Conceptual approach for a LRIC model for wholesale mobile voice call termination

Consultation paper for the Norwegian mobile telecoms industry

27 February 2006

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POST- OG TELETILSYNET
Norwegian Post and Telecommunications Authority

Annexes

1 Introduction

This document presents the conceptual design issues for the development of a mobile long-run incremental costing (LRIC) model for the two main mobile network operators in Norway. The conceptual issues for this model development are presented to industry as the Phase 1 consultation, outlined in the overall timetable below.

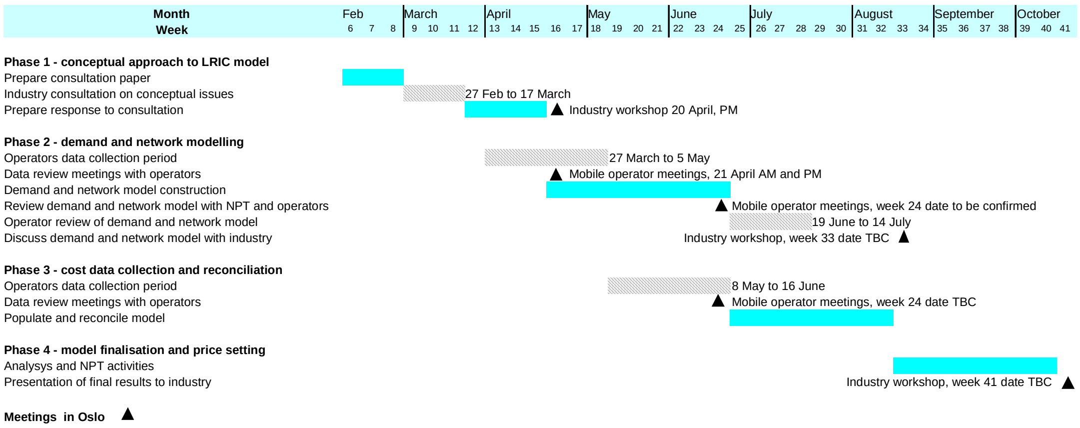

Exhibit 1: *Project plan [Source: Analysys]*

The duration of this first industry consultation is defined as 27 February to 17 March 2006. Responses are requested by NPT before close of business on 17 March 2006.

1.1 Scope of conceptual discussion

In its decision on the market for the termination of voice calls on mobile networks, NPT concluded on the development of LRIC-oriented pricing of mobile termination on Telenor Mobile and Netcom's mobile networks.

This document and its associated consultation determine the principles to be applied in the development of the cost model to underpin NPT's price regulation of these two operators' mobile termination services. In addition, during 2006 NPT will conduct market and remedy analysis that is relevant to other operators, including MVNOs. Depending on NPT's decision on the need for price regulation of MVNOs as part of the 2006 market analysis, the mobile LRIC model may be applicable to the MVNOs operating in Norway. This is envisaged by NPT as likely to take one of two forms: direct application, according to which network hosts the MVNO[1], or a revised application that takes into account the fact that the host network can avoid a small part of its core network switching, whilst the MVNO incurs its own costs in carrying out the avoided functionality[2] – such as HLR and POI switching.

The conceptual issues to be addressed throughout this document are classified in terms of four *modelling* dimensions: operator, technology, service and implementation as shown in Exhibit 2.

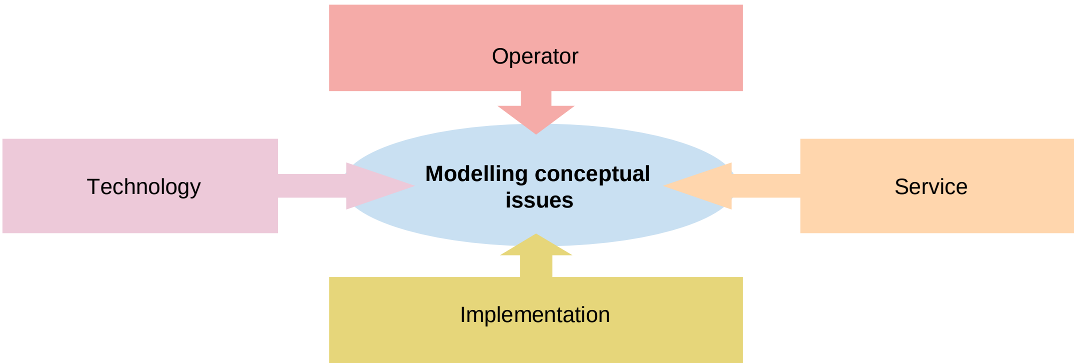

Exhibit 2: *Framework for classifying conceptual issues [Source: Analysys]*

Operator

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

- What **structural implementation** of the model should be applied?
- 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?

