operator that plans to roll out a full national network in Norway.

Finally, NPT would like to emphasize that the question of how the different results from the LRIC model will be used by NPT to set regulated prices in the next decision in Market 7 is outside the scope of this consultation.

At this stage, NPT notes the comments from NetCom regarding the implications of the EC Recommendation and the Ministry's decision[5] for the next pricing decision in Market 7. NPT also notes the arguments from Tele2 regarding the applicability of a pure LRIC calculation in Norway, and the arguments from Telenor regarding the incentive effects of using pure LRIC as the basis for price setting. These issues and other pricing issues will be thoroughly discussed and consulted upon in conjunction with the new draft decision in Market 7.

NPT recognizes that several factors will be important when designing the appropriate price regulation that will take effect from 1 January 2011. These factors will include the Ministry's decision regarding the termination rate for Network Norway and Tele2, as well as the EC Recommendation on symmetric

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[4] http://ec.europa.eu/information_society/policy/ecomm/doc/implementation_enforcement/article_7/recom_term_rates_en.pdf

[5] http://www.npt.no/portal/page/portal/PG_NPT_NO_NO/PAG_NPT_NO_HOME/TJENESTER/PAG_TJENESTER_TEKST?p_d_i=-121&p_d_c=&p_d_v=108875

termination rates. The overall aim of the regulation will be to promote consumer interests by facilitating sustainable competition and encouraging industry development and innovation, cf. Electronic Communications Act § 1-1.

1.6 The structure of this document

In the remaining sections of this document we describe each conceptual issue, explain how each is implemented in the original model, and state whether (and if so how) the issue has been adapted for the upgraded cost model now under consideration.

- Section 2 deals with operator-specific issues
- Section 3 discusses technology-related conceptual issues
- Section 4 examines service issues
- Section 5 explores implementation-related issues.

2 Operator issues

This section describes the choice of operator model in terms of construction, type and scale.

2.1 Structural implementation

There are two main 'directions' for modelling the costs of the mobile network operators: bottom-up or top-down modelling. There is also a third alternative: a combined approach (usually called a hybrid model) can be adopted in which the bottom-up model usually 'leads' the calculation, and the top-down model supplies complimentary and valuable reference data points. It is necessary to define the modelling approach at the beginning of the project, prior to the collection of data, since this choice determines what will eventually be possible with the model – e.g. cross-comparison of operator data, investigation of alternative hypothetical operators.

The advantages and disadvantages of bottom-up and top-down modelling are highlighted in Figure 2.1 below. Of particular importance to NPT at its current stage are the three benefits that a hybrid modelling approach brings to NPT and its future price-setting activities.

Costing implications

Developing an understanding of the costs of the different mobile operators in the Norwegian market can be achieved by being able to model, and parameterise, operators' networks and demand differences within a common structural form (i.e. a bottom-up model). A bottom-up model also has the benefit that it can be issued to industry parties, including non-mobile operators, if the model is adapted to remove confidential information from the circulated versions. This transparent circulation facilitates industry discussion of the approach taken to demand and network modelling. In addition, operator-specific models can be discussed bilaterally with each mobile party.

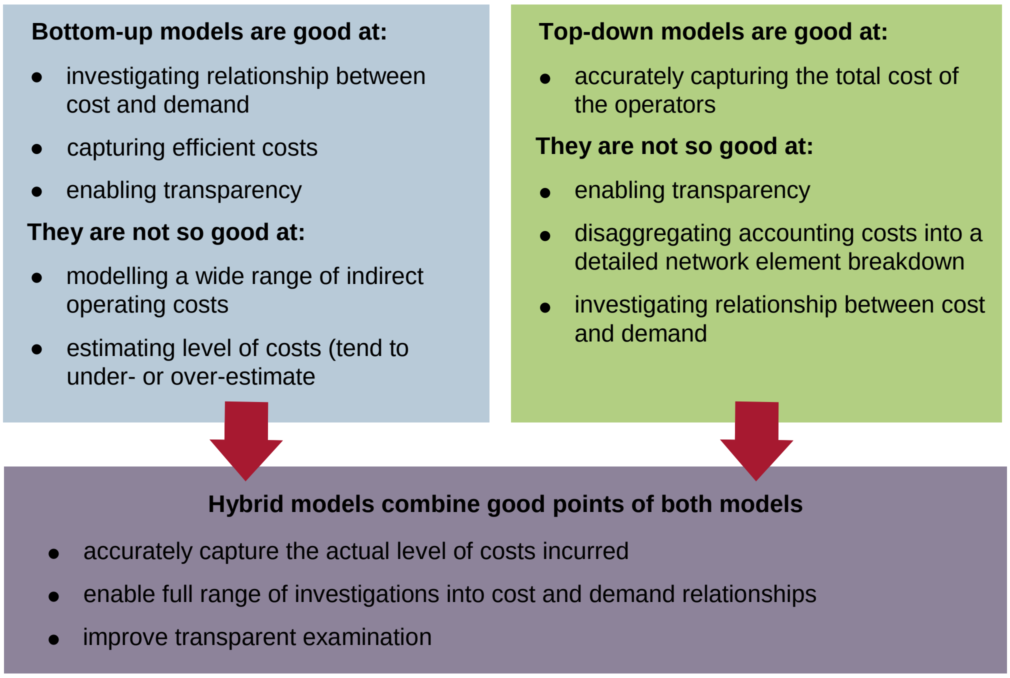

Figure 2.1: Features of bottom-up, top-down and hybrid models [Source: Analysys Mason]

In order to make appropriate decisions regarding price regulation for the Norwegian market, NPT will need to understand the actual costs that each operator faces. Although a top-down model can produce actual costs, it lacks the ability to explore operator differences with certainty or transparency.

Therefore a hybrid model is most likely to satisfy NPT's requirements to:

- achieve industry 'buy-in' to the approach
- provide reassurance to the operators that the model replicates not only their networks, but more importantly their overall costs
- enable accurate understanding of operator cost differences
- have a tool that can be used to explore price-setting issues.

A hybrid model demands information from market parties on both network and cost levels. However, the information demands for a hybrid model are only marginally more extensive than would be needed for just a bottom-up or top-down approach.

NPT believes that bottom-up data will be relatively straightforward to source from operators' management information (e.g. demand levels, network deployments, equipment price lists), and top-down data should be available from financial accounting departments, usually with some requirement for pre-processing stages.[6]

Approach in the upgraded model: unchanged

NPT believes that the modelling approach that will deliver the most benefits and relevant information for its costing and price-setting activities will be a hybrid model, 'led' from the bottom-up direction. This bottom-up led hybrid model essentially means that the top-down part of the hybrid model is less onerous for all parties, and refined for the purpose of being used as inputs to a bottom-up model:

- It is not necessary to construct stand-alone, top-down models capable of full service costing and depreciation (since the bottom-up model is capable of this).
- The model and industry discussions are not hindered by opaque and confidential top-down calculations (since the bottom-up model can be discussed more freely with market parties).
- The top-down 'model' can be condensed to simply a presentation of suitably categorised top-down accounting data, against which the bottom-up model can be reconciled.

Figure 2.2 illustrates the structural overview of the expected hybrid model.

The elements contained in the model are:

- **demand inputs**: market subscribers and traffic

6 For example, separation of fixed and mobile costs, or identification of dedicated 3G expenditure.

- **network design parameters**: busy-hour factors, coverage parameters, switch capacities, network topology, etc.

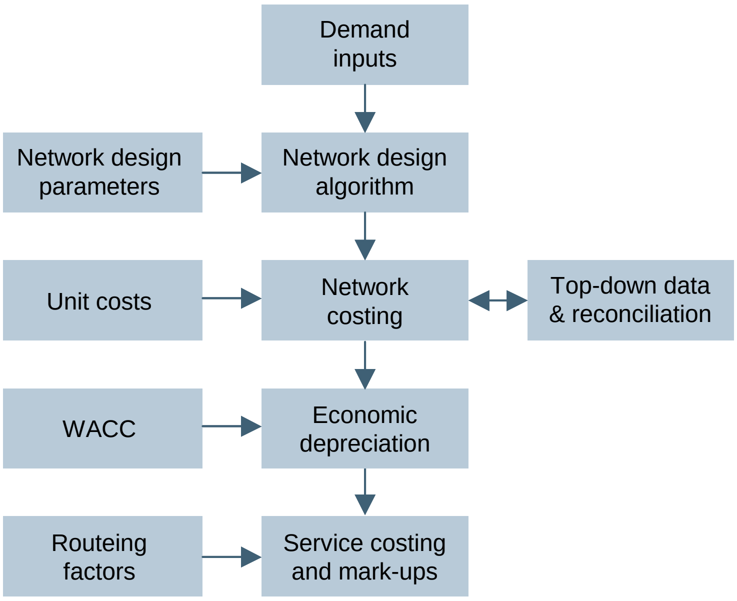

Figure 2.2: Structural overview of the expected hybrid model [Source: Analysys Mason]

- **network design algorithm**: calculation of network element requirements over time
- **unit costs**: modern-equivalent asset input prices for network elements, indirect costs, business overheads and cost trends over time
- **network costing**: calculation of capital and operational expenditures over time
- **top-down data and reconciliation**: categorisation of operators' top-down data and the activity of reconciling this with the calculated bottom-up expenditures
- **WACC**: discount rate
- **economic depreciation**: annualisation of expenditures according to defined economic principles, or other depreciation method
- **routeing factors**: average resource consumption inputs
- **service costing and mark-ups**: calculation of per-unit long-run incremental costs, plus common-cost mark-ups.

Principle 1, unchanged: Develop a bottom-up cost model reconciled against top-down accounting data, resulting in a hybrid model.

2.2 Type of operator

The choice of operator type to be modelled will eventually feed into NPT's decision on pricing for suppliers in Market 7. However, the choice of operator type for cost modelling purposes, as outlined here, does not preclude NPT from adopting an alternative basis for pricing. As a result, this costing and pricing conceptual issue has been separated into its constituent *costing* and *pricing* parts. This section of the conceptual approach refers to the type(s) of operator to be costed in the model, and industry parties should focus their responses on the costing aspect.

The main options[7] for operator type are outlined below.

- **An actual operator**: this reflects the development and nature of an actual network operator over time, and includes a forecast evolution of the operator in order to develop long-run costs. This type of model will aim to identify the actual costs of the operators being modelled, and should result in the most accurate quantification of the operators' cost differences. An operator-specific, top-down reconciliation can be carried out with this type of model. This type of model can also be used to reflect average or hypothetical operators, by adjusting various input parameters.

- **An average operator**: by adopting an average operator approach, the cost model will merge inputs, parameters and other features of actual Norwegian network operators to form an average operator cost model. As a result, it may be harder to explore, identify and quantify the cost differences between the network operators, and reconciliation of a bottom-up model against top-down data must be carried out at an average level.

- **A hypothetical operator**: this type of model aims to generate only the cost level which would be achieved by a hypothetical operator in the market, usually a hypothetical **new entrant**. As such, this type of model is focused on defining the demand inputs, network design and cost levels that the hypothetical operator would experience, and therefore determines the cost base of the hypothetical operator. Because of the hypothetical nature of this model, it is more difficult to

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7 Note that all these options have been selected by regulators in various jurisdictions: *Actual* in Sweden, *Average* in the UK, *Hypothetical* in the Netherlands.

explore and quantify the differences between each actual operator's costs and the hypothetical set-up. Top-down reconciliation of a bottom-up model must also be carried out in a discontinuous[8] manner.

Costing implications

The choice of operator type affects two main outcomes of the modelling work:

- the level of understanding NPT can gain on the costs of each actual network operator (and in particular differences in costs between operators)
- the ability of the model to cope robustly with alternative operator choices when it comes to determining the operator specification and network specification of cost-oriented mobile termination prices.

Approach in the upgraded model: revised to include third entrant and MVNOs

At the start of the current project, Analysys Mason was aware of the presence – and increasing network deployment – of the third mobile operator in Norway, Mobile Norway (which incorporates the mobile activities of Network Norway and Tele2). Mobile Norway, Network Norway and Tele2 were invited to the industry process as mobile network operators, and issued with a data request similar to that issued to Telenor and NetCom in the original project. The objective was to establish the long-run cost of traffic (and mobile termination) on Mobile Norway's network. Since the start of the project, we have had two meetings with the combined group of Tele2, Network Norway and Mobile Norway, and separate meetings with Tele2 and Network Norway, to discuss data collection and modelling of their network.

Based on our meetings with the combined group, we understand the nature of their operations and network deployment. We also understand their scale and position relative to their larger incumbent competitors Telenor and NetCom.

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8 That is, a bottom-up hypothetical operator model will not reflect every relevant historical parameter for the actual operators, and therefore cannot produce a comparable set of accounting data to compare against reality.

