Report for the Israel Ministry of Communications and Ministry of Finance

A study of mobile termination charges

<u>הערות</u>:

1. מסמך זה, בנוסחו המקורי לפני ההשמטות, סווג על ידי מחבריו כ-"Confidential".

2. במסמך זה הושמט מידע שהינו בבחינת סוד מסחרי; במקומות בהן בוצעו השמטות מופיע הסימון - "----".

Analysys

22 July 2004

A study of mobile termination charges

Report for the Israel Ministry of Communications and Ministry of Finance

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Analysys

0 Executive summary

Analysys was engaged by the Israel Ministry of Communications (MoC) and the Ministry of Finance (MoF) in order to determine the long-run incremental cost (LRIC) of terminating a minute of voice telephony on a mobile network in Israel and to recommend an appropriate cost-oriented price on the basis of these results. Furthermore Analysys established the cost of terminating an SMS message on an Israeli mobile network.

This report represents the culmination of this work. Its principal findings are that the current price of mobile termination in Israel is significantly above cost. Furthermore, the calls from a subscriber to a mobile network, to another subscriber within that same network ('on-net' calls) are significantly cheaper than calls to other mobile networks ('off-net' calls) indicating that the excess revenues earned from termination could potentially be being used to subsidise on-net calls and price them below cost – behaviour which could be considered anti-competitive.

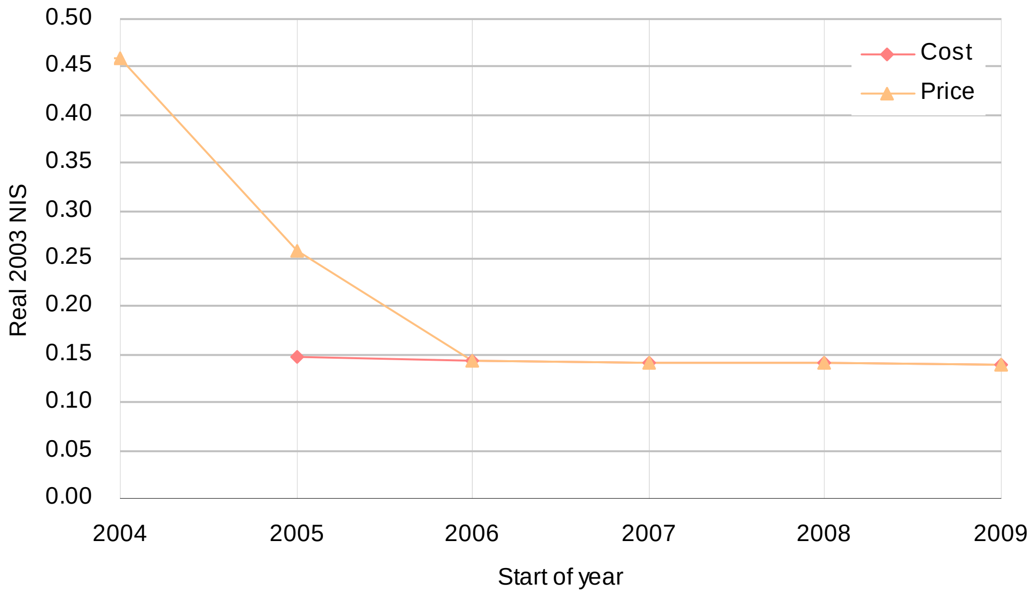
The appropriate and well-established remedy to this market failure is a regulated price-cap on the termination rate set at the cost of providing termination. Price caps have been in place in Israel since 2000; however the current quoted price of NIS0.45 is still more than triple the cost of termination.

The cost of termination is derived from a detailed and comprehensive bottom-up LRIC model which is capable of calculating the actual costs of the three mobile operators being considered (Cellcom, Partner and Pelephone) as well as producing the costs of fourth major new entrant (based upon the existing operators in Israel) under a number of different scenarios.