1 This approach takes the view that termination on the MVNO's network costs the same as termination on the host's network

2 This approach takes the view that mobile termination on the MVNO's network effectively costs the sum of host radio plus MVNO own switching costs

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[3], MSO[4]) 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, we define the scope of the services being examined:

- 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. They are:

- What is the **weighted average cost of capital** (WACC) for the modelled operator?

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

4 Main switching offices, containing one or more MSCs or TSCs (plus various other network switches)

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

In this document, NPT presents its current viewpoint on the conceptual issues. This is done for one of two reasons:

- Collection of data and further modelling will be facilitated by the adoption of a clear a stated position (i.e. NPT's current viewpoint) which enables data requests and model structures to be defined.

- NPT has already developed its current viewpoint, through previous mobile termination proceedings or otherwise, and wishes to receive new arguments or counter-arguments to its current position.

Current viewpoints have been developed by NPT taking into account its priorities for market regulation and development, and where relevant, Analysys's experience of developing mobile LRIC models in other jurisdictions. In the table below we summarise NPT's view of the individual conceptual issues presented here, and in some cases their dependency on prior conceptual choices. NPT requests comment from industry parties on all conceptual issues presented in this document.

Conceptual issue	*NPT has already developed its current view, which is presented in this document*	*This issue is dependent and linked to the decision on another conceptual issue*
1. Structural implementation	Current viewpoint	
2. Type of operator	Current viewpoint	
3. Size of operator		Linked to R2
4. Radio technology standard	Current viewpoint	
5. Treatment of technology generations	Current viewpoint	
6. Extension and quality of coverage		Linked to R2
7. Transmission network		Linked to R2
8. Network nodes		Linked to R2
9. Input costs	Current viewpoint	
10. Spectrum situation		Linked to R2
11. Service set	Current viewpoint	
12. Wholesale or retail	Current viewpoint	
13. WACC	Current viewpoint	
14. Depreciation method	Current viewpoint	
15. Increments	Current viewpoint	
16. Year(s) of results	Current viewpoint	
17. Mark-up mechanism	Current viewpoint	

Exhibit 3: *NPT position on conceptual issues [Source: NPT]*

NPT does not intend to reach a conclusion on pricing issues at this stage. 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 16. Pricing issues will therefore be discussed with the operators once the results of the modelling have been sufficiently analysed and understood. This allows all parties to focus on the cost modelling at this stage of the process.

1.2 The structure of this document

In the remaining sections of this document we present the conceptual issues, implications for costing, and NPT's recommended approach to each issue.

- 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

2.1 Structural implementation

There are two main ‘directions’ for developing LRIC-based costs of the network operators: bottom-up or top-down modelling. There is 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, and 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 Exhibit 4. 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.

Bottom-up models are good at:

- investigating relationship between cost and demand
- capturing efficient costs
- enabling transparency

They are not so good at:

- modelling a wide range of indirect operating costs
- estimating level of costs (tend to under- or over-estimate)

Top-down models are good at:

- accurately capturing the total cost of the operators

They are not so good at:

- enabling transparency
- disaggregating accounting costs into a detailed network element breakdown
- investigating relationship between cost and demand

Hybrid model combines good points of both models

- accurately captures the actual level of costs incurred
- enables full range of investigations into cost and demand relationships
- improves transparent examination

Exhibit 4: *Bottom-up, top-down and hybrid models [Source: Analysys]*

Costing implications

Developing an understanding of the costs of two different mobile operators in the same market can be achieved by being able to model, and parameterise, operators' network 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 circulated (without any confidential operator information) to all industry parties including non-mobile operators. This transparent circulation facilitates industry discussion of the demand and network modelling approach. In addition, operator-specific models can be discussed bilaterally with each mobile party.

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, a top-down model lacks the ability to explore operator differences with certainty or transparency.

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

- industry 'buy-in' to the approach
- providing comfort to the operators that the model replicates not only their networks, but more importantly their overall costs
- enabling accurate understanding of operator cost differences
- 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 pre-processing stages required.[5]

Recommended approach

NPT believes that the modelling approach which delivers 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:

- 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' condenses to simply a presentation of suitably categorised top-down accounting data, against which the bottom-up model can be reconciled.

5 For example, separation of fixed and mobile costs, or separation of dedicated 3G expenditure

Exhibit 5 illustrates the structural overview of the expected hybrid model.

- **demand inputs**: market subscribers and traffic
- **network design parameters**: busy-hour factors, coverage parameters, switch capacities, network topology etc.
- **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.