Given the current situation, we have considered whether it is realistic to attempt to model Mobile Norway as an "actual operator". In our experience, it is likely that this calculation would be subject to considerable uncertainty: sufficient operator data may be unavailable, or may lack the scale and accuracy of data for Telenor and NetCom. Furthermore, the calculations for the third operator will essentially be based on limited actual data, two parallel confidential and potentially different data sets (e.g. due to varying optimism regarding market performance), plus projections for all other aspects of its operations.

As such, we propose to extend the third operator from the original v4 model into one full network design and cost calculation. Therefore the model will contain:

Three national infrastructure players, with separated market shares (reaching 33% each): Telenor, NetCom and a third operator. This approach is an extension of the original model to fully populate the third entrant slot which was already incorporated in the original model, and to include the MVNO parties as distinct cost entities carried by the three national network operators.

In this proposed alternative approach we will develop a *full national third operator* cost model to apply to Mobile Norway. Telenor and NetCom will remain modelled with their *full national incumbent operations*. This third operator model can also be shared with all parties; it would rely on standardised and averaged network, demand and cost parameters.

The *retail and network* share profile of the third entrant in the original model (growing slowly from 0% share at launch) does not appear comparable to the actual third entrant in Norway – that of Tele2 and Network Norway, who have a combined retail market share of around 15% today. Therefore, the network share of the third national network operator will grow according to the rate of transfer of Tele2 and Network Norway retail subscribers and demand to the third network. We do not consider that *immediate* transfer of the Tele2 and Network Norway retail market subscriber base to the third operator is reasonable as the third operator's own network will not provide full national 2G and 3G coverage *at launch*), therefore we shall estimate the rate of transfer to the third entrant on the basis of its network population coverage and the 2G-to-3G migration rate of subscribers in the market.

MVNO operations will be modelled as a functional separation of activities provided by the fully integrated network operators (Telenor, NetCom and the third operator) in line with the smaller scale of MVNOs such as Tele2, Network Norway, TDC and Ventelo.

The complete full national third operator model will be sharable with all network operators. This approach increases transparency as it reduces the influence of hidden information in the costs that is visible only to NPT – these parties will be able to observe the same model inputs and cost estimates.

In order to develop operator-specific costs, a logical separation of operator-specific inputs will be required (although structurally the inputs can be located in the same or similar spreadsheet). This separation is illustrated in Figure 2.3.

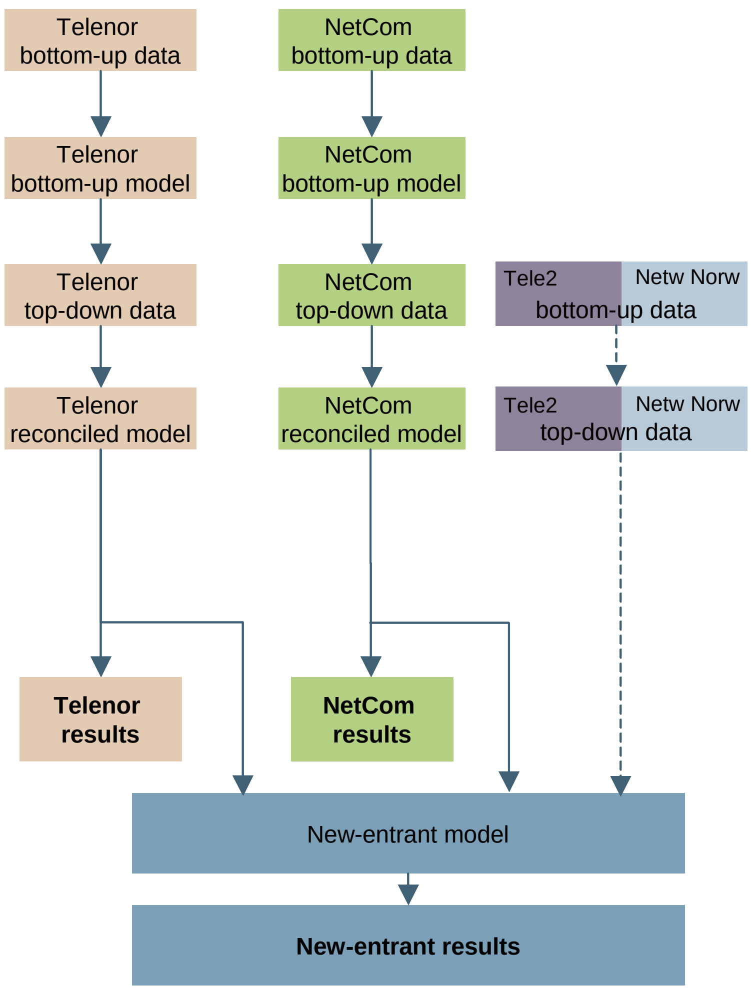

Figure 2.3: Logical separation of operator-specific models [Source: Analysys Mason]

Principle 2, revised: Adopt an actual operator costing for Telenor and NetCom, which can accurately determine the costs of each actual network operator and robustly explore individual cost differences between these two mobile operators. The model will also be populated to calculate the costs of a third national operator in Norway. This third operator should be applicable to Mobile Norway as the third infrastructure operator. Actual MVNOs will also be included.

2.2.1 Operator submissions and NPT response

Telenor

Telenor has submitted comments to NPT's suggestion to model a hypothetical national new entrant, but we cannot see that NPT has taken any of Telenor's comments into consideration. For the credibility of the entire consultation process it is important that NPT seriously considers the comments and proposed amendments from Telenor and other stakeholders.

Telenor will repeat that we disagree with NPT that actual operator costing for NetCom and Telenor is the correct approach.

In principle 2, NPT says that they want to "Adopt an actual operator costing for Telenor and Netcom, which can accurately determine the cost of each actual network operator and robustly explore individual cost differences between these two operators." In 2006 NPT adopted an actual operator costing for Telenor and NetCom, and the outcome was that there was no significant cost differences between these two mobile operators. Therefore it is no reason to repeat operator specific models for Telenor and NetCom.

As Telenor understands, NPT's main objective for this LRIC modelling is to uncover cost differences between the operators in the Norwegian mobile market. This is for instance expressed on page 9 in the conceptual approach document: *"In order to make appropriate decisions regarding price regulation for the Norwegian market, NPT will need to understand the actual costs that each operator faces."*

NPT proposes to model a hypothetical new entrant operator for Mobile Norway (the third operator) and operator specific models for NetCom and Telenor. If NPT uses different approaches for the different operators they will lose the basis of comparison.

Since the proposed modelling approach will not form a basis for exploring cost differences between operators, the obvious implication is that NPT should focus on developing a single model for a hypothetical efficient operator which can form the basis for regulation of all operators.

NetCom

It is still being difficult to understand why there cannot be established a model specifically designed for Tele2/Network Norway. NetCom also finds that different models for the various operators cannot give NPT a sufficient basis for making decisions as to whether differentiating when the price adjustment should be modelled.

Referring to the first-mentioned, we refer to NetCom's last reply in which the operators were given the opportunity to comment on the question as to which model that should be prepared for Tele2/Network Norway. Beyond referring to the meetings between Tele2/Network Norway there is still no satisfactory argument for why it is not possible to establish a model specifically designed for them. That the result from such model for Tele2/Network Norway should be burdened with considerable uncertainty, cannot be a decisive argument, taking into account that [in their view] the model results for Telenor and NetCom could also not be considered secure.

Regarding the latter, NetCom also questions why different models are being developed when the EU Commission has clearly stated that asymmetrical termination rates for newcomers are only acceptable in a transition period of 4 years after entering the market, and that symmetric termination rates in any case must be obtained within the end of 2012. If this recommendation should be complied with, this means that Network Norway's transition period must be effected during 2011.

In this connection NetCom would like to refer to the Commission's decision regarding IT and Telestyrelse (NITA) of 27 August 2009, in which NITA is instructed to carry out a new market analysis so that maintenance of asymmetrical adjustment of the termination rates could be adequately substantiated. The basis for the order was the NITA had granted Hi3G higher termination rates without having given an explicit argument based on objective cost differences. We expect that NPT will be consistent with respect to the EC Commission's recommendation, and does not only comply with parts thereof, e.g. like pure LRIC.

See Section 1.5 for NPT's response on process, approach and pricing.

At the outset of this process in February 2009, Analysys Mason expected to model Tele2/Network Norway's actual network operations business. After a number of subsequent meetings with Tele2, Network Norway and Mobile Norway, Analysys Mason and NPT came to the joint conclusion that to model the actual third operator would be problematic for the robust calculation of its costs. In May 2009, a short note was issued to the operators outlining this situation, as well as the proposition of modelling a third entrant operator, which was not reliant on specific alignment with the Mobile Norway network or business operations. Analysys Mason and NPT consider that this proposition has resulted in a model that is based on stable principles and parameters with which to calculate the third operator's costs. Consequently, we consider our approach to be reasonable and one that sets a suitable economic costing base for a third entrant operator that is in the process of rolling out its network.

TDC

MVNO Radio Access Due to our agreement with Telenor we have both a fixed and traffic related (per minute) fee paid to Telenor. This radio access fee is traffic related cost and should be included in the model in the same way as the access cost for the MNO, Telenor and Netcom.

We request that access related cost should be included in the model for MVNOs. We would like to emphasise that if the MVNO access cost is left out of the model we need assurance from NPT that this will be taken in to account in the market 15 regulation. A price regulation of Market 15 is a minimum to prevent margin squeeze.

See Section 1.5 for NPT's response on process, approach and pricing. The 'v6' model allows direct access costs (e.g. MVNO or NR access charges) to be added to the per minute final cost result. However, setting prices (on the basis of the operator's *own cost or own plus access cost*) is considered by NPT within its Market 7 pricing decision.

2.3 Size of operator

One of the major parameters that defines the cost of an operator is its share of the market: it is therefore important to determine the evolution of the market share of the operator over time. In addition to share measured on a subscriber basis, we also include the volume and profile[9] of traffic that the operator is carrying within this conceptual issue.

Costing implications

The parameters that are chosen to model operator market share over time have a strong effect on the overall level of economic costs calculated by the model (in a mobile network, share of traffic volume is more significant than share of subscribers). These costs can change significantly if short-term economies of scale (such as network roll-out in the early years) and long-term economies of scale (such as fixed costs of spectrum fees) are fully exploited. The more quickly the operator grows[10], the lower the eventual unit cost will be.

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9 By profile, we are referring to the proportion of calls to/from various mobile and fixed destinations and the time-of-day profile.

10 Strictly the net present value of demand – therefore reflecting the discounted combination of eventual share and the rate of acquiring that share.

Approach in the upgraded cost model: unchanged

The retail *and* network share defined by NPT in the original model (see Figure 2.4) assumed that the long-term mobile infrastructure players in the market would be Telenor, NetCom plus a new entrant from 2008.

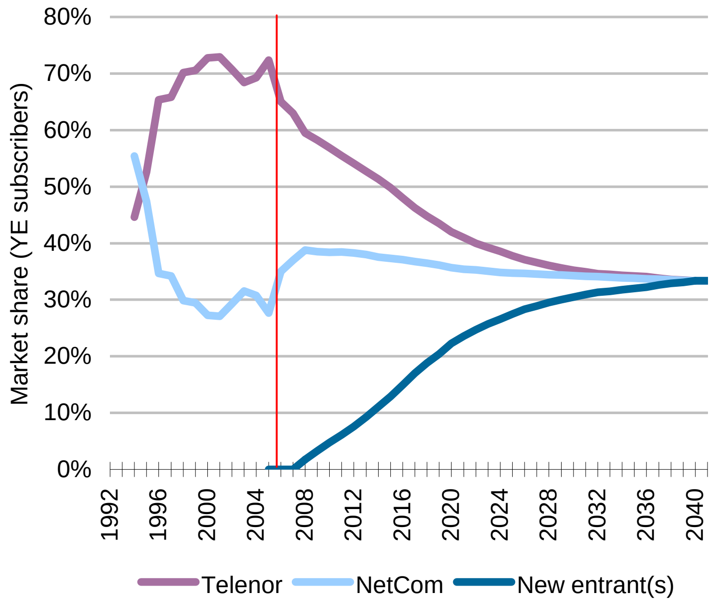

Figure 2.4: v4 retail and network market share forecast [Source: Analysys Mason]

Therefore, for the upgraded model, NPT intends to update this market share forecast with actual data to the end of 2008, and revise the projection based upon established MVNOs Tele2 and Network Norway forming the starting point for the new-entrant network operator.

Principle 3, unchanged: Consistent with Principle 2, the actual size of the two incumbent infrastructure operators should be modelled according to historical market development and including a forecast size for each operator. The scale of the third operator will also be forecast. It is expected that this forecast market development will reflect both subscriber and volume equalisation at some point in the future[11]. NPT will also consider the likelihood of a fourth UMTS infrastructure player entering the market in the

11 This equalisation is parameterised in the demand model.

near future, and whether any demand scenarios are relevant for exploration in this respect. The actual scale of MVNOs will also be modelled.