This report recommends a RPI-X price decline in termination rates from their current quoted price of NIS0.45 to the LRIC cost at the beginning of 2006 of NIS0.144 (expressed in real NIS at 2003). This represents a constant value of X of 44% in each year, with the first change to be implemented at the beginning of 2005. In 2007 and 2008 price declines of approximately 1% should be implemented, as summarised below.

Note on price nomenclature

In this report prices are referred to as either 'quoted' or 'effective'. The current *quoted* price for termination in Israel is NIS0.45[1] per minute. However, this is based on charging on the basis of discrete units of 12 seconds, which means that billed minutes are approximately 5.5% greater than actual call minutes, resulting in an increase to NIS0.475 per minute. Additionally, the revenue derived from interconnection payments is subject to a 3.5% royalty payment, which is removed from this value of NIS0.475 to give an effective price of NIS 0.458. The cost results and pricing recommendations presented in this report are all based purely on the effective price.

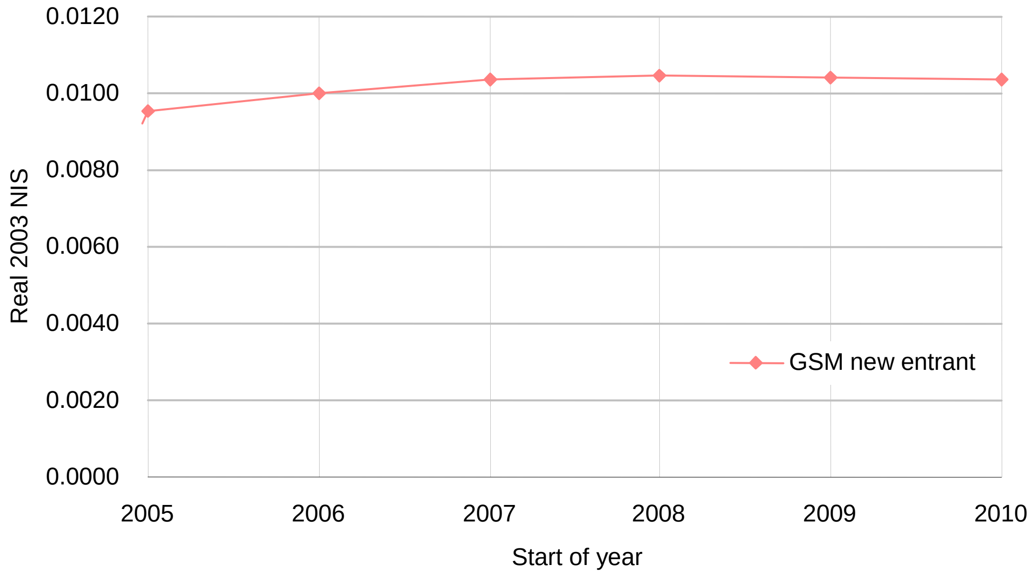


[1] This quoted price applies to domestic termination only. The termination charge for international calls is NIS0.25.

Price	*2004*	*2005*	*2006*	*2007*	*2008*
NIS (Real 2003)	0.458	0.257	0.144	0.142	0.141
X		44%	44%	1.4%	1.1%

Exhibit 0.1: *Price cap recommendation [Source: Analysys]*

The same LRIC model was used to calculated the cost to a fourth major new entrant of terminating an SMS message. The results are shown in Exhibit 0.2 below, with a stable cost of approximately NIS0.01.



	2005	*2006*	*2007*	*2008*	*2009*	*2010*
Real 2003 NIS	0.0096	0.0100	0.0104	0.0105	0.0104	0.0103

***Exhibit 0.2**:* *The cost for a fourth major new entrant of terminating an SMS message [Source: Analysys]*

1 Project overview

This report represents the culmination of work performed by Analysys on behalf of the Ministry of Communications (MoC) and the Ministry of Finance (MoF) to calculate termination costs and prices on mobile networks in Israel.