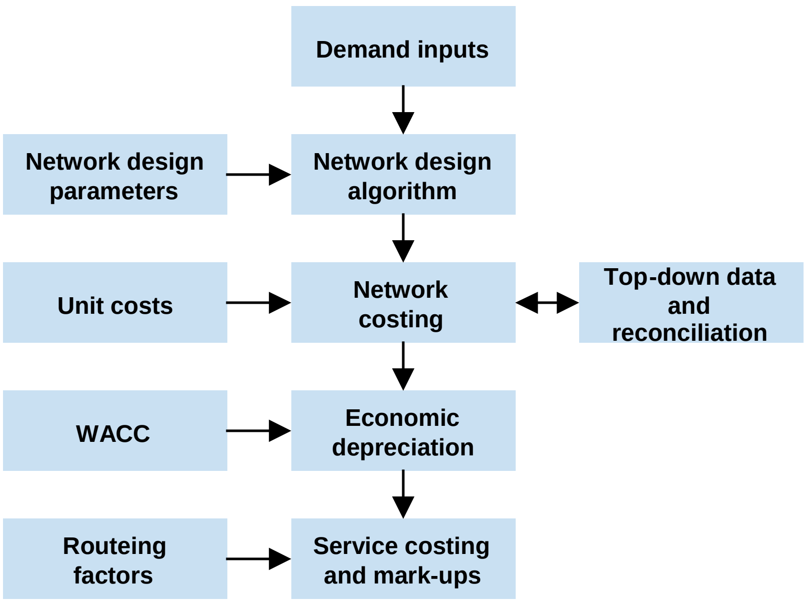

Exhibit 5:
Structural overview
[Source: Analysys]

Recommendation 1: Develop a bottom-up cost model which is reconciled against top-down accounting data to result 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 Telenor Mobile and Netcom. However, the choice of operator type for cost modelling purposes, as outlined here, does not preclude NPT from adopting an alternative basis for pricing. Therefore, we have separated this costing and pricing conceptual issue 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[6] 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 two operators being modelled, and should result in the most accurate quantification of the two operators' cost differences. Operator-specific top-down reconciliation can be carried out with this type of model. Also, this type of model can be used to reflect average or hypothetical operators, by adjustment of various input parameters.

- **An average operator**: by adopting an average operator approach, the cost model will merge inputs, parameters and other features of the two 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 two 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 which the hypothetical operator would experience, and therefore determines the cost base of the hypothetical operator. Because of the

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

hypothetical nature of this model, it is harder to 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[7] manner.

Costing implications

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

- the level of understanding NPT can gain on the costs (and in particular differences in costs) of each actual network operator
- 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.

Recommended approach

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). A subsequent hypothetical operator model could be parameterised at a later stage, once detailed understanding of each operator's cost differences has been gained. This separation is illustrated in Exhibit 6.

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

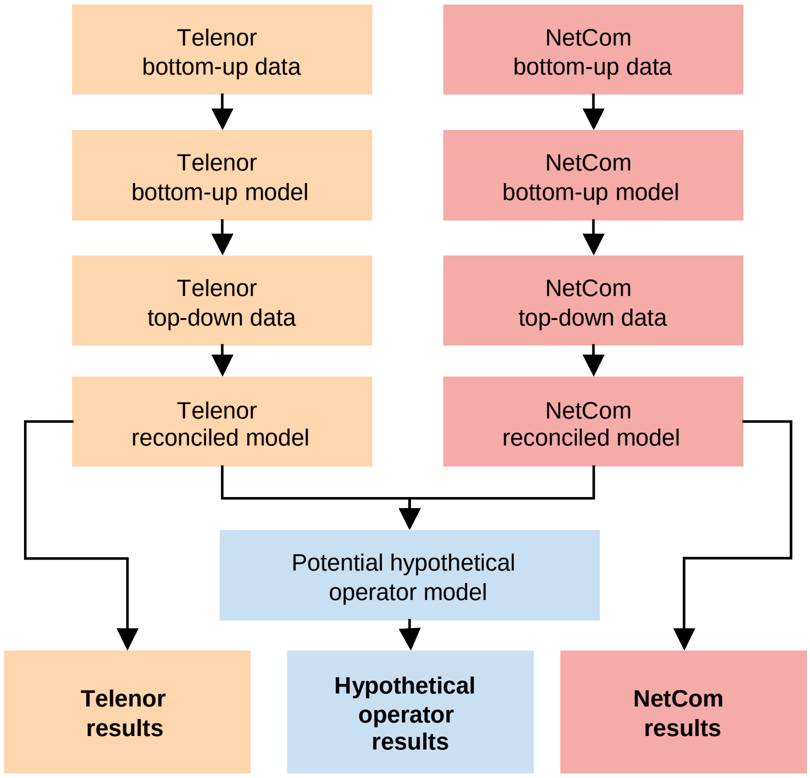

Exhibit 6:

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

Recommendation 2: Adopt an actual operator costing which can accurately determine the costs of each actual network operator, and robustly explore individual cost differences between the two operators.

