Final report for Vodafone Australia

Review of WIK's mobile network cost model

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0 Introduction

Analysys Consulting Limited ("Analysys") has been commissioned by Vodafone Australia to undertake a study between 18 July and 3 August to review the mobile network cost model developed by WIK for the Australian Competition and Consumer Commission (ACCC). The report is structured in two sections:

- review of the principles and approach adopted by WIK in modelling mobile termination costs in Australia for the ACCC
- benchmark of the input data from WIK's model with the input data from public cost models using an efficient-entrant approach. The data is benchmarked with the public models published by Ofcom (UK), OPTA (the Netherlands) and PTS (Sweden). The versions are:
  - Ofcom LRIC model R3 – September 2006
  - OPTA Mobile BULRIC model v3 – June 2006
  - PTS Bottom up model v5 – December 2003.

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1 Review of the principles and approach adopted in the WIK model

An important goal of regulation is to ensure that prices are fair and reasonable, where competitive forces are insufficient. Any regulatory price-control mechanism should encourage prices that reflect what one would observe in a competitive environment.

When setting prices, the regulator must be very careful to strike the right balance between protecting consumers and maintaining incentives to invest, both for existing operators and potential new entrants, and find the appropriate methodology to calculate the prices. A successful cost model that will be used to set prices should be:

- **Accurate**, so that the results can be used to support decisions based on the right level of prices
- **Transparent**, so that the methodologies followed for the attribution of costs and preparation of the results can be verified
- **Credible**, so that the market accepts the methodologies and results of the model.

We believe that the WIK model fails on each one of these counts, for the reasons listed below.

The WIK model's accuracy is undermined by a number of errors

The accuracy of WIK's model and documentation is in doubt as it contains a number of errors such as the use of network traffic as service traffic (see details in Section 1.8). This leads to a significant understatement of mobile termination costs. We have also identified a number of less important issues:

- it assumes 32 channels per E1 instead of 30

– the assumption regarding the type of Base Transceiver Station (BTS) deployed within certain areas is wrong (for example, macrocells are assumed to be deployed only in suburban and rural areas, when in reality urban macrocells are needed to provide outdoor and vehicular coverage for people in urban areas)
– in the WIK model documentation, the maximum number of TRXs per BSC is said to be 800,[1] however the model itself outputs a maximum value of 2689 and a mean value of 1105
– if the WIK model is run under the scenario where the hypothetical operator has a market share of 17% (Vodafone's current market share), the results for the different types of BTS are 3148 macrocells and 807 microcells/picocells, as compared with the data provided by the ACCC (2639 and 1332 respectively).[2]

Despite all the available documentation, the model is not transparent

The WIK model is implemented in a way that does not provide much flexibility in terms of changing inputs and assumptions and does not allow access to intermediate results to validate some of the algorithms.

This lack of transparency in the model could potentially be mitigated by detailed documentation that made the model's workings more readily comprehensible to other users.

Unfortunately, it is not possible to verify whether any of algorithms are correctly implemented (the model is not traceable) and the methodologies followed to calculate some of the algorithms, such as the conversion factors of SMS to equivalent minutes, the routeing factors for the core network, or the determination of the number of

[1] *Mobile Termination Cost Model for Australia* – WIK January 2007 – page 114

[2] *Draft MTAS Pricing Principles Determination 1 July 2007 to 31 December 2008* – June 2007

transceiver units (TRXs) required, are not fully explained in the documentation.

The lack of transparency in WIK's model and supporting documentation generates doubts about the methodologies followed.

The credibility of the model is further undermined by the lack of a detailed consultation process

No mobile operators were consulted during the construction of the WIK model and therefore the model has not been calibrated with industry data. Involving market players is key to refining the argumentation on contentious aspects of the modelling and is becoming the norm in European mobile termination modelling processes as it leads to more robust and reliable results.

One example of the lack of credibility of the model is the input data used to calculate asset costs. The WIK report states "*that equipment prices are derived from benchmarking analyses informed by bottom up costing modelling undertaken in the UK, the Netherlands, Sweden and Germany*".[3] However, it is impossible to correlate the unit asset prices with the data available from the public models, and in most of the cases there is a large variation.

For example, the unit cost of the software switching machine in the WIK model is EUR590 000 compared with EUR1.4 million, EUR3.7 million and EUR1.3 million, in the OPTA, PTS and Ofcom models respectively. We were not able to make any comparison with the German version, since to our knowledge it is not a public model. As a result, its validity as a benchmark can be questioned (for more detail, see Section 2.4). Vodafone has informed us that it will provide the ACCC with software unit cost data to confirm that the unit cost input data used in the WIK model is very different from the costs incurred by an operator in Australia.

[3] *Mobile Termination Cost Model for Australia* – WIK January 2007 – page 115

In the rest of this section, we discuss a number of key issues regarding the principles and approach adopted in the WIK model.

1.1 Top-down and bottom-up costing

Bottom-up and top-down approaches to calculating the costs of mobile services perform important complementary roles in ensuring the accuracy and relevance of the results for regulators. They also facilitate subsequent industry buy-in to both the results and any ensuing regulation.

Bottom-up models are of importance to regulators because they perform a number of key functions:

- they can be constructed independently by the regulator and consultant, initially with general industry data and no confidential information from the mobile operators
- they enable the examination of the impact of different scales (actual operators or hypothetical operators with different market share) and other differences between operators, within a consistent framework (such as GSM900 versus GSM1800)
- they enable the examination of efficiently incurred costs of actual mobile operators.

Top-down models provide key information that cannot be obtained by other means, and are most valuable when used in conjunction with bottom-up models:

- they are based on an operator's actual costs, therefore no costs are ignored
- they capture actual operating environments
- they are usually weak when the core objective is to calculate the long-run incremental cost of a specific service
- they are often constructed by each operator's regulatory accounting department
- the network and cost inefficiencies of specific operators are generally embedded in the modelling approach
- they can only be constructed with confidential operator data.

WIK's model uses a bottom-up approach without any reconciliation with top-down accounting data, or any model calibration. In Analysys's opinion, the ideal approach to investigating and costing mobile services relies on a combination of both methods: the bottom-up model provides flexibility and transparency, while the top-down model provides a viewpoint based on actual operator data, with which to compare the bottom-up model.

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

WIK states: "*In general, by using certain approaches of model calibration it is possible to combine the strengths of both of these approaches. Such a hybrid approach first develops a bottom up model and calibrates the outcomes of that model with the network element and cost components of specific network operators. However, different approaches to model calibration can sacrifice the efficiency aspects of the bottom up costing elements of a hybrid model when it adopts the cost structures and the cost levels of specific operators.*"[4] In our opinion, calibration is very important, since it helps to compare actual data with that produced by the model to verify the legitimacy of the results and better replicate the network and the costs that a hypothetical entrant would have. Calibration makes it more

[4] *Mobile termination cost model for Australia*, WIK, page 5

likely that the market will accept the results and reach an agreement among the different parties. The models developed in UK, the Netherlands and Sweden are bottom-up models calibrated with operator data.

1.2 Network modelling

One of the key assumptions to be made in a bottom up model is the network modelling assumption. There are four approaches to network modelling in a cost model, which we list below.

- Actual network: no adjustment is made to the number and type/capacity of nodes – the actual network is applied in the model.
- Scorched-node: it is assumed that the number and location of nodes in the modelled network is the same as in reality. However, the type/capacity of equipment at each node can be 'scorched' and replaced to modern standards.
- Modified scorched-node: the starting point for this modelling approach is the actual number and location of nodes in the network. However, in carrying out the 'scorching' assumption at each node, the network may be optimised in order to ensure that an efficient network is achieved.[5] Optimisation of the network in this manner might only be applicable to certain parts of the network, such as the Mobile Switching Centre (MSC), or the Home Location Register (HLR), where operators often voluntarily rationalise their architecture) and would not generally be considered applicable to radio sites (where wide-scale physical rationalisation of site locations is not common, at least involuntary).
- Scorched-earth: the starting point for this modelling approach is the greenfield approach, in which the number, location and type/capacity of network nodes can be

[5] An example of this might be where an operator has ten nodes with older switches with a 100k capacity (total capacity 1000k, with a high level of utilisation per switch given the geographic diversity). If the modern capacity of a switch is 300k, then it might be considered inefficient to install the modern switch at all ten locations (total capacity would be 10×300k – 3000k). As such, an optimised, efficient and modern scorched-node network might consist of five nodes (total capacity 5×300k = 1500k, which represents a lower level of utilisation per switch because of the lower geographic diversity).

planned according to the (predictable) modern demands on the network and the modern equipment type/capacity deployment rules.