The primary task in this project was to create a bottom-up LRIC model, reconciled with top-down data, that could calculate the cost of Cellcom's, Partner's and Pelephone's networks in Israel in order to determine the cost of terminating voice calls and SMS messages. This model has been constructed, populated, calibrated and reconciled and gives results for three actual Israeli operators (including Cellcom's TDMA network) and for a major new entrant to the market and various associated sensitivities. The reconciliation is based on publicly available sources (e.g. Partner's SEC filings), data collected by the MoC, and the limited data we have received from operators as part of this project.

Results for the fourth operator in Israel, MIRS, were not included in the model, because it has a very low market share (less than 5%) and its primary network voice service, that of on-net push-to-talk, is not directly comparable with the full duplex voice calling of the other networks. Although cost results are not included for MIRS, any price-cap regulation of mobile termination is expected to apply to MIRS' network as well as the major operators, so as not to leave MIRS outside the regulatory regime.

The price recommendations in this report are based on a fourth new-entrant operator to the Israeli market functioning in an efficient manner. The fundamental reason for this is because the regulated price cap should reflect the price that would occur in a competitive market. This market price is set by the threat of new entrants coming in with lower prices, which they typically could do as the erosion in the price of mobile network equipment would lead to a lower cost base for later entrants.

1.1 Model construction

The model structure was based around established GSM and CDMA network design algorithms. These are, for the most part, quite standardised and can be constructed in isolation with a reasonable degree of confidence in the results.

The TDMA algorithms work in a similar manner to the GSM and CDMA networks, with new algorithms developed where appropriate. This is discussed in detail in Annex A.

1.2 Population, calibration and reconciliation

The data from populating the model came from numerous sources including data from operators, publicly available data on the Israeli market (such as the Israeli census), confidential data from the MoC and industry standard inputs for GSM and CDMA network design parameters.

At the time of writing, no data had been forthcoming from Cellcom, Partner or Pelephone and no top-down models have been presented. As a result many of the inputs, principally the unit cost data, come from Analysys and our experience of building models on the basis of these technologies with data provided by actual operators. Furthermore, much of the cost of either a GSM or CDMA network comes from the equipment costs, which are set in a global marketplace and, in Analysys's experience, do not vary much from operator to operator and from country to country. However, it should be noted that the final result is partially determined by the quantity and quality of data available for calibration and reconciliation and, for this reason, the lack of data submitted by operators may have had some influence on the final result.

An approximate calibration of the number of network elements deployed for each operator has been possible. High-level reconciliation of the capital investment in the network by Partner was also possible given the data in its 2004 SEC filing.

1.2.1 Calibration

Calibration of a model involves understanding the differences between the networks that are calculated by the bottom-up model and the actual networks that are deployed in Israel to support the same coverage area and traffic demand. Once this comparison has been performed, the assumed utilisation profiles for different assets are adjusted to ensure that the networks calculated by the bottom-up model represent the actual networks that are deployed in Israel. This process is based upon the scorched-node assumption, discussed in detail in section 2.3.6.

Radio network

The single most important point of calibration is the number of BTS sites that an operator has. Given that the complexity of radio network design is much greater than core network design, the risk that an un-calibrated bottom-up model may underestimate the number of sites required is commensurately larger.

From Partner’s submissions to the SEC, the number of BTS sites are known and can be compared to the model output, as shown below:

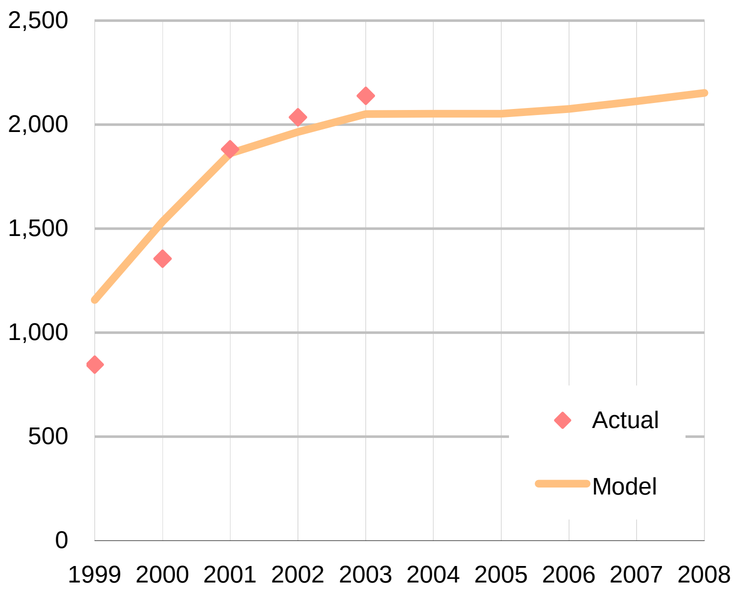


Exhibit 1.1:

Calibration of Partner's BTS sites

[Source: Analysys]

From Exhibit 1.1 it can be seen that the model output for the number of BTS sites matches that of Partner very closely - the model underestimates Partner's sites by just 4% at year end 2003. It can be seen that in the first year of deployment the model overestimates Partner's deployment to a considerable degree (predicting 1,157 sites to Partner's actual 846). However, it should be noted that this accelerated deployment will only increase the cost of termination (and thus can be regarded as conservative) and has an impact on the timing of investment, not on the total volume of investment.

A similar graph can be plotted for Pelephone (using data from the Bezeq prospectus, May 2004) and can be seen in Exhibit 1.2, below.

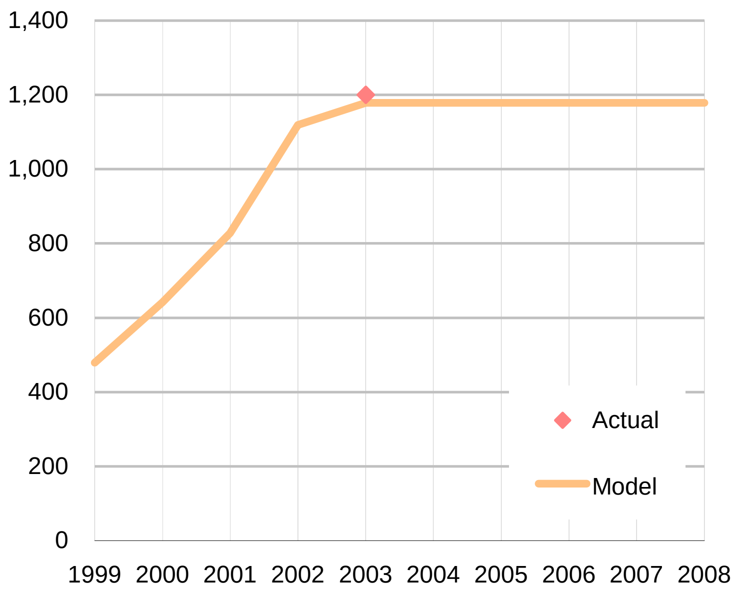


Exhibit 1.2: *Calibration of Pelephone's BTS sites [Source: Analysys]*

Exhibit 1.2 shows only a single point of calibration of sites at year end 2003, however in that year the model produces only 2% fewer sites than are actually in existence in Pelephone's network. Again, this says nothing about the accuracy of the model in predicting the timing of investment prior to 2003, however the total volume of BTS deployed, and thus total capital investment, will be accurate.

Core network

The calibration for the number of switches for operators was based on industry sources from within Israel. The number of switches of different types currently present for each operator in Israel was estimated; this was then compared against the model output for the year end 2003. The results for the three operators can be seen in Exhibit 1.3, Exhibit 1.4 and Exhibit 1.5.