2.3.1 Operator submissions and NPT response

Netcom

NetCom has previously stated that the model premise regarding future tri-partition of the market is unrealistic. The assumptions of the model regarding anticipated market development are burdened with considerable uncertainty. Experience from the present adjustment period clearly shows that the anticipated market development has not been in coherence with the actual development where Telenor has managed to uphold their market share, and where newcomers have had a significantly higher market share than pre-supposed.

NetCom's network share of traffic during the period 2006–2008 was in excess of 33.3%. As such, a tri-partition of the market applied to NetCom implies that its market share will remain broadly constant in the long term. A third network operator is now launching from an MVNO base of 15% retail share, with a growing share of its traffic carried on its own network.

NetCom's suggestion that retail shares will remain static can be approximately quantified by a retail market distribution of:

- 55% Telenor
- 30% NetCom
- 15% Third operator.

NetCom's cost of traffic (termination) is largely insensitive to the difference between a 33.3% or a 30% market share in the long term, since the difference between the two forecasts in discounted terms is small. At only 15% long-term retail share, we consider that the third entrant operator business model requires a sub-national mobile network, since this retail share is insufficient to support a full mobile network roll-out. Even at this level of scale, a third operator may need to develop significant efficiencies elsewhere in its business in order to be reasonably competitive against the larger players NetCom and Telenor. It is worth noting that the EC refers to a 20% *minimum* efficient scale in its recent Recommendation on mobile termination costing. Finally, a sub-national operator would be required to rely on national roaming for a material proportion of its traffic – this would increase the effective **network** share of either, or both, Telenor and NetCom above 55% and 30% respectively. Telenor's costs would be calculated to be slightly lower if it were to maintain 55% of traffic on its network.

Consequently:

- a third national operator with a high cost arising from a static (e.g. 15%) retail share and a full national network would not be efficient or economic
- NetCom's costs are only marginally influenced by differences in its market share forecast around the 30–35% range.

Tele2

In principle 3 it is assumed that Norway will get three operators all with a 33% market share by 2020. For Tele2 it is unclear what the basis for this assumption is.

If we compare with Sweden, the market share there has been stable, even if there is 4 MNOs competing. The market shares have for years been stable approximately around the following levels:

Telia 40%, Tele2 30%, Telenor 20%, 3 10%

In order for the Norwegian market to achieve three operators with 33% there has to be significant shift in market share, compared to the market share in the mobile market today. Tele2 is of the opinion that NPT is too optimistic, when they predict that there will be three operators with 33% market share by 2020. Since "3" also has a UMTS license it would be appropriate also to make an assumption as to which market share this fourth operator will have in the mobile market in 2020.

It would be more correct to apply a more conservative approach as to whether or not it is likely to achieve big shifts in the market share in the mobile market in Norway. And the LRIC model should be constructed in order to accommodate a more conservative approach.

The entry of 3 into the Swedish market can be considered a relevant comparator for the third operator in Norway. Contrary to Tele2's suggestion, 3's share of the retail market has grown slowly but steadily (to approximately 10% as stated above) in its six years of operation. In Sweden, 3 does not offer the same level of coverage as market leader TeliaSonera, as similar to Norway, the investments required to cover very remote populations are considerable (and 3 has not yet made these investments in Sweden). The third-largest operator in Sweden, Telenor, also offers lower area coverage compared to TeliaSonera.

The third entrant operator in the Norwegian market has a pre-existing retail share profile that also reaches 10% retail share after around six to seven years of *retail* MVNO operation. This is consistent with the fourth entrant in the Swedish market, and could be considered conservative given the extra player competition present in Sweden compared to Norway. However, it should be noted that there are three major differences between 3 in Sweden and the third operator in Norway:

- in the Norwegian model, the third entrant operator rolls out full national coverage to match the full coverage extent of the existing players. On this basis, it should have an equal opportunity to compete for all subscribers irrespective of geography or coverage, and without the long-term reliance on national roaming provided by a competing incumbent operator

- in Norway, the third entrant already has a significant retail presence from MVNO activities (around 15% market share of subscribers) prior to network launch. Therefore, the third entrant operator in Norway has immediate access to a 15% market share as its own network is deployed

- Tele2 and Network Norway are allowed to retain asymmetric termination rates.

In the event that the third entrant operator would not achieve an equal share of the market (33%) in the very-long term, then we would consider it reasonable and economically justifiable for the third entrant operator to only roll out its network to a subset of national coverage compared to the larger operators Telenor and NetCom. This “sub-national” third entrant operator would then have lower coverage commensurate with its lower market share and a small, residual reliance on national roaming.

In support of this position, we illustrate the costs of terminated traffic for two different networks:

- the modelled full national third network operator which eventually moves all of its traffic onto its own network, and slowly acquires a 33.3% share of the market

- a sub-national mobile operator providing around 75% coverage whose retail market share is limited to 25%. This operator does not move all of its traffic onto its own network (because it does not have national coverage) and carries a network share of 19% of traffic (19% = 25% x 75%).

The LRAIC+ termination costs of the sub-national operator are approximately NOK0.01 higher than the full national operator until 2011. The sub-national operator has similar costs from 2012 to 2014, and slightly lower costs in the long-term. Consequently, we consider that a smaller share, sub-national network third operator would have approximately the same level of costs over time as the modelled full national operator.

3 Technology issues

In this section we describe the technological aspects of the model: radio technologies and generations, network coverage and transmission topology, scorched-node calibration, equipment unit costs, and the spectrum of the modelled operators.

3.1 Radio technology standard

Mobile networks have been characterised by successive generations of technology, with the most significant progress being the transition from analogue to digital (GSM), and currently a migration to UMTS. The ultimate objective of this model upgrade project is to understand the costs of both GSM and UMTS.

There are four main options for the radio technology standard, which are explicitly included in the model:

GSM only — This approach attempts to construct cost estimates based on the mature current technology, which is then assumed to remain in operation in the long run. A GSM-only approach can be considered conservative because it may not reflect any productivity gains that might be expected from a move to next-generation technology – although proxy treatments for the next generation can be suitably applied to the GSM-only construct.

Including analogue in past years — It is possible to make allowances for higher-cost (but nevertheless valid) technologies in earlier years – such an allowance would involve calculating technology-specific costs and producing a weighted average cost per terminated minute (reflecting the balance of minutes carried on analogue and GSM). However, analogue services are no longer offered in Norway, and so the weighted average cost would not take into account an analogue component, and efficient forward-looking costs will be unaffected by historical analogue operations.

Including UMTS

Including UMTS explicitly adds complexity and model detail, and may produce a lower eventual cost estimate in the situation where voice termination costs are migrating to a lower-cost UMTS technology. The bottom-up model is significantly more complex as a result of including UMTS and will require additional supporting top-down cost data for UMTS.

Including advanced technologies in future years

Today's UMTS networks are characterised by active (but evolving) high-speed data services (HSDPA and HSUPA). In the coming years, two additional UMTS technologies may be deployed in Norway:

- UMTS900, which utilises re-farmed 900MHz frequencies to provide wider area coverage than can be achieved with the current 2100MHz UMTS frequencies

- LTE deployments at 2600MHz – this technology requires a new air interface to be deployed (as well as new user equipment). However, once deployed, this technology will allow both significantly increased data traffic throughput and *proper*[12] mobile voice over IP.

From the perspective of mobile termination regulation, the modern-equivalent technology should be reflected – that is, the proven and available technology with the lowest cost over its lifetime. Twenty years ago, the modern-equivalent technology for providing mobile telephony was analogue (NMT).

At the time of the original cost modelling work in 2006, NPT considered that GSM was primarily the efficient technology for providing voice termination. Currently, all Norwegian mobile networks provide both GSM and UMTS voice and data services, and migration of traffic from GSM to UMTS is proceeding in some way. All UMTS networks in Norway offer HSDPA services as standard.

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12 That is, LTE mobile handsets will not have a circuit-switched LTE transmission mode, and voice will be carried over the air interface as packetised IP traffic.

Costing implications

The implication of developing a model that includes UMTS is the increase in model complexity and range of model results. Including analogue technology in a cost model used to set prices in 2011 and onwards does not satisfy modern-equivalent efficiency standards. The inclusion of future UMTS technologies, such as UMTS900 and LTE, may reflect one possible evolution for the mobile operators, but will further increase complexity in the model and influence the results only to the extent that these technologies have implications for the costs of voice traffic.

Approach in the upgraded model: revised to include UMTS

NPT adopted a GSM-only calculation in the original v4 model. This approach included migration off GSM (see Figure 3.1) and the cost impact of retaining parts of the GSM network (e.g. radio sites) in operation until the entire network was closed down.

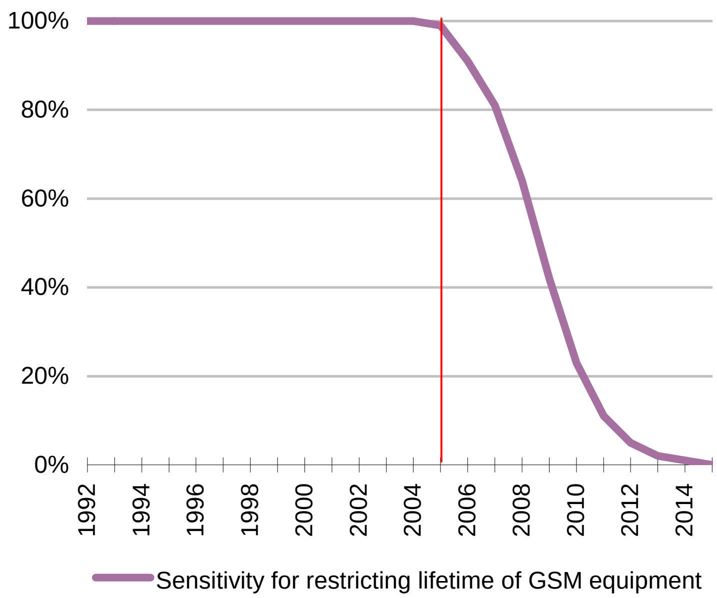

Figure 3.1: GSM recovery profile under the finite GSM recovery scenario in the original (v4) cost model [Source: Analysys Mason]

Now that a measurable proportion of voice traffic is being carried by UMTS networks in Norway, NPT considers it appropriate to include this technology in the model. Therefore, we consider that a combined GSM and UMTS network including migration is likely to present an efficient mechanism for delivering voice traffic and wholesale mobile termination over the next few years. The migration situation for the third operator may differ somewhat from that of the incumbent mobile operators – this will be explored by NPT in the model.

In a large geographical market such as Norway, UMTS900 will be an important technology for the future: it will be necessary for extending the coverage of advanced (UMTS) mobile services across the entire country and replicating the level of GSM 900MHz coverage (required in the event of the legacy GSM networks being shut down). Therefore, if second-generation mobile services will eventually be replaced with third-generation networks, we envisage that UMTS900 will be deployed extensively in rural Norway. Consequently, we think it is necessary to include UMTS900 within the model.

Fourth-generation mobile technologies such as LTE may be deployed in the medium term in Norway. However, these networks are focused on delivering higher-rate mobile data services. The expected spectrum band (2600MHz) is also high frequency which makes it less suitable for wide area or widespread mobile deployments – this is particularly the case if lower-frequency 2100MHz and 900MHz UMTS networks are available. Given the large capacity available in a modern UMTS networks, a fourth-generation overlay is unlikely to be used to deliver large volumes of wholesale mobile voice termination in the short to medium term. Therefore, we propose that the model will exclude LTE technologies and the additional traffic which they will carry.

The unit costs of wholesale termination on the modelled mobile networks will therefore be based on blending together GSM and UMTS costs over time according to the traffic mix between these two technologies.

Principle 4: Use a model which reflects the operator's actual GSM and UMTS networks from 1993 onwards. The model should contain actual GSM traffic and subscriber volumes and reflect the prices paid for modern-equivalent GSM equipment in each year. The model should also contain existing UMTS subscribers, traffic, HSPA data and network equipment, since all Norwegian mobile operators are using UMTS network infrastructure. The rate of migration from GSM to UMTS will be projected from the latest actual status of the mobile operators. Deployment of UMTS900 is anticipated in the situation that GSM networks are shut down. LTE traffic and networks will not be modelled.

3.1.1 Operator submissions and NPT response

Telenor

> Telenor disagrees with NPT in their approach to deal with technology generations. As we understand, NPT has made separate models for each technology generation and then blended together the unit costs for MTR. A more appropriate approach, as we see it, is to model the technology generations in the same way as GSM 900 and GSM 1800 were dealt with in the previous model. In Telenor's view, technology choices should be endogenous in the model and be based on characteristics of equipment at given points of time. Then the output of the model will be one single MTR. This approach will be in accordance with the operators' network rollout.