The ACCC states that *"the WIK model replicates an optimised network for a hypothetical efficient operator under certain assumptions about market penetration and population coverage. This is a scorched earth approach to network design. In this way the WIK model is not intended to represent the actual deployment of any mobile network operator's network in Australia."*[6]

The Independent Regulators Group (IRG) considers the implementation of a modified scorched-node approach to be a principle of implementation and best practice[7] and most of the mobile LRIC models developed by regulators employ this methodology. Analysys agrees that the most appropriate approach to estimate the efficient cost of supplying Mobile Terminating Access Service (MTAS) in Australia is a modified scorched-node.

The scorched-node approach is usually employed because it enables the model to be grounded in reality – i.e. the actual networks that the operators have deployed. It is unlikely that the operators' actual networks are highly inefficient, heavily demand-constrained, or without reasonable headroom for further growth, and hence a scorched-node constraint is most appropriate to ensure a bottom-up model reflects the actual networks of the operators. Conversely, a scorched-earth or greenfield model may not be very closely related to the actual networks of the operators, and as a result may inaccurately calculate resulting network costs.

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 (such as propagation losses based on 3D topographical modelling). The application of network node adjustments indicates the network efficiency standards above which excess cost recovery is not allowed.

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6 *Draft MTAS Pricing Principles Determination 1 July 2007 to 31 December 2008 – June 2007,* - page 36

7 *Principles of implementation and best practice regarding FL-LRIC cost modelling* – 24 November 2000

The scorched earth approach usually makes use of network planning tools (as is the case in WIK's model). While potentially valuable, using such tools runs the risk of underestimating what a reasonably efficient network deployment would be, and thus not allowing the existing operators to recover their efficiently incurred costs. For example, a network deployed in an efficient manner at a given time, might have a new housing development constructed in a previously rural area some time after the network was deployed. In these circumstances, the efficient choice for the network operator is likely to be to add new sites even though an efficient network being deployed after the construction of the housing development might locate its base stations in different places. The modified scorched node approach mitigates this risk.

In the radio network, the roll-out develops over time in response to changes in demand (or forecast demand). To an increasing extent, the location of network nodes is dictated by the availability of suitable radio sites on the ground. Moreover, radio network design is a complex process, involving a very large number of factors and design parameters, not all of which are measurable in advance. Therefore, given that these are real effects that increase the cost of providing service over and above the minimum cost that would arise if the network designer had perfect knowledge and could deploy the network on an unrestricted greenfield basis (i.e. wherever he liked), and that these effects are also impossible to comprehensively capture in a predictive cost model, scorched-node allowance and calibration are reasonable.

In the core network, there are fewer network nodes and their distribution is less complicated. As such, and given the nature of technology evolution in the core network (e.g. core network equipment capacity has increased by a factor of ten in the last 15 years), the application of the scorched-node principle to the core network may need to be accompanied by a degree of optimisation to ensure the resulting network is modern and efficient.

Site sharing

WIK designs the model to account for site sharing, applying a factor to reduce the amount of investment required per BTS site. The assumptions used are that 50% of macrocell sites, 30% of microcell sites and no picocell sites are shared. If the reduction in the investment value for macrocell sites and microcell sites is assumed to be 40%, this yields a net reduction in the investment value of 20% and 12% respectively for the relevant BTS site. The same approach is used for repeater sites such that 30% of the repeater sites share 40% of sites with another MNO. The implied average sharing factor is 12% for each repeater site.

The idea of site sharing is incompatible with the scorched earth approach, which permits a complete redesign of the network, without considering any past investment, or the existing location or number of nodes. There is no reason to suppose that a shared site will be available at the optimal location, therefore it is not sensible to use a scorched earth approach with such a high percentage of shared sites. Under a site-sharing scenario, the number of sites will have to be higher to get the same coverage level, as the location of sites will be suboptimal (i.e. it will not correspond with the location predicted using a scorched earth approach). In our opinion, the site-sharing assumption should be removed.

Mobile operators may choose to co-locate for a number of reasons, other than the cost-saving motivation assumed in WIK's model, which we list below.

- Outsourcing the development and maintenance of the sites is a way to reduce the peak funding requirement. It represents a transfer from capex to opex.
- Sharing existing sites can reduce operators' time to market. Obtaining permits and constructing a tower can take considerable time (from our experience in one European country, up to 18 months), which gives competitors a chance to establish their network and initiate service first.
- Site acquisition is becoming a much more complex activity due to the recent increase in demand for tower space.
- There is a limited number of suitable sites, owing to lack of space.
- Obstacles to establishing new sites are growing. Regulatory, environmental and community concerns include the visual impact on the environment.

1.3 Stand-alone mobile network

The WIK report identifies *"two possible reference case scenarios for the supply of the MTAS by a hypothetical efficient MNO. In both reference scenarios the hypothetical MNO is a new market entrant, has 96% population coverage, operates using GSM technologies and is a stand-alone mobile network. The two reference scenarios only differ in terms of the market share of the hypothetical efficient MNO, one scenario has a market share of 25% and the other 31%."*[8]

Technological neutrality

The ACCC, like all but one EU NRA, has stipulated that MTA voice services are technology neutral, so it does not distinguish between separate terminating access services on 2G (including CDMA), 2.5G and 3G networks. The WIK model's approach is based on the assumption that the 2G mobile network technology is the "best-in-use technology," representing the technology an efficient forward-looking operator would apply today at the current level of demand.

WIK's statement that 3G will result in a lower cost, as otherwise operators would not implement this technology, does not take into account the fact that 3G may have to be rolled out as a defensive move, as the delivery of voice service on 2G may not allow an operator to compete with other operators with more advanced services. Analysys believes that, in developed markets, evolution and migration from one technology to the next is a necessary and important evolutionary requirement that contributes to the long-term efficiency of mobile technology over multiple generations, and gives rise to reasonable allowable costs due to migration and the operation of technology with a finite lifetime. Accordingly, Analysys thinks it more appropriate to assume that migration to 3G will take place, rather than assuming that a 2G network will be operated in perpetuity.

By contrast, in the WIK model, the migration from 2G to 3G is totally ignored on the grounds that if 3G is more efficient, the result of the 2G model should represent the ceiling of efficient long-run termination costs in Australia. In addition, WIK considers that if

[8] *Draft MTAS pricing principles determination 1 July 2007 to 31 December 2008 – June 2007,* Page 37

carriers decide to migrate traffic from 2G to 3G networks, regulators should assume from this market behaviour that the costs of traffic migration (if any) are equal to or lower than the difference in cost between delivering voice calls over 2G and 3G.

WIK's model takes into account the fact that there are cost savings associated with moving from 2G to 3G (e.g. transmission, sites) but does not take into account the fact that migration incurs network-related costs, even when conducted efficiently. Nor does it take into account the fact that operators take time to build a 3G network. In the long term, an efficient operator in Australia should deploy and run networks of both types, 2G in rural areas and 3G in urban areas, which could result in under-utilisation of both 2G and 3G networks in their respective lifetimes. This contention is borne out by the fact that the only 3G-only operator in Australia purchases 2G services from other operators to provide coverage in rural areas.

Market share

We agree that in a fully competitive market with four mobile-only operators, each operator will have a 25% market share in the long term. However to regulate Vodafone, effectively the third player in the Australian mobile market, on the assumption that it can immediately acquire its 'long-run' market share of 25% is not reasonable – especially given that the other two operators are horizontally integrated, having fixed-line operations.

This aggressive case does not stimulate efficient market entry or investment, since if a third player such as Vodafone is regulated on the basis of achieving 25% market share immediately, the higher costs that it will necessarily incur over the period of building up coverage, demand and market share, however effectively it can penetrate the market, will have to be recovered from origination charges (making it uncompetitive against existing market players) or will result in lower returns on investment (making it harder/costlier to raise funds for investment).

If the model is intended to represent a fixed long-run cost, at a stabilised market share of 25%, then its application to regulation should reflect this fact, and mobile termination rates reflect the current scale of operators until they attain 25% market share.

Some regulators, such as in the UK, the Netherlands, Sweden, Norway and Greece, have not assumed that the market is perfectly contestable (and 25% is achievable instantaneously). Instead they have reflected the realistic partial contestability of the market: it takes a number of years to increase scale, and these higher costs should be recovered over the relevant period. Accordingly, we think it aggressive that the WIK model does not assume any costs will be incurred as a result of the increase in scale.