2.3 Size of operator

One of the major parameters that defines the cost of an operator is its market share: it is therefore important to determine the evolution of the market share of the operator over time. In addition to market share when measured on a subscriber basis, we also include within this conceptual issue the volume and profile[8] of traffic that the operator is carrying.

8 By profile we mean proportions of calls to/from various mobile and fixed destinations, and time-of-day profile

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[9], the lower the eventual unit cost will be.

Recommended approach

Recommendation 3: Consistent with Recommendation 2, the actual size of the two operators should be modelled according to historical market development and including a forecast size for each operator. It is expected that this forecast market development will reflect both subscriber and volume equalisation at some point in the future[10].

3 Technology issues

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 in the future to UMTS. The ultimate objective of this modelling project is to understand the costs of both GSM and UMTS, but:

- NPT has defined a technology-independent market for wholesale mobile voice call termination (which therefore does not require technology-specific costs)
- there are practical reasons why we can only robustly calculate GSM costs today.

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

10 This equalisation will be parameterised in the draft demand model, and be distributed to industry parties during the second consultation stage of this process

There are three main options for the radio technology standards 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 which 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, therefore 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 in future years	Including UMTS explicitly adds considerable uncertainty and model detail, and may produce a more aggressive (lower) eventual cost estimate – the bottom-up model is significantly more complex as a result of including UMTS and is intrinsically subject to major uncertainties. In addition, there is little supporting top-down cost data for UMTS.

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. Fifteen years ago, the modern-equivalent technology for providing mobile telephony was analogue (NMT), today it is GSM. At some point in the future, we expect that UMTS will be the modern-equivalent technology for providing mobile telephony (though when this will be is currently highly uncertain).

The model should at least capture today's modern-equivalent technology (GSM) as this was first deployed around 1992 (when mobile markets were emerging), and should remain the dominant mobile technology in Norway for at least a few more years.

Costing implications

The implications of developing a model which includes UMTS is the significant increase in model size and wide range of uncertainty of model results. Including analogue technology in a cost model used to set prices in 2007 and onwards is unlikely to satisfy modern equivalent efficiency standards. Therefore, the only practical, manageable and robust approach to cost calculation is the application of a GSM-based network model.

Recommended approach

Recommendation 4: Use a model which reflects the operator's actual GSM 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 aim to reflect conservative costs for mobile termination based on continued operation of GSM as the primary mobile technology, although proxy sensitivities for UMTS may be explored (see section 3.2).

3.2 Treatment of technology generations

Modelling a single technology network in a long-run cost model is 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 mobile termination costing context:

Migration of traffic

The migration of traffic from one network to another affects the profile of output produced by the network assets of each technological generations. This changes the level of unit costs over time for each generation, irrespective of depreciation method[11]. The long-run cost from a single technology which 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[12]). 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 on the level and timing of cost recovery.

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

12 Which is likely if there are long-lived assets which are technology specific (e.g. a licence fee)

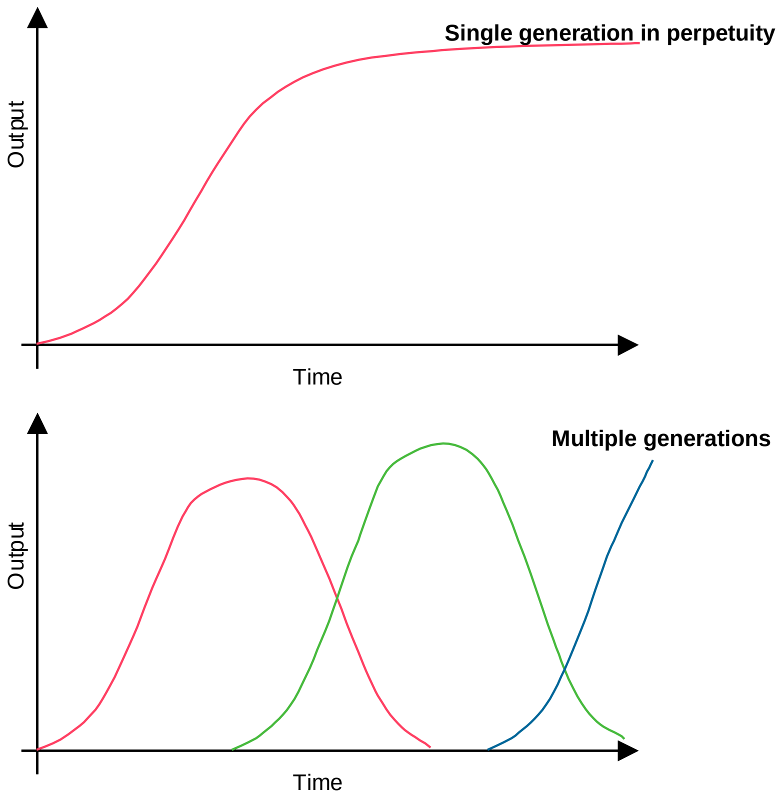


Exhibit 7: Possible output profiles [Source: Analysys]