In the previous model, GSM 900 and GSM 1800 were not distinguished – their expenditures and traffic were amalgamated. However, GSM in general was distinguished from next-generation (UMTS) technology, by the application of a rapid migration profile off 2G. Consequently, the previous model took the view that the overall cost of termination was a blend of the calculated 2G cost and an un-calculated 3G cost (implicitly equal to the 2G cost).

GSM 1800 and GSM 900 equipment can be considered as identical (and was modelled as such in the previous calculation):

- they both carry identical services: voice, SMS and GPRS data
- their technical capacities are identical (1TRX = 8TCH)
- they are jointly supported by backhaul links, BSC and MSC switching.

UMTS equipment in use by the mobile operators differs significantly from GSM equipment:

- new services are supported by UMTS: release 99 data, and particularly HSPA data megabytes

- technical capacities and characteristics are quite different: e.g. soft-handover exists in 3G networks, frequency re-use is equal to 1, higher coding rates support HSPA traffic
- separate RNCs support the UMTS radio access network.

Therefore, Analysys Mason and NPT consider that the model is more transparent and more accurate as a result of treating GSM and UMTS technologies separately. In particular, estimating the relevant MEA price trend reflecting capacity/technology improvements across subsequent generations of technology is particularly difficult.

3.2 Treatment of technology generations

Modelling a single technology network in a long-run cost model provides a simplification of the multi-technology reality. Mobile network generations are only expected to remain valid for a finite number of years – a long-run cost model effectively makes predictions of parameters in perpetuity. Therefore, as operators manage the migration of demand and subscribers from one generation to the next, so too can a LRIC model make corresponding parametric assumptions.

Costing implications

Three particular areas appear most significant in the context of mobile termination costing:

Migration of traffic	The migration of traffic from one network to another affects the output profile produced by the network assets of each technological generation (see Figure 3.2). This changes the level of unit costs over time for each generation, irrespective of depreciation method[13]. The long-run cost from a single technology that can be operated in perpetuity will be lower than the long-run cost of a technology with a finite lifetime (provided there are assets which have a higher lifetime output[14]).

13 Although, of course, the choice of depreciation method determines *when and how* unit costs change as a result of migration.

14 Which is likely to be the case, if there are long-lived assets which are technology specific (e.g. a licence fee).

However, a single technology model will not necessarily capture any productivity gains from moving to the next technology, such as higher system capacity or greater service demand. Therefore, a single-technology, long-run cost may be higher than the blended average cost from improving generations of a mobile cellular technology.

What is important from a cost modelling perspective is to understand the implications of modelling a single technology network and single technology demand for the level and timing of cost recovery when contrasted with the multi-technology situation faced by real mobile operators.

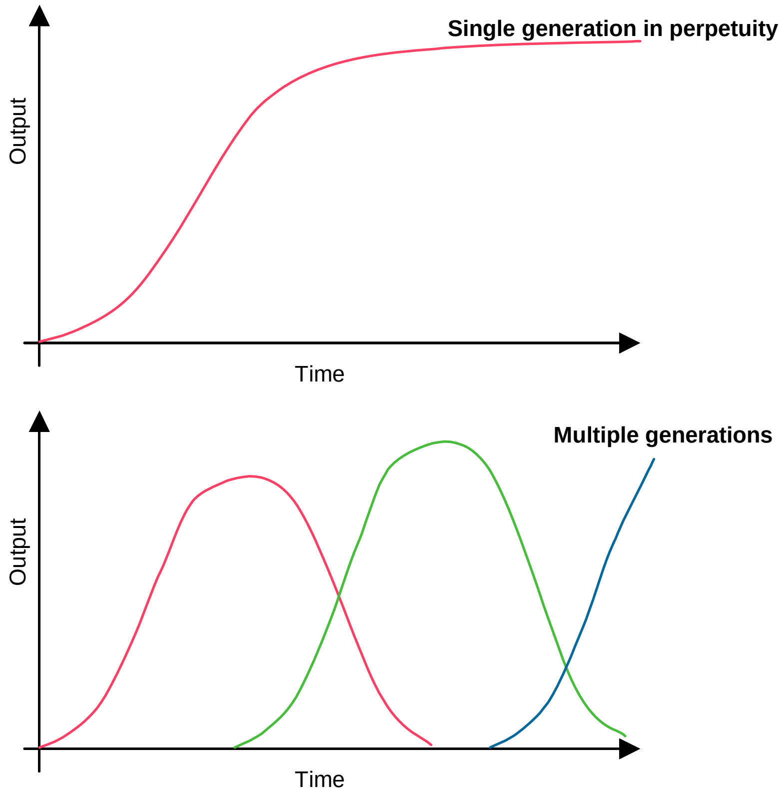

Figure 3.2: Possible output profiles [Source: Analysys Mason]

Proxies for change

Proxies for factors that change from one generation to the next may be applied in a cost model to mimic the effects of successive technology generations. As introduced under 'migration of traffic' above, successive generations of cellular technology can be expected to have measurable output rises[15]. Also, the cost per unit of capacity is likely to reflect continued technological improvement[16]. The nature of these demand and cost proxies is illustrated in Figure 3.3.

The key issue for a LRIC model is consistency: modelling continual levels of demand growth without technological evolution (and vice versa) would appear to be inappropriate.

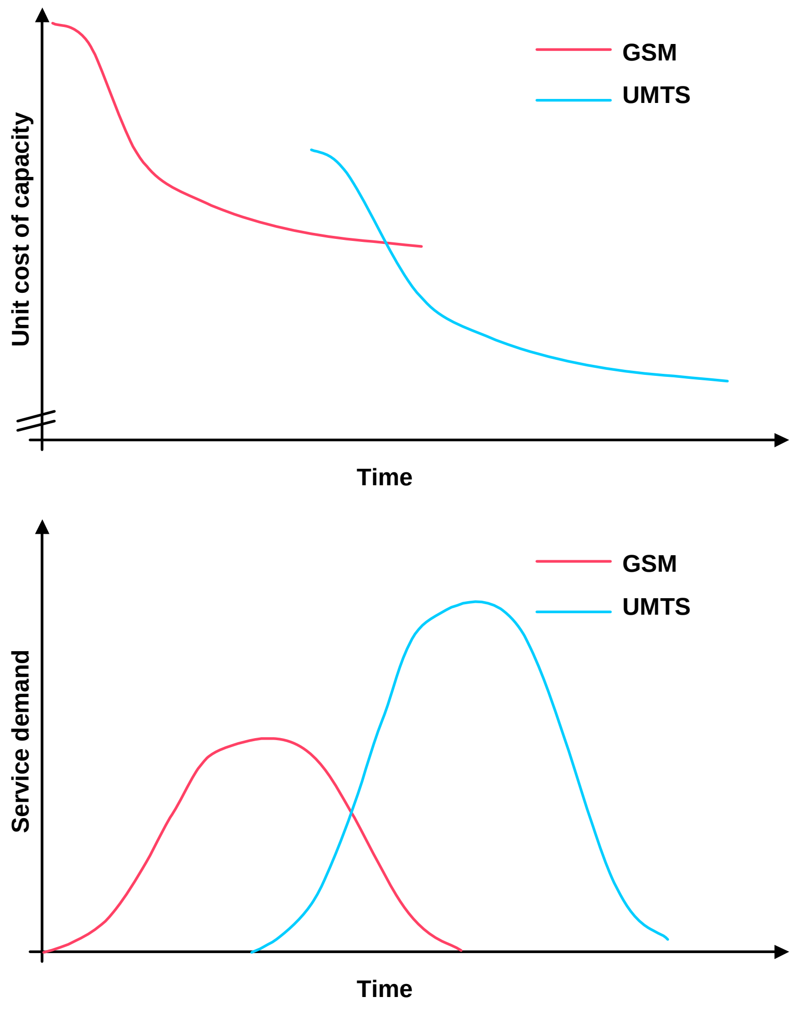

Figure 3.3: Demand and cost proxies for multiple generations [Source: Analysys Mason]

Economies of scope

A number of network and non-network costs will effectively be shared by successive generations of technology – in these instances it will be possible to extract the same (or greater) utilisation from an asset irrespective of the rate or existence of

15 This has been observed for analogue to GSM, and is expected for GSM to UMTS.

16 For example, analogue to digital, TDMA to W-CDMA.

migration. Certain network assets fall into this category: for example, base station sites may continue to be rented from one generation to the next, backhaul transmission may be transparent to 2G and 3G traffic, business overhead functions will support both technology generations, etc. Given these economies of scope between technology generations, service costing for certain assets should be independent of migration.

Approach in the upgraded model: revised to reflect current expectations of technologies

This conceptual issue includes a wide range of uncertain potential situations to be modelled parametrically. Therefore, we propose a pragmatic approach.

Principle 5, revised: Consistent with Principle 4, adopt a consistent set of long-run forecast parameters: in particular, GSM volumes and GSM equipment prices, and UMTS volumes and UMTS equipment prices. An increasing proportion of voice traffic is being carried on UMTS networks in Norway, and migration of data users from GPRS to UMTS/HSPA networks also results in a (significantly) greater proportion of data traffic being carried on the next-generation technology. Next-generation technologies should also enable higher total volumes of voice and data traffic to be carried. According to the current rate of migration to UMTS, it appears that operators are migrating more slowly than forecast in the original model. This suggests that the original expectation of GSM shut-down in 2015 is unlikely to be achieved. Therefore GSM shut-down is projected for 2020. Migration from UMTS is not modelled since the network would not be fully utilised until 2020, and so migration would only be expected in the very long term (i.e. sufficiently discounted to be negligible).

3.2.1 Operator submissions and NPT response

Telenor

> It is a fundamental modelling decision how to deal with technology generations and to alter the assumptions will require very large changes to the model.
>
> Telenor agrees with NPT that the original expectation of GSM shutdown in 2015 is unlikely to be achieved.

Telenor submits that it is a "fundamental modelling decision how to deal with technology generations" suggesting that because the model now includes UMTS, then it is based on new principles. As market parties will recall, the conclusion of the previous conceptual approach and the 'v4' cost model considered the issue of technology generations in some detail. The approach adopted in the previous final model included the effect of migration off 2G technology. The migration off 2G was applied because real operators Telenor and NetCom had already commenced this activity, and started to increase traffic on their new 3G networks. However, in 2006 it was considered premature to attempt to calculate the costs of the new 3G networks with reasonable certainty, and since they were only expected to carry a small percentage of mobile terminated traffic in the period of regulatory interest, the specific costs of UMTS networks were ignored. However, because migration off 2G was *at that stage* included in the model, then the model already took full account of the principle of technology generations. The model previously took the implicit view that the cost of the 3G technology would not be higher than the cost of the modelled 2G technology, including the effects of migration off the 2G network. The current work to upgrade the model now involves the explicit calculation of 3G technology costs, rather than a fundamentally new principle on technology generations, and adjustments to the existing 2G calculations (such as usage, roll-out and migration rates).

Recent rates of migration in the Norwegian market have shown that NPT's (and Analysys Mason's) previous projection of migration off 2G was too rapid, resulting in a cost result higher than would otherwise have been calculated using today's observed market migration profile. It would have been possible to project a 2020 shut-down date for GSM in the previous model; NPT's previous decision in this area has turned out to be conservative.

Tele2

Data traffic has exploded over the last years, due to the increased use of data by mobile customers. How this shift in the usage of the mobile network is treated in the LRIC model has a big effect on the final LRIC result.

For Tele2 it seems that principle 5 is designed in a way that increased data volumes leads to the result that large portion of shared and common cost is transferred from voice to data. This leads to a reduced LRIC price.

In a few years a large portion of data traffic might be transferred to a LTE network, and then the allocation of shared and common cost from voice to data is not correct. In a LTE scenario, where data traffic is mainly carried by a LTE network and not by today's GSM/UMTS mobile network, shared and common cost in a LRIC model should mainly be carried by voice and not by data.

Tele2 is of the opinion that the LRIC model should be constructed in a way that a possible technology change, for instance to LTE networks, also is reflected in the LRIC model.

We recognise that mobile data volumes are growing rapidly, and that higher data volumes implies greater economies of scope leading to a lower unit cost of traffic. Costs are allocated to data services according to three main methods:

- **dedicated data service costs**, such as SGSN, GGSN and HSPA radio upgrades, are directly allocated to the data services

- **shared network costs**, such as NodeBs, are allocated to voice and data services on the basis of equivalent voice channels. This means that the allocation to data services is reduced, for example due to the higher coding rate for data (e.g. 16QAM for HSPA versus QPSK for low-speed and voice services) and the lack of soft-handover for high-speed fast-scheduled traffic.