1.4 Depreciation

The selection of a depreciation methodology is essential for the calculation of annual costs. According to the IRG, economic depreciation is the most appropriate depreciation in current cost accounting systems applied to electronic communications. It states that when using a bottom-up model, *"NRAs should choose CCA asset depreciation periods and profiles that reflect the economic life of the assets."* [9] The IRG goes on to say:

"IRG believes, in respect of top-down or accounting based models, that CCA accounting rules for asset lives can, as a starting point, be consistent with the policies used by the operator in preparing its financial or statutory accounts. However, estimated asset lives for accounting purposes applied historically may not provide an appropriate economic cost base for regulatory decisions. Where these lives, including for example fully depreciated assets that remain in use, conflict with regulatory objectives then objective alternative depreciation profiles should be considered."

Unlike traditional accounting methods of depreciation, which rely upon simplistic schedules for cost recovery that take little or no account of market dynamics, economic depreciation calculates the efficient cost recovery by an operator in a (hypothetical) competitive market.

The IRG acknowledges that appropriate surrogates for economic depreciation may be preferred for practical reasons, and accepts that annuity methods of depreciation are one of the better surrogates: they combine both the capital repayment and capital financing aspects of total costs in a single annualised cost that is either constant over time (if a simple

9 IRG, *PIBs on the use of current cost accounting as applied to electronic communication activities* (November 2005).

annuity is used), or declines or increases at a constant rate over time (if a tilted annuity is used).

In the case of tilted annuity, costs are recovered over the economic lifetime of the asset, on an annuity basis (constant over time) adjusted to reflect the underlying costs of production (modern equivalent asset, (MEA) trends). When using economic depreciation, costs are recovered over the economic lifetime of an asset, according to the same underlying costs of production (MEA trends) but also reflecting the change in output of network assets over time. It is this 'output profile' that distinguishes economic depreciation from a tilted annuity.

The WIK model recovers capex on the basis of the titled annuity methodology. In Analysys's opinion this is not the best methodology to use in a mobile LRIC model. Where the network element output profile does not change significantly over time – i.e. demand levels are relatively stable – it may be possible to adopt the tilted annuity as a good approximation for economic depreciation. In such cases it will be important to check that the difference in unit price derived by each method is immaterial. However where the network element output profile does change significantly over time – for example, a rapidly growing mobile subscriber base – then the tilted annuity result is likely to diverge significantly from economic depreciation in any given year. Tilted annuity will fail to account for the impact that higher asset utilisations and increased economies of scale *in future years* have on the LRAIC *today* when calculated using economic depreciation.

Traditionally, a tilted annuity has been applied to regulatory cost models of *fixed* networks – since fixed network (PSTN) demand has been relatively stable for a reasonable number of years and price regulation has been based on the costs of an operator with the incumbent's level of demand. In *mobile* networks, demand has grown more than tenfold in a small number of years, as penetration has increased from 5% to 80% in a relatively short timeframe, and therefore economic depreciation has been used to calculate unit costs given rapidly rising outputs.

1.5 Cost of capital

The appropriate level of return to be allowed on regulated services is a standard aspect of regulatory cost modelling. The weighted average cost of capital (WACC) can be calculated using a variety of methods, the most common being the capital asset pricing model (CAPM) to determine the cost of equity, which is the methodology employed by WIK and the ACCC. The following table presents the input data used to calculate the cost of capital.

	February 2007 – WIK model	*June 2007 – ACCC proposition*
Gearing	17.2	40
Risk free rate	4.434	5.5–5.7
Market risk premium	4.5	6
Equity beta	1.32	1.1–1.3
Debt premium	1.02	1.02
Debt issuance cost	0.083	0.083
Post-tax WACC	9.53%	10.7–11.8%
Pre-tax WACC	11.68%	13%

***Exhibit 1.2**: Cost of capital used in WIK model February 2007 and proposed by the regulator June 2007 [Source: Analysys based on WIK and ACCC data]*

The WACC proposed by the ACCC is in line with those used by some European regulators for regulatory purposes (see Exhibit 1.3).

Country – operator	*WACC*	*Date*
France	15.0%	Dec-04
Greece	16.3%	Dec-04
Italy	12.0%	Mar-03
Norway – Telenor	13.5%	Jan-06
Norway – Netcom	13.0%	Jul-05
Spain – TME	10.6%	Jan-06
Spain – Vodafone	11.22%	Jul -07
Spain – Orange	11.06%	Jul -07
Sweden	12.6%	May-04
UK	11.0%	Jun-05

***Exhibit 1.3**: Mobile nominal pre-tax WACC used for regulatory purposes [Source: Analysys]*

1.6 Common costs

Common costs include such costs as management, administration and human resources. These common costs need to be recovered from services in some way, generally by using mark-ups. Two main mark-up mechanisms are put forward and debated in the context of mobile termination costing, which we outline below.

- **Equi-proportionate mark-up (EPMU).** In this method, costs are marked up pro rata to cost. This is simple to apply and does not rely on the need to develop additional supporting information to control the mark-up calculation.

- **Ramsey pricing.** It is a targeted common cost mark-up mechanism that places the burden of common cost recovery on those services with low price elasticity.

ERG believes that the Ramsey pricing mark-up is almost impracticable due to the complex and dynamic information requirements regarding demand elasticities.[10] Most regulators use EPMU.

The WIK model allocates organisational-level costs using an equi-proportionate mark-up on network element costs. A predefined, fixed amount of common organisational-level cost is then added in the model to capture other regulatory fees. We believe that WIK's approach is in line with that used by most regulators, but note that the level of the mark-up and size of the organisational costs have not been benchmarked in detail against those of Australian operators.

1.7 Lifetimes

In general, depreciation calculations may consider three types of asset lifetime, which we list below.

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[10] *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.*

- ***Physical lifetime***. This reflects the lifetime of the asset until it is declared impaired and written off the balance sheet.

- ***Financial lifetime***. This reflects the accounting lifetime of the asset, which is used to calculate depreciation charges.

- ***Economic lifetime***. This reflects the productive lifetime of the asset. An asset may become unproductive before the end of its physical lifetime if the present value of its future costs (including operations and maintenance) is higher than the present value of the future revenues associated with the asset.

The financial lifetime of software is usually five years, and the WIK model uses this value. However, a mobile termination cost model for a hypothetical efficient operator should use the economic lifetime. The economic lifetime of software is no more than three years, since vendors tend to produce standard software releases, plus optional feature upgrades on an annual basis. Some telecoms operators are accordingly decreasing the software lifetime used in their financial accounts:

- Telefónica group 2006 annual report: "*These items are stated at cost and are amortised on a straight line basis over their useful life, generally estimated at three years*"
- Vodafone group 2006–7 annual report: "*These costs are amortised over their estimated useful lives being 3 to 5 years*"
- Bouygues Telecom Company 2006 financial statement: "*IT system software and developments are amortised over a period of 4 years."*

1.8 Traffic handling

In this section, we discuss the way the traffic is handled in the WIK model. We present the traditional approach to dimensioning the traffic in bottom-up models and compare it to the WIK approach, including the input modifications that have been made to adjust the model so it better reflects the Australian market in the period under examination (2007–8).

1.8.1 Traffic dimensioning

Mobile networks are dimensioned to handle the traffic in the busy hour (BH). The BH traffic is derived from the total traffic handled by the network by taking into account how the yearly traffic is distributed over the number of average busy days in the year ('Days' in Formula 1 below) and, in turn, how the daily traffic is distributed over the 24 hours of the day.

$$BH\ traffic\ originated = \frac{annual\ traffic \times \%traffic\ in\ BH}{Days} \quad (1)$$

The total volume of traffic quoted by mobile operators is typically mobile-originated. They do not normally include the incoming traffic received by mobile subscribers whether on-net (from another subscriber on the network) or off-net. [11]

If we take, for instance, the air interface between the BTS and the subscribers, it has to be dimensioned to take into account the traffic both outgoing from, and incoming to, the subscriber. This is defined as *network traffic*. BTS network traffic is equal to the sum of off-net outgoing traffic plus off-net incoming traffic, plus on-net minutes weighted by a routing factor of 2 (since the outgoing on-net traffic has a corresponding volume of incoming on-net traffic).

$$Network\ BH\ traffic = \sum_{traffic\,type} BH\ traffic_{traffic\ type} \times Routing\ Factor_{traffic\ type} \quad (2)$$

Different network elements have different routing factors for the various services. For example, the routing factor for the MSC depends on the total number of MSCs in the network, the location of the interconnect points and the traffic profile (volumes and destination of calls).