Proxies for change

Proxies for factors which 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', successive generations of cellular technology can be expected to have measurable output rises[13]. Also, the cost per unit of capacity is likely to reflect continued technological improvement[14]. The nature of these demand and cost proxies is illustrated in Exhibit 8.

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.

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

14 e.g. Analogue to digital, TDMA to WCDMA

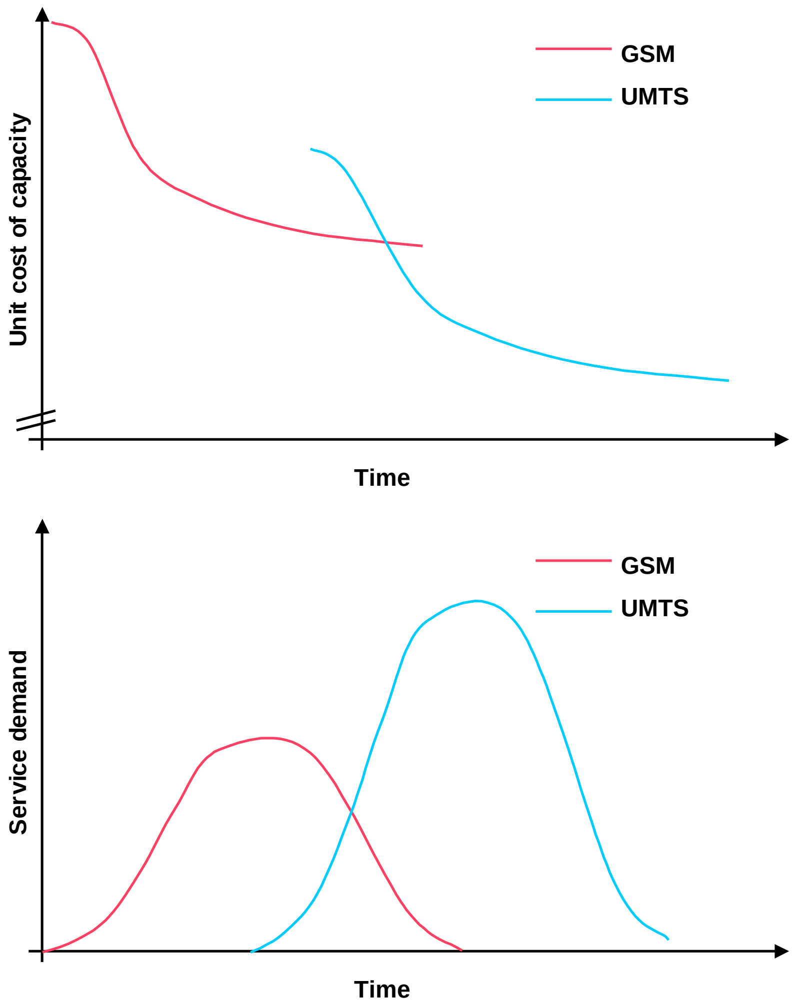


Exhibit 8:

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

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 migration. Certain network assets fall into this category: 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.

Recommended approach

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

Recommendation 5: Consistent with recommendation 4, adopt a consistent set of long-run forecast parameters: in particular GSM volumes and GSM equipment prices. In addition, a sensitivity regarding the effects of migration and technology evolution, in the presence of GSM-UMTS economies of scope should be explored. NPT looks to industry parties to justify further aspects of technology generation effects which could be included as proxies in a GSM-only model.

3.3 Extension and quality of coverage

Coverage is a central aspect of network deployment, and of the radio network in particular. The question of what coverage assumptions to apply to the modelled operator can be understood as follows:

- 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[15] of coverage should be provided, at each point time?