These two factors combine to reduce the cost allocation to high-speed traffic (the majority of megabytes in the network) by a factor of around five compared to voice. This means that it is voice traffic that receives a much larger share of cost allocation than the proportion of *megabytes* of load it generates

- **common costs** are allocated on the basis of a cost-based equi-proportional mark-up. Through this method, all services pay an equal, fair share of network common costs such as coverage deployments and licence fees. The alternative to this allocation method suggested by some parties is one in which some services, i.e. wholesale termination, pay a larger share of the common cost, allowing other services such as mobile broadband to be priced at a lower level. Given that mobile termination rates are paid by competing operators, it can be argued that competitive services such as mobile broadband should not be subsidised below EPMU-based cost at the expense of off-net termination charges.

These cost allocation methods are considered to be fair and reasonable, and have been applied to voice and data service costs in mobile termination cost models across numerous European countries, and in NPT's previous model.

Below, we have compared our forecasts with those from Analysys Research[17], as illustrated in Figure 3.4.

[17] Wireless network traffic forecasts, October 2008

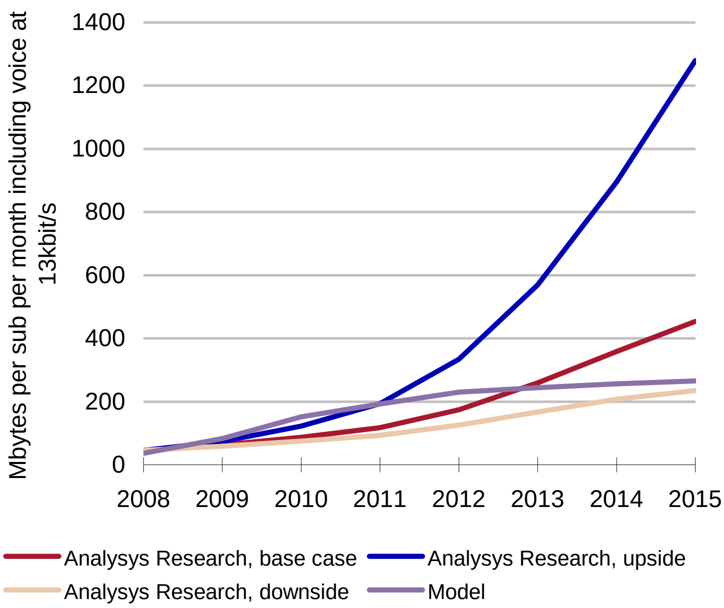

Figure 3.4: Average data usage per subscriber per month in Western Europe versus the model forecast [Source: Analysys Research]

This shows that our average usage in the model is conservative compared to other possible long-term forecasts. While significantly higher forecasts for traffic can be envisaged, these amounts of data traffic for all subscribers would likely require LTE deployments.

Figure 3.5 shows that when new mobile data technologies have been introduced in Norway (Release 99 and HSDPA), the volume of traffic on the 'old' GPRS technology has not declined. As such it is reasonable to take the view that our HSPA traffic volume (as compared in Figure 3.4) is likely to remain on the HSPA network in the long term, and that significant transfer of this traffic to LTE is not likely. LTE may be introduced to support higher volumes rather than the existing (lower levels of) HSPA traffic for which LTE could be uneconomic or unnecessary.

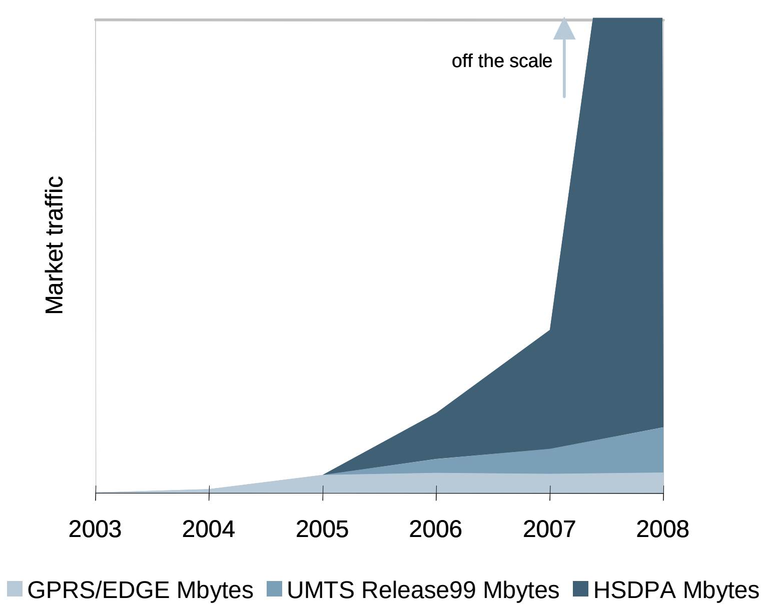

Figure 3.5: Recent evolution of mobile data traffic in Norway [Source: v6 market data]

3.3 Extension and quality of coverage

Coverage is a central aspect of network deployment, and of the radio network in particular. Appropriate coverage assumptions to apply to the modelled operator can be determined through the following questions:

- How should historical coverage be reflected?
- How far should geographical coverage extend in the long run?
- How fast should the long-run coverage level be attained?
- What quality[18] of coverage should be provided, at each point in time?

Costing implications

The definitions of coverage parameters have two key implications for the cost calculation:

Level of unit costs due to present value — The rate, extent and quality of coverage achieved over time determine the present value (PV) of associated network investments and operating costs. The degree to which these

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18 By quality of coverage we are specifically referring to the density of radio signal – within buildings, in hard-to-reach places, in special locations (e.g. airports, subways, etc.).

(PV) of expenditures

costs are incurred before demand materialises represents the size of the 'cost overhang'. The larger this overhang, the higher the eventual unit costs of traffic will be. The concept of a cost overhang is illustrated in Figure 3.6, and may apply equally in UMTS and GSM networks.

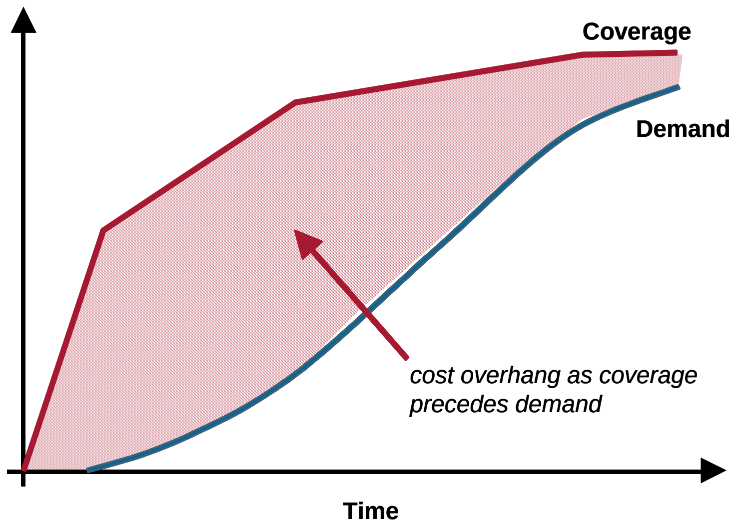

Figure 3.6: Cost overhang [Source: Analysys Mason]

Identification of network elements and common costs that are driven by traffic

In a situation where coverage parameters are relatively large, fewer network elements are likely to be dependent on traffic. This reduces the sensitivity of the results to assumed traffic algorithms.

Furthermore, common costs are generally incurred when costs remain fixed in the long run. With larger coverage parameters specified for an operator, increasing proportions of network costs are invariant with demand and hence likely to be common costs. This aspect will have particular implications when combined with the new Recommendation on increments (Section 5.3).

Approach for upgraded model: unchanged

The original model included a forecast of network coverage beyond what was offered in 2005[19]. It was projected that, consistent with market share equalisation, both operators would eventually roll out to the same area coverage of the country:

- both operators would roll out to 88% area coverage (outdoor signal strength), although NetCom would achieve this coverage four years later than Telenor because its 2005 coverage was behind that of Telenor
- both operators would complete their infill coverage with additional base stations in infill areas during 2006 and 2007 (again later for NetCom)
- both operators would complete their roll-out of tunnel sites according to the model forecast (again later for NetCom).

It will be important to update GSM coverage for 2006 onwards with actual data for Telenor and NetCom available for year-end 2008, as well as implement a third-operator national coverage profile. The forecast of GSM coverage for each operator will also need to be revisited to ensure that it remains consistent with the overall *equalisation* approach of the model.

Actual UMTS coverage for Telenor and NetCom, including a forecast, will need to be captured in the model, together with an efficient level of cost overhang arising from the deployment of UMTS networks and the launch of services.

19 As calculated by the radio coverage simulations of Telenor and NetCom that were run by NPT's Frequency department.

Principle 6, unchanged: Consistent with Principle 2, actual historical levels of geographical coverage and coverage quality should be reflected in the model. A forecast for future geographical coverage should be applied in the model, consistent with operators' planned coverage expansions. Planned improvements in coverage quality should also be reflected in parts of the network that are not driven by traffic. A national coverage profile will be applied to the new third network operator. The GSM and UMTS coverage profiles of the mobile networks should be modelled separately, taking into account UMTS900 which is expected for eventual full national coverage by 3G.

3.4 Transmission network

A large number of factors affect the choice of transmission network used by an operator. These include:

- historical demand and network evolution
- forecast demand and network evolution
- build or buy preference of individual mobile operators
- availability of new generations of transmission technology from alternative providers
- range and price of wholesale transmission services.

During the upgrade of the model, it will be necessary to analyse differences in network transmission to carry traffic from the base stations, and to connect switching sites with backbone capacity.

Costing implications

All differences between the modelled operators' actual networks will have associated cost implications. Therefore, it will be necessary to identify material transmission differences and explore the method and rationale for selecting the chosen network transmission.

Targeted questions and investigation of submitted data should yield information to support this aspect of the model.

Approach in the upgraded cost model: unchanged

The original model contained a number of different transmission architectures:

- 64kbit/s leased lines used in Telenor's low-traffic areas, but later replaced by E1 links
- inter-switch transmission based on either an *Oslo mesh* or a *national transit mesh* using multiple STM-1 links and distance (see Figure 3.7 and Figure 3.8).

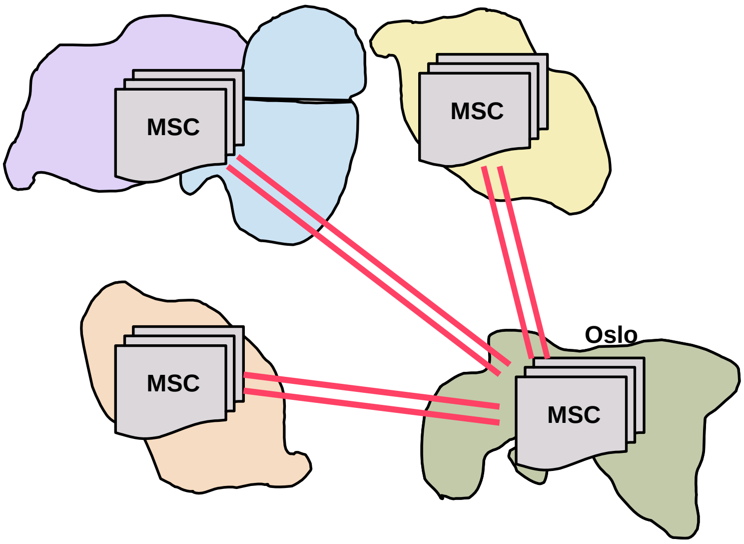

Figure 3.7: MSC–MSC transmission (no transit layer) [Source: Analysys Mason]

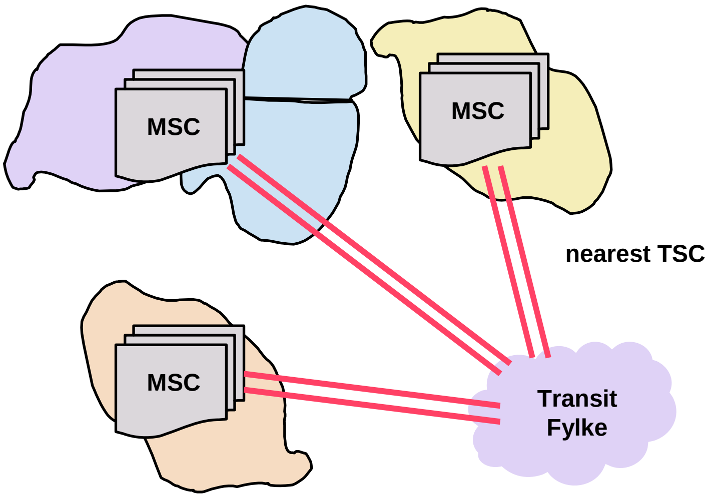

Figure 3.8: MSC–TSC transmission with the deployment of a transit layer [Source: Analysys Mason]

We will revisit the transmission network design of the model taking into account the current approach of the three mobile operators, and develop a simplified model including aspects such as:

- whether transit layers are still present
- whether Oslo is still a relevant transmission mesh for mobile operators
- whether circuit and IP traffic (e.g. HSDPA) is carried over separate transmission mechanisms
- whether a single IP transmission network is being deployed to carry both voice and data traffic.