Two more factors that need to be taken into account are the proportion of unbilled minutes and the difference between the holding time and the billed time, which results in a greater

[11] Note that MNOs in Australia are required under the RAF requirements to report both service traffic originating minutes and off-net incoming minutes.

total traffic than that resulting from the application of Formula 2. In Formula 3 below, we represent both these factors by K, where K>1.

$$Total\ Network\ \ BH\ traffic = K \times Network\ \ BH\ traffic \quad (3)$$

It is on the basis of this traffic that the network should be dimensioned.

Once the network is dimensioned, it can be costed by multiplying the number of assets deployed by the asset unit costs. The investment costs are annualised and operating expenditure is added onto the annualised investment costs for each element. The traffic unit cost per network element is then calculated as the total annual cost per network element (asset type) divided by the total network traffic handled by that asset type, which is calculated using the routing factor for that asset (e.g. an on-net call minute generates two minutes of BTS traffic).

$$Element\ Unit\ Cost = \frac{Total\ \ Annual\ Cost\ to\ be\ \mathrm{Recov}\,ered}{Element\ Total\ \ Network\ Traffic} \quad (4)$$

Finally, the service unit cost can be derived from the sum of the weighted unit costs of the network elements required for its provision (using routing factors for the weighting) and the network traffic going through that element divided by the service traffic.

$$Service\ Unit\ Cost = \frac{1}{ServiceTraf} \sum_{Elements} RF_{Elem} \times Element\ \ Unit\ Cost \times Network\ Traf_{Elem}$$

(5)

1.8.2 WIK model implementation

We have identified four major issues with the WIK model's handling of traffic, which we list below.

- In the WIK model, BH traffic per subscriber is the basic traffic input for dimensioning the network, instead of total volume of traffic. Although the WIK calculation of annual network traffic/BH traffic relationship is back to front compared to the method used by European regulators, this should not affect the final answer if calibrated correctly.

- The 8.3 mill-Erlang (mE) input used in the model was based on traffic data in line with 2004–5 traffic volumes. The ACCC has since agreed to update the model to reflect current traffic volumes. This shows the importance of calibration.

- In the consultation process between the ACCC and interested parties regarding the WIK model, it became apparent that the WIK model uses network traffic (i.e. including a RAN routing factor of 2 for on-net calls) to calculate unit cost per service. If this mistake is corrected, the WIK model fails to recover all the cost, recovering only 72%. The cost of MTAS increases by up to 60%.

- The WIK model assumes that the average subscriber generates the same amount of traffic regardless of his or her location, and that subscribers are evenly distributed throughout the coverage area. These assumptions will lead to a network with under-capacity in high traffic areas.

We discuss these issues in more detail in the rest of this section.

Annual traffic/BH traffic relationship

The WIK model addresses the traffic-dimensioning problem differently to the method described in Section 1.8.1 in that the input parameter is the BH traffic per subscriber and the total traffic in the network is the result of the conversion process described in Formula 6 below:

$$Annual\ traffic = \frac{BH\ traffic \times Days}{\%traffic\ in\ BH} \quad (6)$$

The BH traffic is actually calculated from an average BH traffic per subscriber multiplied by the number of subscribers. The BH traffic per subscriber is assumed to be constant for any subscriber and any network.

This raises the two issues listed below.

- Firstly, annual traffic is easier to benchmark than BH traffic for any given network.
- Secondly, using WIK's method, one cannot adjust for different traffic profiles in the various networks, as a change in the profile would automatically result in a change to annual traffic and consequently yield a different unitary cost.

However, provided the conversion ratio values are correct, both WIK's and Analysys's suggested approaches should result in the same BH traffic for a given total volume of traffic.

Total traffic adjustment

Possibly due to the lack of relevant Australian benchmarks, the original version of the WIK model used a BH traffic input of 8.13 mE per subscriber, which implied an overall traffic volume in Australian networks of 27.5 billion minutes.[12] This figure is closer to the volume of traffic in the networks in 2004–5 than in 2006–7.

	Total	Origination/ termination	On-net	Total network minutes
Telstra	8,026	2,124	5,902	13,928
Optus	5,527	4,287	1,240	6,767
Vodafone	2,628	1,777	851	3,479
Other	180		180	360
Total	**16,361**	**8,188**	**8,173**	**24,534**

Exhibit 1.4: *Traffic 2004–5 (million minutes) [Source: Market Indicator Report, ACCC]*

The ACCC has agreed to update the model to reflect the traffic volume in the networks today (although we note that this has not yet been implemented in the model). Given that the conversion parameters have not changed (see exhibit below), there is a constant ratio

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between the BH traffic per subscriber input and the overall traffic implicitly assumed in the model.

Conversion Parameters	
Subscribers (million)	19.6
Percentage busy hour day	8.5%
Number of days	250
Mark-up other services	6%

Exhibit 1.5: *Traffic conversion parameters [Source: WIK]*

The total traffic volume in Australian networks has been estimated to be 43.5 billion minutes,[13] which is approximately the mean of two estimates of overall traffic that are derived from Telstra annual traffic, shown in bold in Exhibit 1.6 below.[14]

	Traffic [million min]
Telstra	
Voice traffic, first half results	4,147
Total year	8,294
Total minutes	16,588
Market share	43%
Overall Voice market	38,577
Data services	6%
Data services (eq voice min)	2,315
Volume (eq voice min)	**40,891**
Potential underestimate	16%
Total (eq voice min)	**47,434**

1

Exhibit 1.6: *Traffic estimates [Source: ACCC, WIK]*

We note that the unbilled traffic has been accounted for as 4% of the overall traffic (which would give rise to a value for K of 1.04 in Formula 3 above). In our experience, this value lies in the lower part of the range for adjustments used to account for the unbilled minutes in this kind of model.

On the basis that the assumption of 8.3 mE per subscriber of BH traffic was correct for the overall traffic assumption of 27.5 billion minutes, for an overall traffic volume of 43.5

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14 The second estimate takes into account the historical understatement (c. 16%) between the figures included in the ACCC market indicator report and those reported by Telstra in its accounts, the first does not. The Telstra figure is from its latest financial reports

billion minutes in all Australian networks, the corresponding BH traffic input should be 13.1 mE per subscriber. We are satisfied that this adjustment has been done correctly.

Use of routing factors

It is important to note that the figures of 27.5 billion minutes (2004–5) and 43.5 billion minutes (2006–7) minutes refer to the overall traffic in the access network (network traffic): the subscriber-originated traffic as reported by Telstra, 8294 million minutes, is multiplied by 2 (Step 1 in Exhibit 1.6 above) to take into account the subscriber-terminated minutes, whether originated on-net or off-net, on the assumption that the network on the whole generates as much traffic outgoing as incoming.

The WIK model documentation, dated June 2007, explicitly states that routing factors are used to calculate the service unit costs:

"The cost per minute of a service is calculated by using the unit costs for each network element and the corresponding usage factors."[15]

However, how routing factors were used to dimension the network and calculate the minutes of service is less clear. Since the figure of 8.3 mE per subscriber already took into account the incoming and outgoing traffic per subscriber, we understand that no further routing factor should be applied. We also understand that the number of TRXs is determined as that required to guarantee a given grade of service for the traffic offered at a given location (i.e. BH traffic per subscriber × subscribers). The references to this step of the calculation are not as clear as for the calculation of service unit costs.

However, we note that the volume of traffic equivalent to the 8.3mE (27.5 billion minutes) did take into account the routing factors (i.e. it is network traffic). Therefore, before applying Formula 5 above, one would need to adjust for it to calculate the service traffic.

This leads us to believe that there is a mistake in that step. We have done a robust side calculation that seems to confirm that this is the case, shown in the exhibits below.

15 *Mobile Termination Cost Model for Australia*, January 2007, page 93

- Scenario 1: overall traffic (27.5 billion minutes) is assumed to be service traffic (billed traffic) and is not the traffic used to dimension the network. Under this scenario, the WIK model recovers 90% of its costs from voice (a similar proportion to 94%, which represents the proportion of total traffic which is voice).