Costing implications

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

Level of unit costs due to PV of expenditures	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 costs are incurred prior to demand materialising represents the size of the 'cost

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

overhang'. The larger this overhang, the higher eventual unit costs of traffic will be. The concept of a cost overhang is illustrated in the exhibit below:

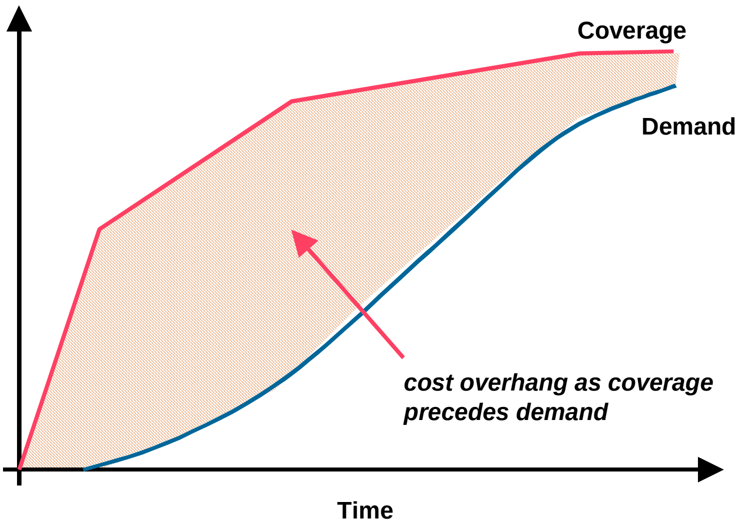


Exhibit 9:

Cost overhang

[Source: Analysys]

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 decreases 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.

Recommended approach

Recommendation 6: Consistent with Recommendation 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.

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 development 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 differences. 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.

Recommended approach

Recommendation 7: Consistent with recommendation 2, each operators' actual transmission network should be modelled, identifying where possible material differences in the choice, technology or cost of transmission elements.

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, RSO and MSOs. 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. Allowing the model to deviate from the operators' actual number of nodes may be allowed in the situation where the operators' network is not viewed as efficient or modern in design, or where network rationalisation is planned.

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 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 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 above which excess cost recovery through regulated prices is not allowed.

Recommended approach

Prior to assessing the operators' actual networks and deconstructing their evolution in terms of cost drivers, it is difficult to assess the extent of differences between operators with respect to network nodes.

Recommendation 8: Consistent with Recommendation 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.

3.6 Input costs

To calculate the costs of a GSM network using a bottom-up LRIC model, the unit cost of different network equipments 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 their full costs. Using the lowest unit costs carries the risk of underestimation of costs because:

- 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 that go into 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, 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 demonstrated to be unreasonable under certain circumstances and instead provides a reasonable, practicable alternative.

Recommended approach

Recommendation 9: 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[16].

3.7 Spectrum situation

Mobile operators' spectrum allocations – in terms of amount[17], band[18], and any fees[19] 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 results in different network deployments, how these are best captured and parameterised in the model, and ultimately what the resulting cost differences are. The benefits of being able to model the actual spectrum of the operators is that it greatly assists

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

17 Amount of paired MHz, less guard bands

18 PGSM, EGSM or DCS

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

manageable scorched-node calibration of a bottom-up network design with actual data, and reconciliation of calculated costs with actual costs.

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

Recommended approach

Recommendation 10: Develop a model capable of capturing the network and cost differences due to the actual operator's spectrum allocations by the modification of a small number of key parameters. Such a model could also be capable of reflecting and analysing a hypothetical spectrum allocation if required.

4 Service issues

4.1 Service set

Whether the modelled operator offers non-voice SMS, GPRS and EDGE services to its subscribers determines the treatment of economies of scope achieved by the actual voice and data operators. Economies of scope arising from the provision of these services across a shared infrastructure will result in a lower unit cost for voice services. Also, the stand-alone 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

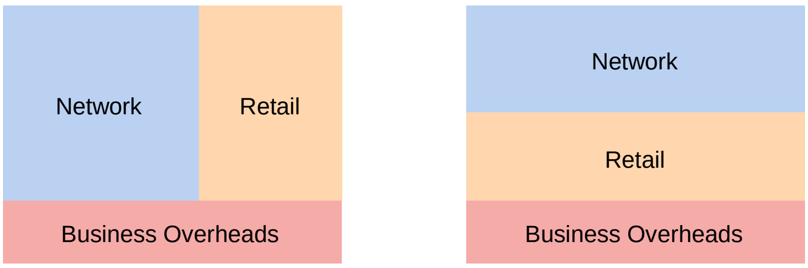
Assessing both voice and data services in the model increases the complexity of the calculation and the supporting data required, and will result in a lower unit cost for voice services due to economies of scope. Conversely however, excluding costs relevant to non-voice GSM services (and developing a stand-alone voice cost) can also be complex[20]. In Norway, the majority of non-voice services are reasonably proven services rather than emerging services that might be undermined by inclusion in regulated prices for voice or require operators' cross-subsidy by the profits of scope economies. In the case of GPRS and EDGE, traffic volumes may currently be limited – therefore a conservative approach to forecasting GPRS and EDGE may therefore be appropriate if suggested economies of scope are significant (therefore strongly reducing the economic cost of voice on the basis of an uncertain and aggressive data traffic forecast).