Principle 7, unchanged: Consistent with Principle 2, each operator's actual transmission network should be modelled, identifying material differences in the choice, technology or cost of transmission elements but aiming to adopt an efficient, modern and standardised modelling approach where possible.

3.5 Network nodes

A mobile network can be considered as a series of nodes (with different functions) and links between them. Of these node types, the most important are radio sites, RSOs and MSOs[20]. In developing algorithms for these nodes, it is necessary to consider whether the algorithm should and does accurately reflect the actual *number* of nodes deployed. In situations where the operators' network is not viewed as efficient or modern in design, or where network rationalisation is planned, the model may be allowed to deviate from the operators' actual number of nodes. This aspect may be highlighted when looking at GSM and UMTS networks – since later equipment tends to have a higher capacity and is therefore more likely to be located in fewer, larger switching sites.

Specification of the degree of network efficiency is a crucial regulatory costing issue, and one which is sometimes encompassed by the application of a 'scorched-node' principle. This ensures that the number of nodes modelled is the same (exactly or effectively, as required) as in reality, albeit with modern-equivalent equipment deployed at those nodes. This is coupled with the commonly held view that mobile networks are generally efficiently deployed and operated due to infrastructure competition. The main alternative is the 'scorched-earth' principle, which allows the number and nature of nodes modelled to be based on a hypothetical efficient network, even if it deviates from operational reality.

Costing implications

Adopting a scorched-node principle requires an appropriate calibration of the model, to ensure node counts correspond with reality. This ensures that the level

20 *Remote Switching Offices* containing only BSCs, and *Main Switching Offices* containing MSCs and other switches.

of assets in the model is not underestimated due to factors that are not explicitly modelled. The application of network node adjustments indicates the network efficiency standards which will define the level of cost recovery allowed through regulated charges.

Approach in the upgraded model: unchanged

The original model broadly reflects the number of radio, RSO and MSO sites in operation in each operator's network. This calibration is performed over a number of years in order to increase the consistency of the model with reality.

Principle 8, unchanged: Consistent with Principle 2, adopt actual network designs in terms of numbers of network nodes. The starting point for this will be submitted data on the number and nature of nodes in operators' actual networks, which we shall validate for high-level efficiency with our expert view. In the radio network, we suggest applying a scorched-node calibration to ensure that the model can replicate operators' actual deployed site counts: this effectively ensures that radio network design parameters which are not modelled explicitly are implicitly captured in the model. The efficient nodes for the third operator will also need to be estimated in the model.

3.6 Input costs

To calculate the costs of a mobile network using a bottom-up incremental cost model, the unit costs of different types of network equipment are a required input. There are four general approaches, discussed below, that could be taken in defining input costs:

- actual cost
- lowest cost
- highest cost
- average cost.

Actual cost of each operator

This method allows the identification of the unit costs applicable to each operator in order to develop two complete sets of equipment cost data. This method, whilst comprehensive, can result in difficulties when trying to understand reasons for overall cost differences between operators, since there may be no cross-references between unit costs when populating the two models.

Lowest-cost operator

The mobile operators in Norway have strong incentives to purchase and operate their network equipment at the lowest possible cost. Therefore, it is reasonable to assume that the price paid by any operator for a given unit of equipment will be the lowest possible price that the operator could pay, and using any lower value will result in the operator being unable to recover its full costs. Using the lowest unit costs carries the risk of underestimation of costs, since:

- one operator might have access to lower unit costs that cannot be replicated by the other operator
- a lower unit cost in one category might be balanced by a higher unit cost in another
- the efficient unit cost might not necessarily be the lowest, as there are other considerations involved in a real purchasing decision (e.g. ties to maintenance contracts, vendor selection, etc.).

Highest-cost operator

Using the highest unit costs has the same potential problems as using the lowest unit costs, but leading to a risk of overestimating cost.

Average cost of operators

Given the staggered nature of network deployment, the price paid for any given unit of equipment by each operator at any given time will naturally vary. However, the discipline of competition in the retail market should mean that all operators aim to minimise their costs over the long term. Therefore, using averaged unit costs should produce an efficient overall network cost.

A further advantage of using average costs is that it avoids adhering dogmatically to a particular principle (e.g. lowest or highest cost), which can be unreasonable under certain circumstances, and instead provides a reasonable, practicable alternative.

Approach in the recommended model: unchanged

The original model adopts a mixed approach to setting the input costs of equipment:

- many equipment costs (capex and opex) are set identical for both Telenor and NetCom
- certain equipment costs (capex and opex) are identified to be different for Telenor and NetCom due to various differences in these operators' businesses.

Principle 9, unchanged: Given the practical and regulatory difficulties of accurately and unambiguously defining the lowest cost base for an operator, we recommend a mixed approach based on actual and average costs. Our starting point for assessing the level of input costs will be the actual costs incurred by the operators – informed by data submitted by the operators. Where it can be shown that unit costs equate closely to the same functional network elements (e.g. a BSC of the same capacity) we shall endeavour to use average costs applicable to both operators. Where it can be shown that each operator has a materially different unit cost base (e.g. in the price of a suite of equipment from a particular vendor) then operator-specific actual costs will be adopted[21]. Efficient unit costs will need to be estimated for the third operator model, without revealing confidential operator data.

3.6.1 Operator submissions and NPT response

NetCom

NetCom has previously questioned the principle that the models shall be based on a mixture of actual costs and average costs in related to input costs. The consequences of this principle, which called attention by both NERA and Ovum in connection with the last modelling, is that Telenor is allowed to have significantly higher unit costs than NetCom. That this round should also estimate effective unit costs for a hypothetical third operator will in NetCom's opinion render a handoff of this principle impossible. Considering that an equal treatment of the operators it is thus NetCom's opinion that only average costs should be the basis of the model.

In the previous ('v4') costing model, it was concluded that due to structural differences in the actual networks of Telenor and NetCom, different unit costs were relevant. Between Telenor and NetCom we found differences in:

- radio networks

21 Details of the choice of average or actual unit costs will be communicated to industry parties in the later stages of this process.

- number and size of BSCs
- number and size of MSCs
- magnitude of other network costs and overheads activities, etc.

We believe that these differences remain in the GSM networks of Telenor and NetCom and within the other aspects of their mobile businesses.

In terms of Tele2 and Network Norway, it is not currently possible to determine whether these parties (or Mobile Norway) have **higher or lower** costs for equipment and operations compared to Telenor and NetCom. As such, they are modelled with a typical average unit cost in the model.

3.7 Spectrum situation

Mobile operators' spectrum allocations – in terms of amount[22], band[23] and any fees[24] paid – and use of their allocated spectrum, are likely to differ. Some of these differences may be assessed to be outside of the operators' control – e.g. restrictions on the availability and packaging of spectrum over time.

Costing implications

Any cost differences arising from spectrum allocation or use should be understood and estimated, and could be taken into account in the cost basis of regulated prices if appropriate (and significant). This involves understanding how the differences in operators' spectrum result in different network deployments, how these are best captured and parameterised in the model, and ultimately what the resulting cost differences are. The benefit of being able to model the actual spectrum of the operators is that it greatly assists manageable scorched-node calibration of a bottom-up network design with actual data, and reconciliation of calculated costs with actual costs.

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22 Amount of paired MHz, less guard bands.

23 PGSM, EGSM or DCS.

24 One-time or recurring fees, including duration of any licence payment.

Alternatively, some hypothetical amount of spectrum could be defined – but this would require a clear understanding of the cost differences between this hypothetical allocation and the actual operator allocations. It would be possible to attempt to construct a purely hypothetical spectrum model without clear reference to actual operator factors, but this would be characterised by uncertainties that are difficult to resolve.

Approach in the upgraded model: unchanged

The original cost model reflects the actual spectrum of Telenor and NetCom. However, both these parties have access to practically identical 900MHz and 1800MHz allocations, and so no significant spectrum differences were observed in the original modelling work. This situation should still be the case for Telenor and NetCom in their GSM networks. For the third operator, we shall implement Mobile Norway's spectrum allocation in the cost model and if necessary explore spectrum-related differences.

All operators have access to the same amount of UMTS 2100MHz spectrum, and so there will be no material spectrum-related cost differences with the UMTS networks.

Principle 10, unchanged: Develop a model capable of capturing the network and cost differences due to the actual operator's spectrum allocations, through modification of a small number of key parameters. It is expected that spectrum differences are negligible for Telenor and NetCom, and unlikely to be significant for the third operator.

4 Service issues

In this section we outline the scope of services in the model.

4.1 Service set

The treatment of economies of scope achieved by the actual voice and data operators depends on whether the modelled operator offers non-voice SMS, GPRS, EDGE and HSPA services to its subscribers. Economies of scope arising from the provision of these services across a shared infrastructure should result in a lower unit cost for voice services where total traffic volumes are higher. Also, the standalone network costs (e.g. hardware and software) incurred by the operators – and therefore likely to be reflected in the model – implicitly include the support for non-voice services.

Cost implications

Assessing both voice and data services in the model increases the complexity of the calculation and the supporting data required, and should result in a lower unit cost for voice services due to economies of scope. Conversely, however, excluding costs relevant to non-voice GSM services (and developing a standalone voice cost) can also be complex[25]. In Norway, some non-voice services (e.g. SMS and GPRS) are reasonably proven services rather than emerging services. In the case of HSPA, traffic volumes may currently be small but they are growing rapidly – therefore a conservative approach to forecasting data traffic may be appropriate if suggested economies of scope are significant (subsequently strongly reducing the economic cost of voice on the basis of an uncertain data traffic forecast).

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25 For example, actual top-down costs representing voice and data operation will need to be divided into standalone voice-relevant costs and additional data costs.

Approach for the upgraded model: unchanged

The original model adopted a GSM voice and data cost calculation. In the modelled radio network, SMS was not assumed to drive Erlang capacity (instead, being carried in a *signalling channel reservation*). However, resulting average traffic costs were allocated to SMS and GPRS on the basis of the utilised amount of their voice-equivalent capacity.

NPT's original recommendation was that economies of scope are shared across all services. This meant that shared resources (such as base stations, switches, transmission, overheads, etc.) were shared across all services, with voice, SMS and GPRS services combined into a total traffic measure to apportion shared costs. This was related to the original Principle 15, regarding traffic LRAIC+ costing.

The alternative to the approach of sharing out *economies of scope in traffic* is one in which various services are calculated as pure incremental costs (see the new Principle 15).

NPT does not think it is appropriate to recover all voice and data common costs from voice services only.

Principle 11, unchanged: The modelled operator should provide data services (SMS, GPRS, EDGE and HSPA) alongside voice services. The associated economies of scope will be shared across all services, although care will be taken where uncertain growth forecasts significantly influence the economic cost of voice. The approach to allocating costs between voice and UMTS data services (particularly HSPA) will be carefully examined during the implementation of Principle 15 (choice of increment) since there is likely to be a much larger proportion of traffic from data services in today's networks (compared to four years ago when data accounted for less than 5% of network traffic).

4.2 Wholesale or retail

This issue is best described by Figure 4.1 below.

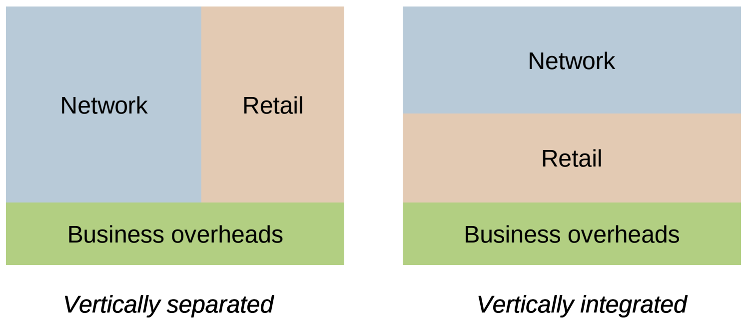

Figure 4.1: Wholesale or retail [Source: Analysys Mason]

In the vertically separated model, network services (such as traffic) are costed separately from retail activities (such as handset subsidy or brand marketing). Business overheads are then marked up **between** network and retail activities, and the wholesale cost of supplying mobile termination is only concerned with the costs of network plus business overhead shares.

In the vertically integrated model, retail costs are considered integral to network services and included in service costs through a mark-up, along with business overheads.