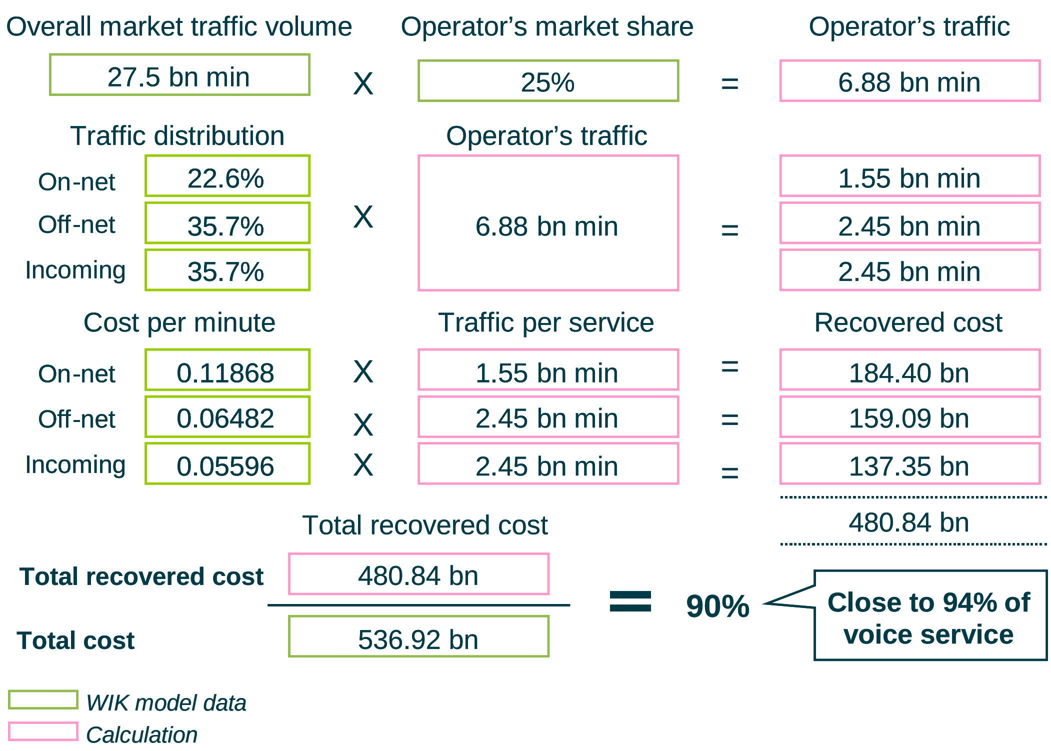

__Exhibit 1.7:__ Scenario 1 – overall traffic is assumed to be service traffic [Source: Analysys][16]

- Scenario 2: overall traffic (27.5 billion minutes) is assumed to be network traffic, i.e. the traffic used to dimension the network. Accordingly, on-net minutes are included with a routing factor of 2 for the radio access network. Billed minutes amount to around 22.2 billion minutes. In this scenario, the WIK model recovers only 72% of costs.

16 Note that row and column totals may not sum precisely, due to rounding

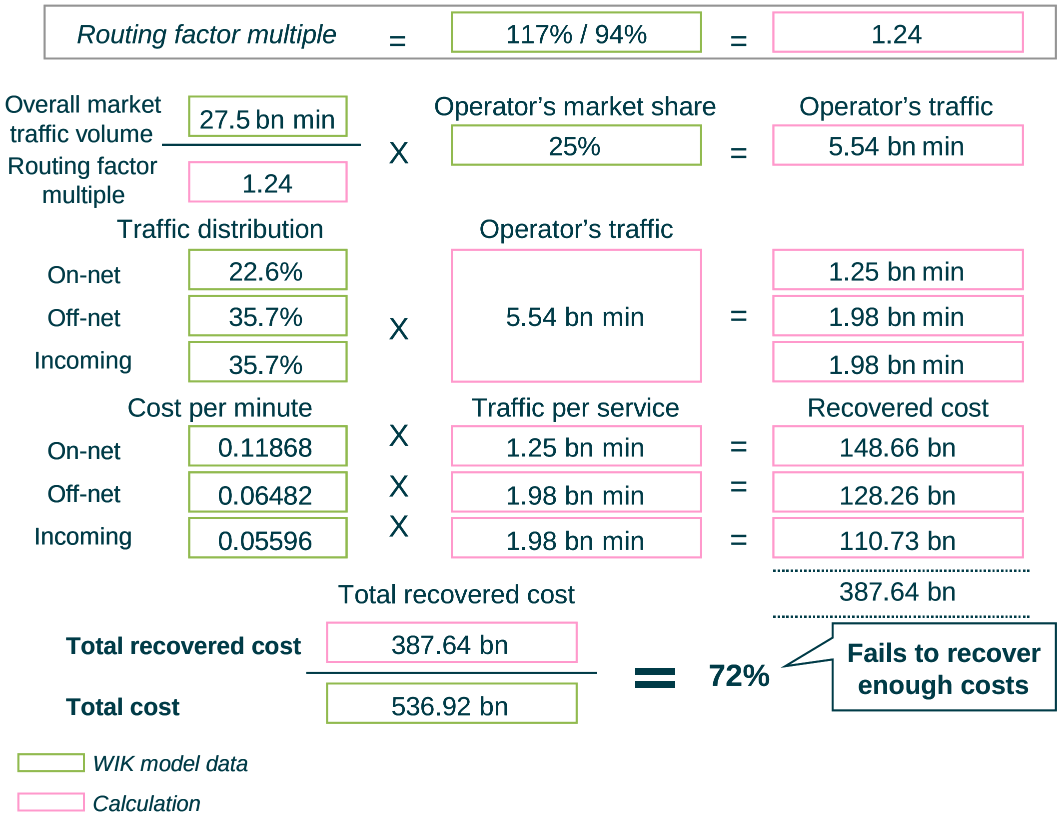

Exhibit 1.8: *Scenario 2 – overall traffic is assumed to be network traffic [Source: Analysys]*[17]

While we cannot implement the change in the WIK model, we estimate that correcting this mistake could increase the cost of MTAS by up to 60%.

Traffic offered to a BTS

The WIK model calculates the traffic that is offered to a BTS from the total number of subscribers in the coverage area and the BH traffic per subscriber. We have identified two main flaws with this methodology, namely:

- the assumption that the average subscriber generates a constant amount of traffic, regardless of the location

[17] The routing factor is derived by multiplying the On-net traffic by two: ((22.6*2) +35.7+35.7)/94

- the assumption that the subscribers of a given operator are evenly distributed throughout its coverage.[18]

Constant traffic regardless of location

The WIK model assumes that a subscriber generates a constant amount of traffic regardless of the location (Postal Area/POA) where he or she is. The number of subscribers in a given location is adjusted to take into account the resident population as well as the working population. However, these adjustments are not visible in the model and the parameters that define the network coverage are, at all times, in terms of inhabitant density per POA.

The lower traffic per subscriber in rural areas means that urban areas handle more traffic than the WIK model estimates. This has the effect of requiring further investment in urban areas and reducing the efficiency of the deployment in rural areas, which results in an overall higher investment per minute. This factor is also not taken into account in the WIK model.

Even distribution throughout the coverage

The WIK model assumes that the operator modelled has a constant market share of subscribers throughout its coverage. This assumption is not appropriate as the market share is a national figure and the actual market share in a given region (or on a given cell) may depend on factors that go beyond a network model, such as the competitiveness/availability of the distribution channels in that particular region or even neighbourhood.

Adjusting the model for both assumptions would result in a more uneven, but more realistic, distribution of traffic and consequently in a higher number of TRXs (and perhaps BTSs and BSCs). This discrepancy between the modelled network and the network in real operating conditions could have been avoided by carrying out a network calibration.

[18] On net traffic multiply by two: (22.6% *2 + 35.7% +35.7%) / 94%

1.9 Dimensioning of TRXs and deployment of BTSs

The TRX is the radio device that handles the subscriber traffic on the air interface. It is a key item in the network as it drives investment cost in its own right (total number of TRXs × unit TRX cost) and because it affects the number of BTSs and BSCs in the network, since BTSs and BSCs have limitations in terms of the maximum number of TRXs that they can host and manage respectively.

We note that the number of TRXs is referred to several times in the various documents associated with the WIK model, but that the methodology for deriving the number of TRXs is not described.