Item	*Number produced by model, year end 2003*	*Actual number currently in network*	*Model divergence from actual*
BSC	---	---	0%
MSC processors	---	---	0%
MSC sites	---	---	0%
HLR	---	---	0%
VMS	---	---	0%

Exhibit 1.3: *Partner core network calibration [Source: Analysys]*

Item	*Number produced by model, year end 2003*	*Actual number currently in network*	*Model divergence from actual*
MSC 1X processors	---	---	---
MSC sites	---	---	---
HLR	---	---	---
VMS	---	---	---

Exhibit 1.4: *Pelephone core network calibration [Source: Analysys]*

Item	*Number produced by model, year end 2003*	*Actual number currently in network*	*Model divergence from actual*
MSC processors (TDMA and GSM)	---	---	15%
MSC sites	---	---	-14%
HLR	---	---	0%
SMSC	---	---	0%

Exhibit 1.5: *Cellcom core network calibration [Source: Analysys]*

As can be seen from these Exhibits, there are some relatively small differences in the number of switches of each type for each operator. However, there are a number of factors that have to be considered when interpreting these results. The first is that the calibration data is a single snapshot and does not say anything about the deployment in the periods immediately following or preceding this point. This means, as for the radio network, that the discrepancies could simply be an issue of timing of investment rather than total investment in the long-term. Furthermore, the capacity of a particular switch unit is often dictated by the contract with the equipment supplier, for example the hardware within a Home Location Register (HLR) unit might be able to support 2 million subscribers, but the software might limit the actual number of subscribers that the unit can support to 800 000. If the operator needed to increase their HLR capacity to 1.5 million subscribers they would not need to purchase another HLR, but would simply alter their software, the cost of which would be determined by the equipment supplier. From a cost point of view, therefore, it is most important to obtain the correct cost for the capacity that a switch provides, not the precise number of switch units and the capacity of each unit.

1.2.2 Reconciliation

Reconciliation of the model results involves a comparison of the overall expenditure on the network predicted by the model and the actual expenditure recorded by real operators in Israel. It is the next logical step after calibration and ensures that the model is not underestimating the overall cost of the network. Once the model has been successfully reconciled, the only scope for variance is in the allocation of costs onto services. This is covered in detail in section 2.4.

The primary source of reconciliation for this model was taken from Partner's SEC filings. The reason for this is that Partner separates out the gross book value of its capital investment in network equipment from other capital investment, making it possible to make a direct reconciliation with the model. The results of the reconciliation are shown below:

Network GBV, USD	*1999*	*2000*	*2001*	*2002*	*2003*
Partner	269,100,000	379,770,000	450,515,000	506,419,000	582,764,000
Model	291,223,980	378,712,059	458,967,548	493,184,030	519,985,363
Model divergence	7.6%	0.3%	1.8%	-2.7%	-12.1%

Exhibit 1.6: *Partner reconciliation [Source: Analysys]*

As can be seen in Exhibit 1.6, the model output for Partner's capital investment is very close to Partner's recorded capital investment. There are, of course, discrepancies which will have arisen from differences in any combination of the following:

- inclusion of 3G investment in 2003 (which is explicitly not included in the model)
- number of units of equipment purchased
- unit costs for equipment
- timing of purchasing
- costs included in network GBV

For the other operators, where capital investment in the network is not separable from overall capital investment (and thus this direct form of reconciliation is not possible) the method below was adopted.

- Use Analysys benchmark data for equipment cost per unit.

- Adjust to bring in line with reconciled unit cost for Partner where equipment is common to each operator (e.g. Cellcom's GSM equipment, site preparation capital works, switch site capital expenditure, microwave equipment for all operators).

A similar approach was adopted for operating costs: using Analysys benchmark data as the basis for the unit operating costs, the reconciliation process then adjusted for costs specific to Israel, such as site rental (from data provided by MIRS) and leased line prices (from data provided by the MoC, originally provided by Bezeq). Details of all cost inputs are provided in Annex G.

1.3 Model results

One of the principal modelling strengths of using a bottom-up model with top-down reconciliation, is that this captures the real-world features of the market being modelled. In the case of Israel, there are two striking features which set it apart from many other countries thus making direct international comparisons difficult. In particular:

- Israel is a small country with a high population density
- it has very high minutes of use per subscriber.

These features both act to increase the average utilisation of the network and thus lower the cost per minute of termination.

High minutes of use per subscriber

The high minutes of use per subscriber enjoyed by mobile operators in Israel gives those operators access to greater economies of scale than would be the case with, say, a Western European operator in a country of similar population.