To date, NPT has identified its market analysis as that relating to the wholesale call termination market. As such, NPT intends to consider only those costs that are relevant to the provision of the wholesale network termination service in a vertically separated business. However, costs that are common to network and retail activities will be recovered from wholesale network services and retail services. This will be treated as a mark-up on the LRAIC (though excluded by definition from the LRIC).

Costing implications

A vertically separated approach results in the exclusion of many non-network costs from the cost of termination. However, it brings with it the need to assess the relative size of the economic costs of retail activities in order to determine the magnitude of the business overheads to be added to the incremental network costs.

Approach in the upgraded model: unchanged

The treatment of vertically separated wholesale and retail costs in the original model is illustrated in Figure 4.2 below.

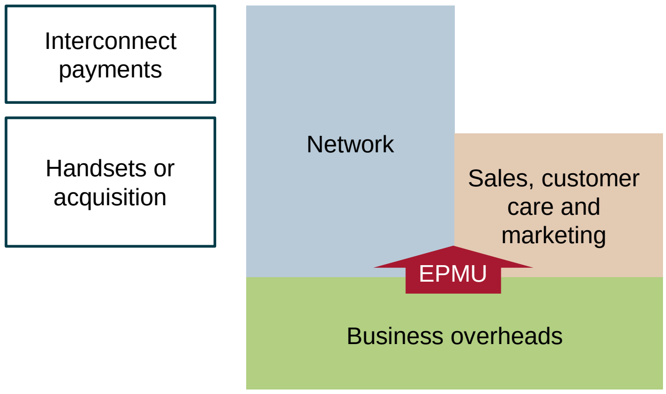

Figure 4.2: Business overhead mark-up [Source: Analysys Mason]

In this approach, business overheads were treated primarily as indirect variable costs, rather than common costs. As such, the proportion allocated to interconnect, handset or acquisition costs was assumed to be negligible.

Principle 12, unchanged: Consistent with the original model, we propose to maintain the indirect cost treatment of business overhead expenditures. This allocation results in an approximately 75:25 split between network and retail activities respectively. In the upgraded model, retail costs will not be remodelled; instead the 75:25 split of overhead costs will be applied as an exogenously defined cost allocation.

5 Implementation issues

This section details choices in the cost model construction and its calculations: WACC, depreciation method, increments, time period of calculation and mark-up mechanism for common costs.

5.1 WACC

The appropriate level of return to be allowed on regulated services is a standard aspect of regulatory cost modelling.

Costing implications

The level of WACC has a direct, material effect on the calculated cost of termination, but it does not need to be applied in the model until the final costing stages.

Recommended approach: revised with an updated WACC

Principle 13, revised: Update NPT’s mobile operator WACC calculation.

5.1.1 Operator submissions and NPT response

Telenor

Telenor agrees with NPT that it is reasonable to update NPT’s mobile operator WACC calculations, inter alia owing to the fact that this new model includes new services (high speed data etc.) that the previous model did not include.

No response required.

5.2 Depreciation method

The model for mobile network services will produce a schedule of capital and operating expenditures. These expenditures must be recovered over time, ensuring the operator can also earn a return on investment. There are four main potential depreciation methods:

- historical cost accounting (HCA) depreciation
- current cost accounting (CCA) depreciation
- tilted annuity
- economic depreciation.

Economic depreciation is the recommended approach for regulatory costing. The table below shows that only economic depreciation considers all potentially relevant depreciation factors.

	HCA	*CCA*	*Tilted annuity*	*Economic*
Modern-equivalent asset (MEA) cost today		✓	✓	✓
Forecast MEA cost			✓	✓
Output of network over time				✓
Financial asset lifetime	✓	✓	✓	✓[26]
Economic asset lifetime			✓	✓

Figure 5.1: Factors considered by each depreciation method [Source: Analysys Mason]

In a mobile network cost model where demand varies over time (e.g. for an actual operator), results produced using tilted annuity will differ significantly from economic depreciation. The difference between HCA and CCA depreciation is inclusion of modern-equivalent asset prices – which is applied in the calculation as *supplementary depreciation* and *holding gains/losses*. The difference between HCA and CCA is generally uninteresting, in the light of more significant differences between HCA and economic depreciation.

26 Economic depreciation can use financial asset lifetimes, although strictly it should use economic lifetimes (which may be shorter, longer or equal to financial lifetimes).

Costing implications

Economic depreciation is a method for determining a cost recovery that is economically rational, and therefore should:

- reflect the underlying costs of production: i.e. modern-equivalent asset (MEA) price trends
- reflect the output of network elements over the long run.

The first factor relates the cost recovery to that of a new entrant to the market (if that market were competitive), which would be able to offer the services based on the current costs of production.

The second factor relates the cost recovery to the 'lifetime' of a mobile business, in that investments and other expenditures are in reality made throughout the life of the business (especially large, up-front investments) on the basis of being able to recover them from all demand occurring in the lifetime of the business. All operators in the market are required to make these large up-front investments and recover costs over time. These two factors are not reflected in HCA depreciation, which simply considers when an asset was bought, and over what period the investment costs of the asset should be depreciated.

The implementation of economic depreciation to be used in the model is based on the principle that *all (efficiently) incurred costs should be fully recovered, in an economically rational way*. Full recovery of all (efficiently) incurred costs is ensured by checking that the PV of actual expenditures incurred is equal to the PV of economic costs recovered. An allowance for a return on capital employed, specified by the WACC, is also included in the resulting costs.

Approach in the upgraded model: unchanged

The original model adopted an economic form of depreciation.

Principle 14, unchanged: NPT intends to retain the original model's economic depreciation calculation to recover incurred network expenditures over time, with a cost recovery in accordance with MEA price trends, network output over the long run, and the discount rate. In addition, for comparative purposes only, a straight-line accounting depreciation calculation will also be applied in the model. Further details of economic depreciation are supplied in the Annex, but operators have the opportunity to comment on the implementation of economic depreciation in the draft model released to industry during this consultation process.

5.3 Increments

Increments in a cost model take the form of a service, or set of services, to which costs are allocated, either directly (for incremental costs) or via a mark-up mechanism (if common costs are to be included). Specifically, the model constructed is used to gain an understanding of how costs vary, or are fixed, in response to different services. This enables costs to be identified as either common or incremental. In final costing stages, common costs may be marked up onto the relevant increments.

The size and number of adopted increments affects the complexity[27] of results and the magnitude[28] of the marked-up incremental costs.

Incremental costs should in practice be determined by calculating the difference in costs *with* and *without* the increment present. Subsequently, calculating the difference in costs with and without *combined increments* would determine the precise structure of costs that are *common* to the various sets of increments. An incremental costing approach that runs through this complete set of small increment permutations can give rise to very complex results, which must be resolved carefully to ultimately identify marked-up incremental costs. However, calculating the incremental cost of *only a single increment* simply requires the model to calculate *with* and *without* the defined increment.

27 More increments = more calculations required of the model and more common costs (or a larger aggregate common cost) to deal with in the mark-up.

28 Through the mark-up mechanism.

Where increments include more than one service, rules will need to be specified to allocate the incremental costs to the various component services. These allocation rules could be on the basis of average loading, peak loading or some other method. Increments which combine distinguishable services such as voice traffic, SMS traffic and GPRS traffic will need carefully assessed routeing factors for allocating costs to the services – since in this combined increment approach it is through routeing factors, rather than network algorithms, that non-voice service incremental costs are identified.

Most of the costs associated with a mobile network are driven by traffic (i.e. it is the marginal increase in traffic that drives the marginal increase in cost). However, this is not the case for a subset of network costs that are driven by the number of subscribers. These costs typically include the visitor location register (VLR) and home location register (HLR), which principally function as databases of subscribers and their locations, plus the switching costs associated with the service of periodically updating the location of all active subscribers.

Whilst the network cost of updating the HLR and reporting the location of handsets is dependent on subscriber numbers, there is a precedent in Europe for recovering these costs through received calls (which should therefore include on-net voice and also SMS delivery). This is because location updates and interrogating the VLR/HLR for subscriber location are only required for terminating traffic – and can be considered a common cost for all terminated traffic.

Costing implications

The magnitude of incremental costs, and costs common to increments, depends on the interaction of the number and nature of increments with the cost functions of network elements. More complex increments will require network design algorithms that are cognisant of relevant volume components.

Applying a combined traffic increment implies focus on the routeing factors which share out traffic costs – particularly the degree to which SMS and data traffic load the network (or are accommodated by it in other ways, such as channel reservations).

Applying small increments implies a focus on the network design algorithm at the margin, and the degree to which capacity-carrying elements vary in the long run with the variance of different traffic types.

Approach in the upgraded model: revised to include the EC recommended LRIC approach

On 7 May 2009, the EC published its Recommendation on the Regulatory Treatment of Fixed and Mobile Termination rates in the EU[29].

NPT wishes to take into consideration this new recommended approach to calculating the costs of wholesale termination services for regulation. The EC Recommendation specifies the following approach for the calculation of the incremental costs of wholesale mobile termination service:

- *Pure* LRIC: the relevant increment is the wholesale termination service, which includes only avoidable costs

- The difference between total long-run costs of an operator providing full services and total long-run costs of an operator providing full services except termination should be calculated

- Non-traffic related costs should be disregarded, and traffic-related costs should be attributed firstly to other services

- Costs that are common and do not increase in response to termination traffic should not be allocated to the wholesale terminating increment.

The NPT's original v4 model adopts a different costing method from that now recommended by the EC: LRAIC+. In the LRAIC+ method, the average incremental costs of traffic are defined in aggregate, then allocated to the various traffic services according to average routeing factors. In the original model, costs common to the traffic services are defined through a process (illustrated in

29 See http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/termination_rates/index_en.htm

Figure 5.2 below and explained in detail in the original model documentation), then included as a mark-up to the incremental costs.

Principle 15, revised: In order to supply NPT with the range of potential costs, which it may apply to wholesale termination regulation, the model should calculate both LRAIC+ and LRIC results. Accordingly, the original model LRAIC+ method will be updated to include the relevant UMTS aspects, whilst the EC Recommendation will be used to define an avoidable cost calculation ('pure LRIC') approach to the wholesale mobile termination service. In the pure LRIC case, we shall explore the sensitivity of the result to the technical assumptions that are applied in the model to estimate the difference in costs without mobile termination volumes.

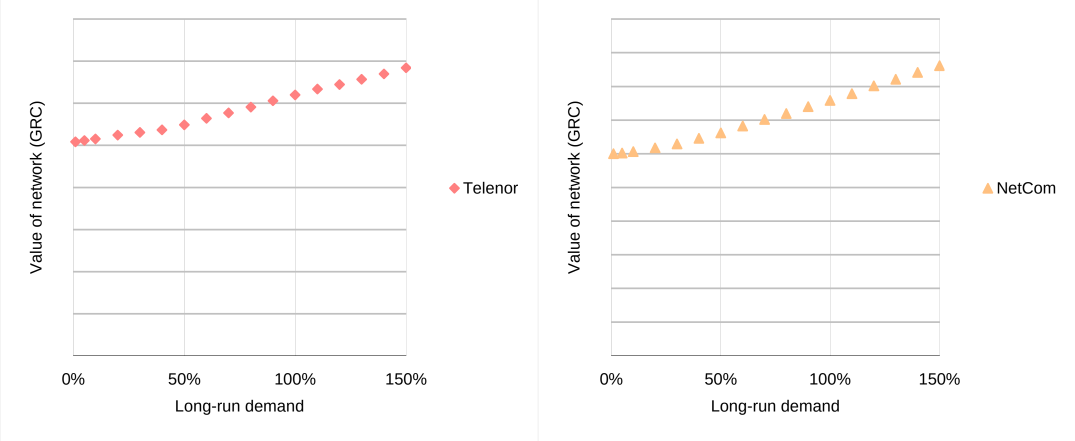

Exhibit 36: *Modelled cost function [Source: Analysys]*

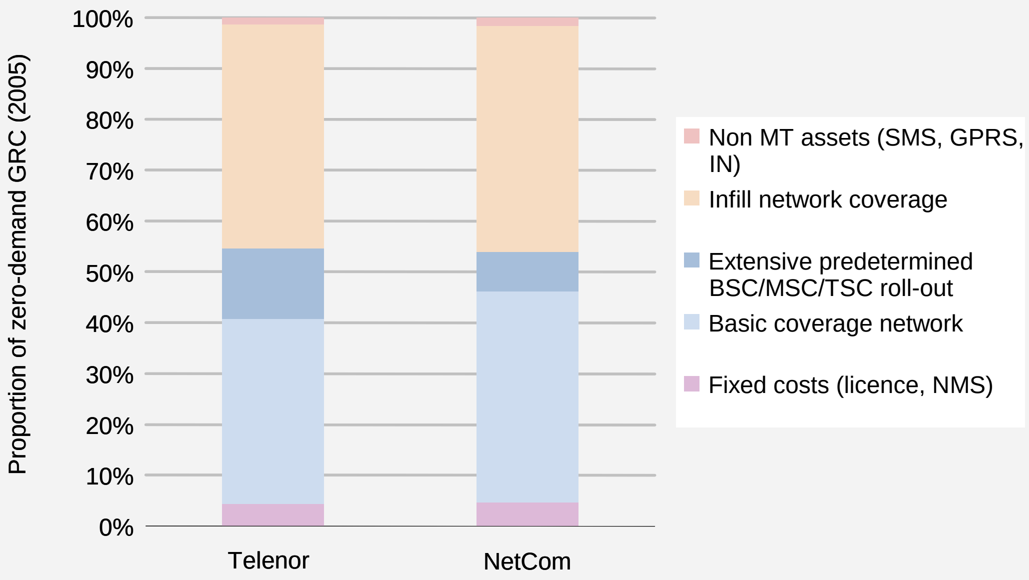

Exhibit 37: *Constituents of zero-demand network [Source: Analysys]*

Figure 5.2: *Illustration of process used in the original model to define costs common to the traffic services [Source: Analysys Mason original model documentation]*

5.3.1 Operator submissions and NPT response

Telenor

Mobile termination rates will be set below the efficient level, if pure LRIC is used as the foundation for regulation.