Furthermore, when it addresses the deployment of BTSs, the WIK model assumes that specific BTS types are deployed within certain areas: picocells in urban areas, microcells in suburban areas and macrocells for suburban and rural areas. In our view, WIK’s approach is not accurate since macrocells and microcells can be deployed in urban areas and picocells are not limited to urban areas.

Finally, the WIK model also estimates a high number of double-band BTSs in rural areas. if the WIK model is run under the scenario where the hypothetical operator has a market share of 17%, the result output is that 64% of sites have both GSM900 and 1800BTSs. One would expect a lower proportion, given that traffic density is typically lower than in urban areas.

1.10 Cost of spectrum

The WIK model assumes that a hypothetical operator is provided with spectrum in the 900MHz and 1800MHz bands. The cost of spectrum in the 900MHz band is equal to the annual charge that an operator with an equivalent spectrum assignment to that assumed in the model would have to pay.

In contrast, 1800MHz spectrum was assigned on the basis of an auction. Telstra, Optus and Vodafone paid different upfront amounts for gaining access to the spectrum. The model assumes that the amount paid by the hypothetical operator would be the average of the amounts that the three operators paid, which is plausible. However, when describing the way the upfront payment was annualised, WIK states that:

"This calculation would, however, be incorrect insofar as there is growth in the services using the spectrum. The annual amortised amount would change on the principle that each unit of service, independently of when it is delivered, should bear as a cost the same amount of amortisation."[19]

We have identified two main causes for concern here.

- This methodology for calculating the annual cost, taking into account the annual average growth rate of mobile services is more in line with economic depreciation methodology but is not consistent with the methodology used to calculate the annual cost of other network assets. The methodology used to calculate the annual cost of other network assets uses a tilted annuity approach, which takes into account annual price changes, not traffic growth.

- The proposed methodology is not in line with IFRS standards either. According to IFRS standards, the amount annualised each year should be constant, regardless of subscriber or traffic growth.

According to the new methodology the amortisation in year 1 is AUD10.68 million, as stated in WIK's documentation: "*The amount of amortisation in year 1 is A$10.68 million. This amount will be used in the current parameterisation of the WIK MNCM as the cost of spectrum in the 1800 MHz band."*[20] If we use the same methodology as is used for the other network assets, the result is higher: AUD13.93 million therefore it will increase the MTAS.

19 *Mobile Termination Cost Model for Australia*, January 2007, page 44

20 *Mobile Termination Cost Model for Australia*, January 2007, page 44

1.11 Allocation of the licence costs

The WIK model documentation states:

"The licence is related to the whole mobile business of an MNO and should therefore be treated in the same way as common organisational-level costs. One third of the licence fee is allocated to network services (this is consistent with the relative proportion of network costs to total costs of an MNO) and 2/3 to retail services."

In our opinion, the licence cost should be allocated to network services only, since the mobile operator would not be able to operate a network without the licence, which is needed to offer all network services.

The proposed allocation methodology is not consistent since it uses two different drivers to allocate the same cost. Furthermore, the 2:1 split is arbitrary. We note that the proposed methodology means that retail services are allocated approximately 66% of the cost plus 33% multiplied by on-net and outgoing share minutes.

1.12 Modifications proposed by the ACCC in June 2007

As part of the consultation process between the ACCC and interested parties regarding the WIK model, the Commission[21] proposed some modifications to the original version of WIK model released on 16 February 2007. As shown in Exhibit 1.9 below, some of the modifications have not been implemented.

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	WIK model January 2007	*June 2007 ACCC determination*	*Implemented in the model*
SMSCs	1	2	Yes
Recognition of transient population in POAs	No	Yes	Yes
Unbilled minutes	No	4%	Yes
HLR routing	All services	On net and off net term	Yes
Removal of the redundant terrain parameter	Elimination	Elimination	Yes
MSC	5	9	No – 5
Increasing mE demand	8.3	13.1	No – 8.3
Traffic reduction factor	0.1	0	No – 0.1
Influence of radio frequencies	Cell deployment	Single and dual band	No
WACC	11.68%	13%	No – 11.68%

Exhibit 1.9: *WIK model estimates that have been updated [Source: Analysys]*

2 Comparison of WIK inputs with other publicly available bottom up mobile LRIC models

As part of verifying the impact of WIK's inputs on publicly available cost models, several key parameters are compared between the WIK model and these models. We then test the public models using WIK's inputs for comparable parameters. Since the models are built using different concepts and methodologies compared to the WIK model, some parameters are not directly comparable, while other parameters require additional calculations to make them comparable. We have implemented these sensitivities in models from the UK, the Netherlands and Sweden.

For all the models, we have chosen parameters for the year where the operator's market share is about 25%. For the Swedish and UK models, parameters from 2006–7 were chosen, while for OPTA, the year 2016 was chosen,[22] as the hypothetical operator's market share stabilises at 25% in that year. Where the Ofcom model is concerned, we have used the 2G-only scenario.

2.1 Demand parameters

As described in Section 1.8, in the WIK model, BH demand is the basic input for dimensioning the traffic, whereas in the benchmark models the total traffic is an input based on operator data.

[22] For unit cost data comparison we have included also the 2006 scenario.

Each model calculates the network demand slightly differently, as the model specifications are typically adapted to the local context following consultation with the key stakeholders. Some assumptions were made when calculating the parameters listed below.

- OPTA – in the model, SMS services are excluded from the BH dimensioning. GPRS BH demand has been included in the dimensioning of the network.
- Ofcom – in the model, the demand for all services is converted into the equivalent BH Mbit/s and used to dimension the network. This differs from the other European models, where demand is dimensioned using equivalent BH Erlang traffic. Given that the conversion factors for voice, SMS, MMS and data into BH Mbit/s are available in the model, the traffic volumes for these services can be easily converted to BH Erlang.
- PTS – in the model, the demand for voice, SMS and GPRS services are used to dimension the network.

	WIK	*OPTA*	*Ofcom*	*PTS*
Busy hour percentage (%)	8.5	8.3	10.0	10.0
Traffic usage per subscriber	8.30 mE	9.95 mE	17.05 mE	10.55 mE
Voice usage per subscriber	7.83 mE	9.92 mE	16.50 mE	10.28 mE
Number of busy days a year	250	250	250	250

Exhibit 2.1: *Network dimensioning benchmark [Source: Analysys]*

WIK uses a significantly lower traffic per subscriber. We note that this cannot be really benchmarked between countries, but rather should be benchmarked against actual data from operators.

2.2 Traffic distribution

The WIK model uses information from the 2004–2005 Market Indicator Report published by the ACCC and traffic flows observed in the Australian market to approximate the distribution of traffic. The benchmark models use data provided by the operators to calculate these percentages.

- OPTA – the proportions for OPTA are calculated as equivalent service-level BH Erlang demand for voice and GPRS services. Note that SMS service traffic has been excluded from the distribution calculations
- Ofcom – the distribution for the Ofcom model is the percentage of equivalent mobile minutes as a proportion of total service-level mobile minutes. SMS and other data services have been converted into the equivalent minutes
- PTS – this is the service-level equivalent BH Erlang traffic for voice, SMS and GPRS services.

	WIK	*OPTA*	*Ofcom*	*PTS*
On-net voice traffic %	22.6%	15.6%	18.8%	17.8%
Off-net incoming voice traffic %	35.7%	42.8%	35.8%	43.0%
Off-net outgoing voice traffic %	35.7%	41.2%	42.4%	36.0%
HSCSD traffic %	0.8%	-	-	-
GPRS data traffic %	3.0%	0.3%	2.3%	3.0%
SMS data traffic %	0.1%	-	0.1%	0.2%
MMS data traffic %	0.1%	-	0.6%	-
Basic data traffic %	2.0%	-	-	-

Exhibit 2.2: *Traffic distribution benchmark [Source: Analysys]*

The traffic profile used in the WIK model is completely different from that in the benchmark models. WIK’s on-net voice traffic percentage is high compared to that in the benchmark models. In addition, we were unable to correlate the percentages used by WIK with the data available in the Market Indicator Report (the alleged source of WIK’s data). As we can see in Exhibit 2.3 below, the percentage of on-net traffic used by WIK is similar to that exhibited by Optus in 2004–5. However, we cannot be sure that this was the input data used by WIK, since this point is not specifically addressed in the documentation.