Recommended approach

Recommendation 11: The modelled operator should provide SMS, GPRS and EDGE 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.

4.2 Wholesale or retail

This issue is best described by the diagrams below:



Vertically separated *Vertically integrated*

Exhibit 10: *Wholesale or retail* *[Source: Analysys]*

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

[20] 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

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. Consequently, there is no concept of 'wholesale' access to mobile termination in the vertically integrated model as all retail costs are included in the service costing.

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. 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 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.

Recommended approach

Recommendation 12: Consistent with NPT's definition, only wholesale network costs should be calculated, though business overheads that are common to retail and network operations should be included through a mark-up on all services.

5 Implementation issues

5.1 WACC

The appropriate level of return to be allowed on regulated services is a standard aspect of regulatory cost modelling. NPT has previously considered the WACC applicable to mobile operators[21].

Costing implications

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

Recommended approach

Recommendation 13: Update and apply NPT's existing mobile operator WACC calculation.

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 annuities
- economic depreciation.

21 Thore Johnsen: *Kapitalkostnad for norske mobilselskaper*, March 2005. The report is available in Norwegian at: http://www.npt.no/iKnowBase/Content/kapitalkostnad_mobilselskaper.pdf?documentID=44292

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 cost today		✓	✓	✓
Forecast MEA cost			✓	✓
Output of network over time				✓
Financial asset lifetime	✓	✓	✓	✓[22]
Economic asset lifetime			✓	✓

Exhibit 11: *Factors considered by depreciation methods [Source: Analysys]*

The primary factor in the choice of depreciation method is whether network output is changing over time. In a fixed network, circuit switched traffic levels are generally stable, and so tilted annuities are often chosen as a proxy for economic depreciation. In a mobile network cost model where demand is varying over time (e.g. for an actual operator), then results using tilted annuities 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.

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

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

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 upfront 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 utilised 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 = the PV of economic costs recovered, or alternatively the net present value of cost recovery minus expenditures is zero. An allowance for capital return earned over the lifetime of the business, specified by the WACC is also included in the resulting costs.

Recommended approach

Recommendation 14: NPT intends to implement an 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 is supplied in the annex, however operators will have the opportunity to comment on the implementation of economic depreciation in the draft model released to industry in the second consultation of this process.

5.3 Increments

Increments in the LRIC 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 (for common costs). 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 are marked-up onto the relevant increments.

The size and number of increments adopted affects the complexity[23] of results and the magnitude[24] of the marked-up incremental costs. Where increments combine one or more services, 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 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.

Considering coverage deployments in mobile networks, it is evident that a significant amount of traffic-carrying capacity[25] can be associated with the coverage deployment. With increasing traffic levels, upgrades to coverage sites will occur: additional TRXs, additional sectors, and eventually additional sites through cell splitting. Applying smaller increments will capture the effect of these deployment upgrades on the long-run cost at the margin – and importantly, this long-run cost function gradient at the margin will include a proportion of coverage capacity deployed in that network area. This is illustrated in Exhibit 12, along with the associated conclusion that, depending on the assumed long-run traffic volume, only long-run fixed coverage costs are considered common whilst short-run coverage capacity is treated along with other incremental costs.