The EC Recommendation concludes that "avoidable cost" is the appropriate incremental cost measure in order to ensure efficient pricing of mobile termination rates. Telenor agrees that avoidable cost will ensure prices that are efficient in a static sense. However, Telenor is of the view that it is premature to conclude on this issue without taking dynamic considerations into account. Termination services are one of many services being produced on telecommunications platforms. In a static perspective, given that a platform already is installed, avoidable cost will result in efficient pricing. Platforms will over time be upgraded and/or replaced. An efficient, regulated price must also give sufficient incentives to make such investments. By ignoring joint and common costs, pure avoidable cost will not provide such incentives.

The distortion created by prices based upon pure LRIC depend upon the extent to which pure LRIC prices vary from prices that allow recovery of joint and common costs, and the extent to which different prices drive substitution. In general, mobile networks are characterised by high fixed (joint and common) costs, driven largely by coverage costs. Of all European markets, Norway has among the largest coverage per capita, and hence prices based on pure LRIC would have a greater distortive effect in Norway. Common costs have to be recovered somewhere, and the extent to which they are not recovered on call termination other prices would have to increase; thus reinforcing any substitution effect. Pure LRIC based prices in Norway would have a substantial distortive effect and should not be proposed without thorough consideration of these effects.

In Telenor's view a regulation of MTRs based on pure LRIC, according to the EC recommendation, represents a fundamental and substantial change in the Norwegian regulation. Fundamental changes must be properly discussed with the operators in the market – and if pure LRIC should be the basis for regulation of

MTRs there must be a separate public consultation on pure LRIC as a principle for regulation. It is not sufficient to deal with this in a draft decision in market 7.

In Telenor's opinion, the pure LRIC calculation made by NPT/Analysys, is not very well thought-through. The EU recommendation is unclear in several respects (confirmed by NPT/Analysys at the meeting Sept 22). Furthermore, the development of a pure LRIC model is a pioneering work. Then it is very premature to consider to use pure LRIC as a basis for regulation without a proper consultations on conceptual design. The discussion at the meeting Sept 22 confirmed that the pure LRIC modelling is not based on proper deliberations. This observation is confirmed, e.g. regarding the fact that the economic depreciation calculation used for LRAIC is also used for pure LRIC without examining more closely whether this is the most appropriate way of doing it.

Furthermore, NPT/Analysys is making a distinction between pure and purest LRIC. At the meeting, Sept 22, Telenor requested a clarification of the difference between these concepts. The difference was not clarified during the meeting. Telenor's view, that it is immature to deploy a pure LRIC concept as a basis for regulation, is reinforced by the fact that NPT/Analysys is considering two different pure LRIC concepts, without a basis in the EC recommendation, without any basis in economic literature (to our knowledge), without consultation, and even without explaining the difference and the reasoning behind it.

See Section 1.5 for NPT's response on process, approach and pricing.

The issue of choice of pure LRIC for price setting was not put forward in this consultation, and our draft model demonstrates that there are differences in pure LRIC depending on the technical assumptions (*pure* versus *purest* LRIC). Consequently, the difference between pure and purest LRIC was specified in Section 7.2 of the model document, which was issued to industry parties in June 2009. This difference was not discussed at the meeting in September 2009 with Telenor due to the duration of the meeting being taken up with other topics.

While the EC Recommendation can be considered unclear in some areas, it also states on page 11, *"Coverage can best be described as the capability or option to make a single call from any point in the network at any point in time… The need to* *provide coverage to subscribers will cause non-traffic-related costs to the incurred which should not be attributed to the wholesale call termination increment."* Our purest LRIC approach takes this statement into account: no coverage-related costs fall into the calculation of the purest LRIC.

Further discussion on the mechanical calculation of pure LRIC is annexed to the model documentation issued with this consultation response.

Tele2

2.1 The Recommendation

Not repeated here for brevity

2.2 The exclusion of coverage cost. The effect for the mobile market in Norway

Not repeated here for brevity

2.3 The exclusion of coverage cost – overall regulatory goals in Norway

Not repeated here for brevity

2.4 Conclusion

Not repeated here for brevity.

See Section 1.5 for NPT's response on process, approach and pricing.

5.4 Year(s) of results

There are three options for timeframes for the calculation:

One year only This approach can simply compare costs today with prices

(e.g. 2009)	today.
Forward-looking only (e.g. 2009 onwards)	A forward-looking calculation is capable of answering questions about the future, but is difficult to reconcile with the past (and therefore, potentially, the present).
All years (e.g. 1992 onwards)	Having a calculation for all years will make it easier to use full time-series data and consider all costs over time. It provides the greatest clarity within the model as to the implications of adopting economic depreciation (compared to other forms of depreciation).

Costing implications

The calculation of mobile termination costs in particular years provides a range of information:

- current-year costs can be compared to current-year prices
- forecast costs can be used to define RPI-X price caps
- a full time series of costs can be used to estimate windfall losses/gains due to a change from historical to accounting cost paths and provides greater clarity as to the recovery of all costs incurred from services over time.

Analysys Mason's experience of bottom-up LRIC models, and their use in conjunction with top-down information, indicates that a full time-series model provides:

- the greatest clarity and confidence in results, particularly when it comes to reconciliation against historical top-down accounting data
- the widest range of information with which to understand how the costs of the operators vary over time and in response to changes in demand/network evolution
- the opportunity to include additional forms of depreciation (such as accounting depreciation) with minimal effort.

Approach in the upgraded model: unchanged

Principle 16, unchanged: NPT proposes to adopt a full time-series model that calculates the costs of operators from their GSM launch in 1993 (and capturing the first GSM expenditures in 1991 and 1992), following on to UMTS deployments in 2001 and beyond. The model will therefore be able to calculate operators' costs in current and future years, giving NPT the greatest understanding of cost evolution and flexibility in exploring pricing options. The third operator will be modelled according to a recent entry date, in a full-time series approach that considers its current and future years of operation.

5.5 Mark-up mechanism

The specification of an LRAIC+ cost model will result in certain cost components being classified not as incremental, but as common costs. Common costs are those costs required to support one or more services, in two or more increments, in circumstances in which it is not possible to identify which specific increment causes the cost. Such costs do occur in mobile networks (and more extensively in mobile business overheads). However, depending on the maturity of the network, they may not be as significant as in a fixed network. These common costs need to be recovered from services in some way, generally by using a mark-up on incremental costs in a LRAIC+ situation.

Two main methods for mark-up mechanism are put forward and debated in the context of mobile termination costing:

Equal proportionate mark-up (EPMU)	In this method, costs are marked up pro-rata to incremental costs. It is simple to apply, and does not rely on developing additional supporting information to control the mark-up calculation. EPMU has been applied by Ofcom and PTS in their previous mobile cost calculations.
Ramsey pricing, and its variants	Ramsey pricing is a targeted common-cost mark-up mechanism which loads the burden of common-cost recovery on those services with low price elasticity (thus least distorting consumer consumption and welfare away from the optimal).

> Variants exist on Ramsey pricing methods which take into account operator profit (as opposed to welfare) maximising incentives, or additional effects such as network externalities. Supplementary information is required by these approaches to control the mark-up algorithms.

NPT discussed Ramsey pricing in its decision for Market 16, on 19 September 2005. NPT refers to viewpoints from ERG. ERG believes that the method is practically infeasible due to the complex and dynamic information requirements regarding demand elasticities[30].

NPT also shares the assessments of Ofcom and PTS, and has not previously accepted the allocation of costs according to the principles of Ramsey pricing. NPT maintains the same position regarding the use of Ramsey pricing for allocating common costs in the LRAIC model.

Costing implications

The choice of mark-up mechanism affects the resulting marked-up unit costs, particularly where non-equal mark-ups are applied, and especially if common costs are large. This choice therefore directly influences the cost-oriented price for mobile termination.

Approach in the upgraded model: unchanged

The original model uses an LRAIC+ approach to calculate service costs and applies an equal proportionate mark-up (EPMU) for common costs. NPT proposes to follow the same EPMU methodology in the upgraded cost model for the LRAIC+ results. In a pure LRIC model, the issue of mark-up mechanism is not relevant.

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

Principle 17, unchanged: NPT proposes to apply an equal proportionate mark-up (EPMU) for network common costs and the network share of business overheads in the LRAIC+ calculation.

Annex A: Details of proposed economic depreciation calculation

A.1 Implementation of economic depreciation principles

The economic depreciation algorithm recovers all efficiently incurred costs in an economically rational way by ensuring that the total revenues[31] generated across the lifetime of the business are equal to the efficiently incurred costs, including cost of capital, in present value terms. This calculation is carried out for each individual asset class, rather than in aggregate. Therefore asset-class specific price trends and element outputs are reflected in the components of total cost.

Present value calculation

The calculation of the cost recovered through revenues generated needs to reflect the value associated with the opportunity cost of deferring expenditure or revenue to a later period. This is accounted for by the application of a discount factor on future cash flow, which is equal to the WACC of the modelled operator.

The business is assumed to be operating in perpetuity, and investment decisions are made on this basis. This means that it is not necessary to recover specific investments within a particular time horizon, for example the lifetime of a particular asset, but rather throughout the lifetime of the business. In the model, this situation is approximated by explicitly modelling a period of 50 years. At the discount rate applied, the present value of a krone in the last year of the model is fractional and thus any perpetuity value beyond 50 years is regarded as immaterial to the final result.

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31 Strictly, cost-oriented revenues (rather than actual received revenues).

Cost recovery profile

The NPV=zero constraint on cost recovery can be satisfied by (an infinite) number of possible cost recovery trends. However, it would be impractical and undesirable from a regulatory pricing perspective to choose an arbitrary or highly fluctuating recovery profile[32]. Therefore the costs incurred over the lifetime of the network are recovered in line with revenues generated by the business. The revenues generated by an asset class are a product of the demand (or output) supported by that asset class and the price per unit demand.

In the modelled environment of a competitive market, the price that will be charged per unit demand is a function of the lowest prevailing cost of supporting that unit of demand, thus the price will change in accordance with the costs of the modern-equivalent asset for providing the same service function[33]. The shape of the revenue line (or cost recovery profile) for each asset class is thus a product of the demand supported (or output) of the asset and the profile of replacement cost (or modern equivalent asset price trend) for that asset class.

Capital and operating expenditure

The efficient expenditure of the operator comprises all of the operator's efficient cash outflows over the lifetime of the business, meaning that capital and operating expenditures are not differentiated for the purposes of cost recovery. As stated previously, the model considers costs incurred across the lifetime of the business to be recovered by revenues across the lifetime of the business. Applying this principle to the treatment of capital and operating expenditure leads to the conclusion that they should both be treated in the same way, since they both contribute to supporting the revenues generated across the lifetime of the operator.

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32 For example, because it would be difficult to send efficient pricing signals to interconnecting operators and their consumers with an irrational (but NPV=0) recovery profile.

33 In a competitive and contestable market, if incumbents were to charge a price in excess of that which reflected the modern-equivalent asset prices for supplying the same service then competing entry would occur and demand would migrate to the entrant which offered the cost-oriented price. The rate of demand migration is determined by the contestability of the market under consideration.

A.2 Implementation details

The proposed depreciation method has the following characteristics:

- it explicitly calculates the recovery of all costs incurred across the specified time horizon (50 years), in present value terms
- the cost recovery schedule is computed for each asset along the output profile of the asset
- cost recovery is computed separately for capital and operating expenditures (allowing for potentially different MEA price trends of capex and opex)
- costs are calculated with reference to network element output – the routeing factor weighted sum of service demand produced by the network element in each year.