Indeed, if minutes of use per subscriber were lowered by a third, to make them more akin to Western European usage, the cost of termination on an Israeli network would rise by around 18%.[2] Exhibit 1.7 compares average minutes of use for a number of countries around the world. The remaining difference is accounted for by the high population density of Israel, as follows.

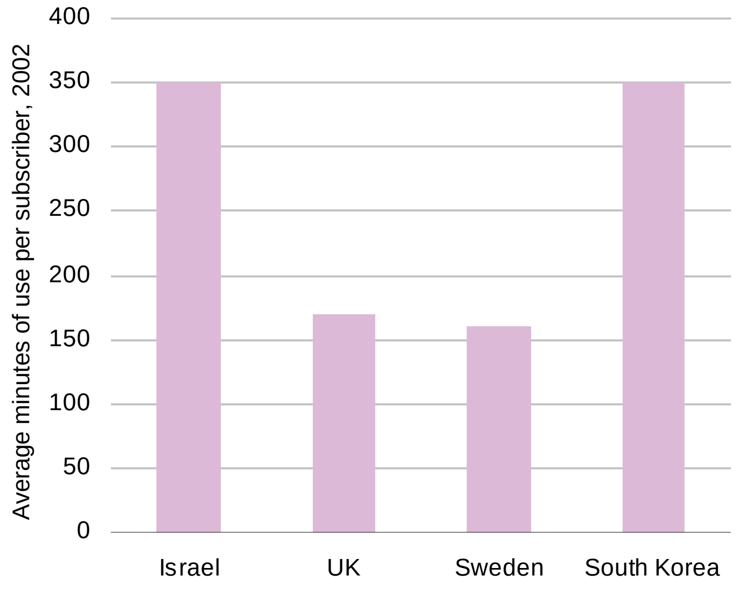


Exhibit 1.7: *Average minutes of use (MoU) per subscriber for sample countries in the rest of the World [Source: Analysys]*

[2] Model prediction based on Partner's network

Small country with high population density

The relatively small size and high population of Israel allows operators to enjoy a much higher average utilisation of their network than would be the case in a country with a more evenly distributed population, where cells in rural areas might have extremely low levels of utilisation.

This is reflected in the model results for common cost, where less than 1% of base stations are calculated to be invariant with demand in the long-run. In effect, this means that additional cell sites will have to be deployed in almost every part of the coverage network in order to accommodate increasing demand.

This low common cost is indicative of a very high level of utilisation in the network, since almost every cell site is driven purely by traffic demand and not by the requirement to provide coverage.

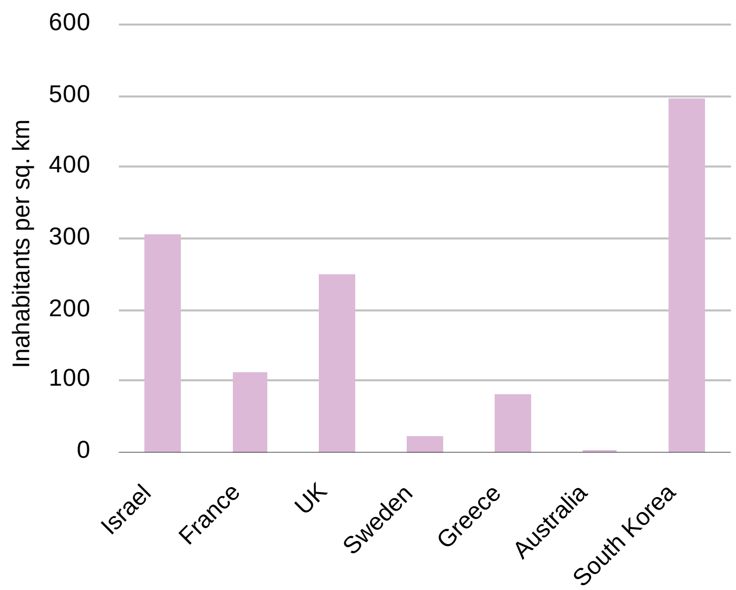


Exhibit 1.8:
Density of inhabitants in selected countries
[Source: Analysys]

2 The model

The model developed for the MoC and MoF by Analysys is a bottom-up model to determine the LRIC of terminating voice telephony and SMS on the networks of Cellcom, Partner and Pelephone.