	Total billed traffic	*Origin/Term*	*On net*	*Total network minutes*
Telstra	8026	2124	5902	13 928
Optus	5527	4287	1240	6797
Vodafone	2628	1777	851	3479
Other	180	0	180	360
Total	16 361	8188	8173	24 534

Exhibit 2.3: *Traffic data (million minutes) [Source: Analysys calculations based on ACCC data]*

2.3 Capacity limitations for network equipment

WIK does not provide the source of the data used to calculate the capacity for network equipment. The parameters used in the benchmark models to set the network capacity or utilisation ratio are based on operator data.

	WIK	*OPTA*	*Ofcom*	*PTS*
Max number of TRXs/BSCs	800	1024	512	512
Max ports per MSC(E1ports/MSC)	4032	600	2048	512
Max users per HLR	1,200,000	1,000,000	300,000	1,000,000
HLR utilisation ratio	80%	65%	60%	79%

Exhibit 2.4: *Network topology benchmark [Source: Analysys]*

The assumptions in the WIK model regarding network capacity appear to be more aggressive than those in the benchmark models. The parameters used by WIK could have an impact on network resilience and quality of service.

In addition, as explained in Section 1, the maximum number of TRXs per BSC used in the model is not 800, the number stated in the WIK documentation. For example, the BSC located in Carlton South has 2684 TRXs which is excessive compared with the data used in the benchmark models (or even the WIK model's own stated constraints).

2.4 Equipment unit costs

The WIK model uses current replacement values for the network assets. Equipment prices are calculated using European cost benchmarks employed in costing models used in the UK, the Netherlands, Sweden and Germany. The benchmark models' inputs are based on operator data. The WIK data includes the site-sharing savings enjoyed by the operator, 20% in macrocell site construction and 12% in microcell site construction.

	WIK	OPTA 2006	OPTA 2016	Ofcom	PTS
Site construction per BTS macrocell	68,605	76,955	73,820	114,787	50,000
Site construction per BTS microcell	48,433	29,316	28,122	73,179	24,000
Site construction per BTS picocell	44,158	29,316	28,122	45,737	10,000
Total site construction	161,196	135,587	130,064	233,703	84,00
Site construction per BSC	95,996	2,134,495	1,835,090	1,106,806	-
1-sector BTS macrocell equipment	62,717	28,800	19,556	92,863	81,356
2-sector BTS macrocell equipment	70,397	-	-	109,107	94,916
3-sector BTS macrocell equipment	77,436	28,800	19,556	125,350	104,976
3-sector BTS microcell equipment	39,038	28,800	26,125	45,461	39,366
3-sector BTS picocell equipment	29,439	14,400	9,778	45,461	17,715
TRX	5,120	2,724	1,943	6,571	5,774
Hardware per BSC	1,393,215	2,494,036	2,054,477	2,154,313	1,968,300
Software per BSC	464,618	-[23]	-[24]	-[25]	-[26]
Total access equipment	2,141,980	2,597,522	2,124,867	2,579,127	2,312,403
Site construction per MSC	1,313,218	970,225	834,132	2,258,105	1,500,000
Hardware per switching machine	1,770,157	3,303,150	2,336,229	1,910,798	4,264,650
Software per switching machine	590,052	1,676,206	1,411,826	1,318,340	3,665,278
2Mbit/s port	1,920	-[27]	-[28]	2,497	2,296
HLR functionality	1,741,358	1,173,878	973,619	1,724,220	1,443,420
Total core equipment	4,103,488	6,153,234	4,721,674	4,955,854	9,375,644
SMSC unit	1,165,385	2,139,063	1,726,996	738,407	328,050
2MB Radio mini link	17,919	16,727	12,497	13,448	16,403
2MB Radio link system	17,919	16,727	12,497	13,448	16,403
8MB Radio link system	27,519	28,172	21,047	14,918	17,715
34MB Radio link system	41,598	-	-	18,315	21,651

Exhibit 2.5: *Equipment unit cost benchmark (euros) [Source: Analysys]*

23 Included in MSC hardware cost

24 Included in MSC hardware cost

25 Included in MSC hardware cost

26 Included in MSC hardware cost

27 Included in MSC and BSC cost

28 Included in MSC and BSC cost

The table above compares the unit cost data in the WIK model and in the benchmark models. While WIK claims to have benchmarked its asset prices against those used by public European models, WIK's cost data differs significantly. As shown below, the ratio of the values of the access equipment input data used in public models to that in the WIK model is between 0.99:1 (2016 OPTA scenario) and 1.21, and for core equipment, between 1.15:1 and 2.28:1.

	OPTA 2006	OPTA 2016	Ofcom 2006/07	PTS 2006
Access equipment	1.21	0.99	1.20	1.08
Core equipment	1.50	1.15	1.21	2.28

Exhibit 2.6: *Ratio of WIK asset cost data and other public data [Source: Analysys]*

The WIK model is closest to the OPTA 2016 scenario. If WIK used this input data, this would not add credibility to WIK's results, as the OPTA 2016 scenario is the most aggressive scenario, and assumes nine years of reductions in asset prices.

One of the network items that has the most significant variance is the MSC software. The cost of MSC software in the WIK cost model is assumed to be 33% of the hardware cost. We think that this cost is underestimated. In the benchmark models this cost ranges from 51% to 86% of the network cost.

2.5 Annual rates of price change

To calculate the annual rates of price change, WIK uses the information from other regulatory proceedings relating to the bottom-up modelling of mobile and fixed networks. Price changes for sites as well as for IT and software equipment are based on the Australian Bureau of Statistics (ABS) cost index. In the benchmark models, operators usually provide this data. In some models, parties disagree about the likely evolution of equipment prices, and so the data is based on consultants' experience.

	WIK	OPTA	Ofcom	PTS
BTS site	+1.1%	-0.3%	+1.0%	+0.0%
BTS equipment	-3.2%	-3.2%	-5.0%	-10.0%
TRX	-3.2%	-3.2%	-5.0%	-10.0%
BSC site	+1.1%	-1.5%	+1.0%	-
BSC hardware	-1.5%	-1.5%	-4.0%	-10.0%
BSC software	-4.8%	-1.5%	-4.0%	-
TRAU (TRAU – Transcoder and Rate Adaptation Unit)	-1.5%	-	-	-
MSC site	+1.1%	-1.5%	+1.0%	+0.0%
MSC hardware	-3.2%	-3.2%	-4.0%	-10.0%
MSCS software	-4.8%	-1.5%	-5.0%	-5.0%
MSC ports	-1.5%	-1.5%	-4.0%	-10.0%
HLR	-1.5%	-1.5%	-4.0%	-10.0%
SMSC	-1.5%	-1.5%	-4.0%	-10.0%
2Mbit/s mini link	-3.2%	-2.5%	-10.0%	-10.0%
Radio link	-3.2%	-2.5%	-10.0%	-10.0%
Radio link repeater	-3.2%	-	-	-
Radio link repeater site	+1.1%	-3.2%	-	-
Leased line	+1.5%	-2.3%	-	+0.0%

Exhibit 2.7: *Annual rates of price change benchmark [Source: Analysys]*

We do not find major issues with the annual rates of price change. While WIK claims to have benchmarked its values with data from other regulatory proceedings relating to the bottom-up modelling of mobile and fixed networks, we were not able to verify this information, or correlate the data with the benchmark models (the WIK data most closely resembles the OPTA data, which is probably the most conservative in this respect).

2.6 Lifetimes

In the WIK model, the information on economic lifetimes is based on information from other regulatory proceedings relating to the bottom-up modelling of mobile and fixed networks. The asset lifetimes used in the benchmarked models are based on accounting lifetime data provided by the operators and general principles applied in the mobile industry, including IFRS.

	WIK	OPTA	Ofcom	PTS
BTS site	15	14	20	25
BTS equipment	8	8	10	10
TRX	8	8	10	10
BSC site	15	17	20	-
BSC hardware	8	7	10	10
BSC software	5	7	10	-
TRAU	8	-	-	-
MSC site	15	17	20	10
MSC hardware	8	7	10	10
MSCS software	5	5	10	5
MSC ports	8	7	10	10
HLR	6	6	10	10
SMSC	8	6	10	10
2MBPS minilink	8	8	10	10
Radio link	8	8	10	10
Radio link repeater	10	-	-	-
Radio link repeater site	15	8	-	-
Leased line	8	8	-	10

Exhibit 2.8: *Lifetimes benchmark [Source: Analysys]*

We do not find major issues with the annual rates of price change. While WIK claims to have benchmarked its values with data from other regulatory proceedings relating to the bottom-up modelling of mobile and fixed networks, we were not able to verify this information, or correlate the data with the benchmark models. The WIK data is closest to the OPTA data, which implies the shortest lifetime (i.e. is the most conservative).