23 More increments = more calculations required of the model and more common costs to deal with in the mark-up

24 Through the mark-up mechanism

25 For example, deployment of a tri-sectored site with 2 TRX per sector (for redundancy) can support 90 traffic channels

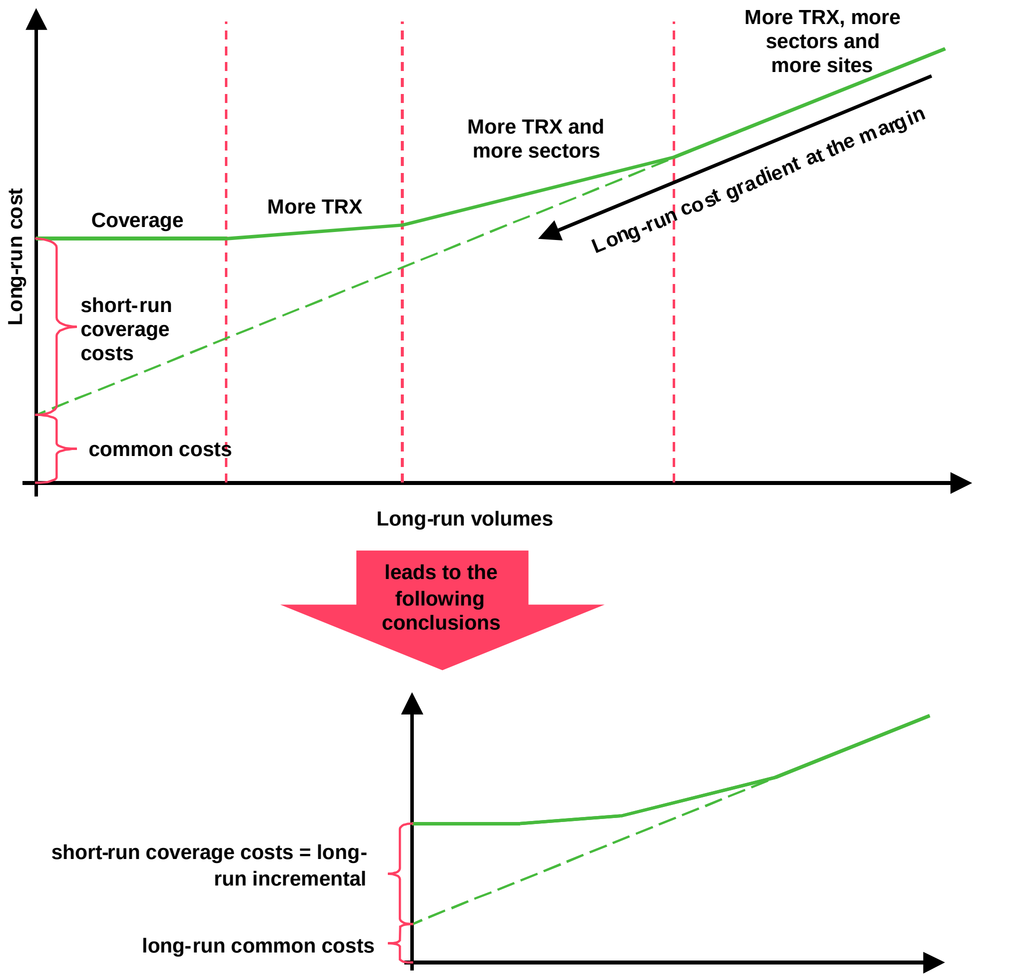


Exhibit 12: *Identification of long-run common and short-run coverage costs [Source: Analysys]*

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 an emerging 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 is only required for terminating 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, GPRS and EDGE traffic load the network (or are accommodated by it in other ways such as channel reservations). Assessing what proportion of the coverage network capacity is part of the long-run cost function indicates the importance of the modelled long-run traffic volumes on the magnitude of common costs.

Recommended approach

Recommendation 15: Only long-run fixed costs (rather than the entirety of the coverage network) are to be identified as common to network services. Therefore elements of the coverage network which contribute capacity to traffic-driven parts of the network will be considered as part of the incremental cost of traffic at the margin. Traffic incremental costs should be shared out according to average traffic routeing factors, since this approach ensures that all traffic services pay a fair share of traffic costs – this includes data services which will be assessed on a voice-equivalence basis. Network subscriber incremental costs should be separately identified and recovered through relevant traffic services.

5.4 Year(s) of results

There are three options for time frames for the calculation:

One year only (e.g. 2005)	This approach can simply compare costs today with prices today.
Forward-looking only (e.g. 2005 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 utilise 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.

Given Analysys's experience of bottom-up LRIC models, and their use in conjunction with top-down information, 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.

Recommended approach

Recommendation 16: 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). 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.

5.5 Mark-up mechanism

The specification of an incremental 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.

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

Equal-proportionate mark-up	In this method costs are marked up pro-rata to incremental costs. It is simple to apply, and does not rely on the need to develop additional supporting information to control the mark-up calculation. EPMU has been applied by Ofcom and PTS in their recent mobile LRIC 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 has discussed Ramsey pricing in the decision for Market 16, on 19 September 2006. 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[26].

NPT also shares the assessments of Ofcom and PTS, and has not previously accepted allocating 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 LRIC 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.

Recommended approach

Recommendation 17: NPT proposes to apply an equal proportionate mark-up for network common costs and the network share of business overheads.

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

Annex A: 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 of the revenues[27] 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 cashflow, 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 fifty 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.

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

27 Strictly cost-oriented revenues, rather than actual received revenues

regulatory pricing perspective to choose an arbitrary or highly fluctuating recovery profile[28]. 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[29]. 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 of all 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 the supporting the revenues generated across the lifetime of the operator.

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28 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

29 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 implemented 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.

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