2.7 WACC

In all the models, the WACC input data is based on information provided by financial institutions, specific studies, overseas regulatory authorities and market data.

	WIK	*OPTA 2006*	*Ofcom*	*PTS*
WACC (%)	11.68	14.23	14.08	15.00

Exhibit 2.9: *Nominal pre-tax WACC benchmark [Source: Analysys]*

In the OPTA and Ofcom models, the WACC inputs into the models are in real terms. To scale the real WACC for the WIK nominal input, the formula above becomes:

$$WACC_{real} = (1+WACC_{nominal}) \,/\, (1+Inflation\ rate)-1$$

The PTS model has WACC inputs in nominal terms, so no conversion is required.

The WACC used in the WIK model is lower than those used in the benchmark models. However, the ACCC considers that while the WACC of 11.68% is reasonable and even appropriate in an Australian context, it has discretion as to the WACC it can apply in a policy context and considers that 13% is a reasonable figure to use in the WIK model.

2.8 Opex mark-up

The mark-up for opex used in the WIK model is applied to each category of network assets. It is not clear how the percentage is calculated. In the benchmark models, operating costs are modelled for each type of network asset included in the model, taking into account the costs that would be incurred in maintaining deployed networks.[29] The cost is calculated using operator data.

29 The very high ratios for some network elements (e.g. leased lines) in the benchmark models stem from the fact that some of these elements have no actual investment to speak of.

	WIK	OPTA	Ofcom	PTS
Opex BTS	11%	10%	11%	27%
Opex BSC	11%	7%	14%	25%
Opex TRAU	11%	0%	0%	0%
Opex MSC	11%	32%	15%	8%
Opex HLR	11%	15%	18%	8%
Opex SMSC	11%	49%	1%	4%
Opex 2Mbps mini link	11%	3%	42%	27%
Opex radio link	11%	2%	25%	37%
Opex leased link	11%	203%	0%	N/A[30]
Opex STM-1 leased link	11%	247%	0%	1,150%
Opex core leased link	11%	62%	1,427%	159%

Exhibit 2.10: *Opex mark-up benchmark [Source: Analysys]*

To make a comparison of opex costs is not usually appropriate because it does not take sufficient account of local factors such as Australian labour costs. As we can see in the table below, using an aggregate level, the data for the benchmark models is completely different in each country.

	OPTA 2006	OPTA 2016	Ofcom 2006/07	PTS 2006
Aggregated BTS, BSC, TRAU	7.91%	9.57%	11.51%	27%
Aggregated MSC, HLR	21.73%	31.44%	15.22%	8%

Exhibit 2.11: *Aggregate opex mark-up [Source: Analysys]*

2.9 Common cost mark-up

In the WIK model, common organisational-level costs are calculated as a percentage mark-up on the total network cost. It is not clear how this percentage is calculated. In the benchmark models, common costs are based on operator data.

	WIK[31]	OPTA	Ofcom	PTS
Mark-up for common costs	10%	9%	4%[32]	16%

Exhibit 2.12: *Common cost mark-up benchmark [Source: Analysys]*

As for opex costs, making a comparison of common costs is not usually appropriate because it does not take sufficient account of local factors such as Australian labour costs. As we can see in the table above, the data for the benchmark models is completely different in each country. However, the model results are not that sensitive to this mark-up.

2.10 Routing factors

The WIK model documentation states that the intensity of use is expressed by usage factors, which are endogenously calculated by WIK. In the benchmark models, routing factors are derived from inputs and calculations in the model.

31 A predefined fixed amount of common organisational level costs to capture licence and other regulatory fees is also added: AUD5.5 million.

32 This amount is fixed at GBP112 million every year. Externality has been excluded from this total.

Voice on-net service	*WIK*[33]	*OPTA*	*Ofcom*	*PTS*
BTS	2.00	2.00	2.00	2.00
BSC	2.00	2.00	2.00	2.00
MSC[34]	1.63	3.40	3.50	3.50
Signalling	1.63	3.40	3.50	3.50
HLR	1.00	-[35]	-[36]	-[37]
SMSC	-	-	-	-
Mini link	2.00	2.00	2.00	2.00
AN link	2.00	2.00	2.00	2.00
BN link	2.00	2.00	2.00	2.00
CN link	0.63	0.97	1.33	0.50[38]

Exhibit 2.13: *Routing table for voice on net service [Source: Analysys]*

33 A predefined fixed amount of common organisational level costs to capture licence and other regulatory fees is also added: AUD5.5 million

34 Routing factors for MSC processing in the benchmark models, usually BH milliseconds/call attempt or processing speed, are rebased so that voice outgoing off-net routing is 1

35 In the OPTA model, location update for MSC and HLR is costed as a separate subscriber service, and is therefore excluded from voice service routing

36 In the Ofcom model, HLR is costed in a separate subscriber service, and is therefore excluded from voice service routing

37 In the PTS model, HLR is costed in a separate subscriber service, and is therefore excluded from voice service routing

38 Interswitch routing factor

Voice off-net incoming service	*WIK*[39]	*OPTA*	*Ofcom*	*PTS*
BTS	1.00	1.00	1.00	1.00
BSC	1.00	1.00	1.00	1.00
MSC[40]	1.63	2.40	3.29	2.50
Signalling	1.63	2.40	3.29	2.50
HLR	1.00	-	-	-
SMSC	-	-	-	-
Mini link	1.00	1.00	1.00	1.00
AN link	1.00	1.00	1.00	1.00
BN link	1.00	1.00	1.00	1.00
CN link	0.63	1.03	1.60	0.95[41]

Exhibit 2.14: *Routing table for voice off-net incoming service [Source: Analysys]*

Voice off-net outgoing service	*WIK*[42]	*OPTA*	*Ofcom*	*PTS*
BTS	1.00	1.00	1.00	1.00
BSC	1.00	1.00	1.00	1.00
MSC[43]	1.00	1.00	1.00	1.00
Signalling	1.00	1.00	1.00	1.00
HLR	1.00	-	-	-
SMSC	-	-	-	-
Mini link	1.00	1.00	1.00	1.00
AN link	1.00	1.00	1.00	1.00
BN link	1.00	1.00	1.00	1.00
CN link	-		1.00	0.50[44]

Exhibit 2.15: *Routing table voice off net outgoing service [Source: Analysys]*

39 A predefined fixed amount of common organisational level costs to capture licence and other regulatory fees is also added: AUD5.5 million.

40 Routing factors for MSC processing in the benchmark models, usually BH ms/ call attempt or processing speed, are rebased to so that voice outgoing off-net routing is 1

41 Interswitch routing factor

42 A predefined fixed amount of common organisational level costs to capture licence and other regulatory fees is also added: AUD5.5 million.

43 Routing factors for MSC processing in the benchmark models, usually BH ms/ call attempt or processing speed, are rebased to so that voice outgoing off-net routing is 1

44 Interswitch routing factor

The values of the routing factors appear plausible, but as noted in Section 1.8, we believe that they have not been applied correctly in the derivation of service traffic.

2.11 Conversion factors

In the WIK model, the methodology used to calculate the conversion factors is not explained. In the benchmark models, the methodology is usually as follows:

- voice minutes are counted as one unit of demand
- SMS messages, of average length 40 bytes, are assumed to be conveyed by Stand-alone Dedicated Control Channel (SDCCH) channels, each of which comprises one-eighth of a traffic channel
- GPRS data traffic (expressed in megabytes) is assumed to be 50:50 uplink:downlink and typically carried on CS2 traffic channels.

	WIK[45]	*OPTA*	*PTS*
SMS	432	144	144
GPRS	0.08	0.08[46]	0.15

Exhibit 2.16: *Conversion factors [Source: Analysys]*

The WIK model conversion factor for SMS is more aggressive than that used by benchmark models. WIK's conversion factor is based on 125 bytes per message, which would imply a channel rate in excess of that used by mobile operators. The WIK model conversion factor for GPRS is in line with the benchmark models.

45 A predefined fixed amount of common organisational level costs to capture licence and other regulatory fees is also added, AUD5.5 million.

46 For the OPTA model, information from mobile operators suggests that there is no "efficiency" of packetisation, therefore the ratio is set to 100%. The PTS model suggests an efficiency of 50%