2.1 Use of LRIC in setting the price for termination

The imposition of price-caps at the cost of mobile termination requires the most appropriate definition of cost to be established. The most widely used measure of cost of termination for regulatory purposes is the long-run average incremental cost (known as LRAIC or LRIC). LRIC is used because it best resembles the actual economic cost that an operator incurs in providing termination in a competitive market and allows the operator to recover the full cost of its network. The LRIC methodology embodies a number of principles which are explained further below.

The principle of cost causation means retail costs are excluded from the cost of termination

Cost causation should be the guiding principle in determining the cost of providing the termination service. The cost of termination is the sum of costs that are incurred in providing the termination service or those costs that directly benefit the consumer of the termination service (the originating caller).

The major implication of adopting the cost causation principle is that only the costs of providing the network should be included and all costs associated with the operator's retail activities should be excluded. Retail costs, such as advertising, marketing and handset subsidies are neither required to terminate calls nor do they directly benefit the originating caller.

In the study, consideration is given to the argument that the acquisition and retention of subscribers on the terminating network provides benefit to the originating caller in that it provides them with the ability to call and be called by these subscribers. As part of the study, the value of this 'network externality' was calculated to be a negligible fraction of the cost of termination.

LRIC is similar to marginal cost pricing, modified to reflect the market reality

In a perfectly competitive market, the price of a service will be set at the marginal economic cost of providing that service. Pricing at marginal cost does, however, have two major drawbacks when used to price mobile termination. The first is that it is highly dependent on the volume of traffic that is carried and the second is that it does not allow for recovery of sunk costs.

Exhibit 2.1 below shows the relationship between cost and traffic volume on a mobile network with constant returns to scale at high traffic volumes. In this diagram, the marginal cost would be the gradient of the line for a given traffic volume. It is clear that this will vary significantly from low traffic volumes (where the marginal cost is close to, or equal to, zero) to high traffic volumes, where the marginal cost has a constant value. Setting the price at marginal cost will therefore vary with the traffic volume carried by the operator and also will not allow the costs marked as 'common cost' on this diagram to be recovered.

Using LRIC overcomes both of these problems by taking the cost of a traffic increment equal to the long-run[3] traffic volume and dividing it by the long-run traffic volume to give the long-run average incremental cost, usually expressed as cost per minute. This value is then 'marked-up' for the common cost value which would otherwise not be recoverable by the operator.

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[3] The long-run is defined as the period after which the utilisation of network elements and the cost of factors of production per unit output have become constant

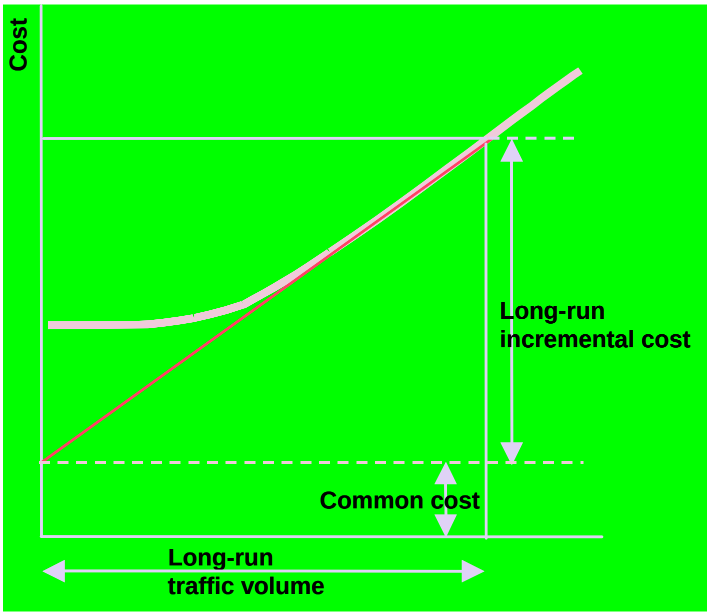

Exhibit 2.1:

Cost-volume relationship for mobile termination [Source: Analysys]

LRIC is recommended as the best-practice methodology for interconnection costing

Mobile termination models adopting a long-run incremental cost (LRIC) approach have been developed in a number of jurisdictions in recent years – including European such as the UK and non-European countries such as Malaysia. Further countries are in the process of developing LRIC models for establishing termination costs, and are expected to publish their conclusions in the coming months. LRIC methodologies have been recommended by a number of overarching industry bodies such as the Independent Regulators' Group (IRG) and the FCC.

EU law requires cost-orientation in price controls and the EC recommends LRIC for determining interconnection prices

Under EU law, regulatory intervention can be justified in markets where single operators are deemed to have significant market power (SMP). In many EU countries, the market for mobile termination has been determined to be one such market. If cost-orientated price controls are determined to be the appropriate means of intervention, then the method for determining cost should, according to EC Directives, "serve to promote efficiency and sustainable competition and maximize consumer benefits"[4].

4 Directive 2002/19/EC of the European Parliament on Access and Interconnection.

LRIC is the most complete method that adheres to the principles of promoting efficiency, sustainable competition and maximization of consumer benefit. The European Commission reflected this opinion in its recommendation of January 1998 to use LRIC for interconnection pricing[5]

The IRG endorses the EC recommendation of LRIC

The Independent Regulators Group also endorses LRIC as a method for determining cost-based interconnection prices. Indeed, the IRG recognizes LRIC as a method which 'maximises social welfare by promoting sustainable competition'[6] and the IRG provides fundamental justification for endorsing LRIC in that it "leads to results that best reflect interconnection tariffs that would occur in a competitive environment"[7].

2.2 Key elements of the Analysys LRIC model

Analysys constructed a LRIC model in order to calculate the costs of mobile termination in Israel. This model was in effect a hybrid model. In the first instance an engineering model was used to calculate the networks that would be required to support the given level of demand in Israel, given the technology chosen. The hybrid aspect of this model came into play in that the results of model were both calibrated and reconciled to actual networks in Israel to ensure that the model was producing realistic network costs that are currently being achieved by the operators in Israel.

A calibrated model produces a similar number of network elements to the real networks

The process of calibration involves adjusting the inputs to the bottom-up engineering model to make sure it generates a number of key network elements similar to the actual networks in Israel. The tacit assumption of this 'scorched-node' approach is that the network layout that the operators currently have is an efficient one, given their historical deployment.

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5 Recommendation 98/195/ECon Interconnection in a Liberalised Telecommunications Market (Part 1 – Interconnection Pricing), 8 January 1998.

6 Principles of Implementation and Best practice on the application of remedies in the mobile voice call termination market, 1 April 2004

7 Principles of Implementation and Best Practice regarding FL-LRIC Cost Modelling, 24 November 2000.

This ensures that any price based on this cost will not assume that existing operators can simply optimise the number and location of existing nodes within the network (a ‘scorched-earth’ approach).

A reconciled model produces similar costs to the real networks

The process of reconciliation involves adjusting the prices of units of equipment in the model to ensure that the overall costs of the network are similar to those overall costs that have been incurred by actual operators.

This ensures that any price based on this cost will allow operators to recover the full cost of their networks.

The costs of the fourth new-entrant major player are based on the operators’ actual efficiency

In costing a fourth new-entrant major player to the market, it is assumed that they will be able to operate at the same level of efficiency that the current operators are able to achieve.

This assumption ensures that any price based on this cost will not require the operators to increase their efficiency from current levels and still be able to recover their costs.

2.3 The application of LRIC principles

This section explains how the major principles of LRIC modelling are implemented in this model. The flow of calculation in the model is shown in Exhibit 2.2 below, with the network design algorithms covered in detail in Annex A.

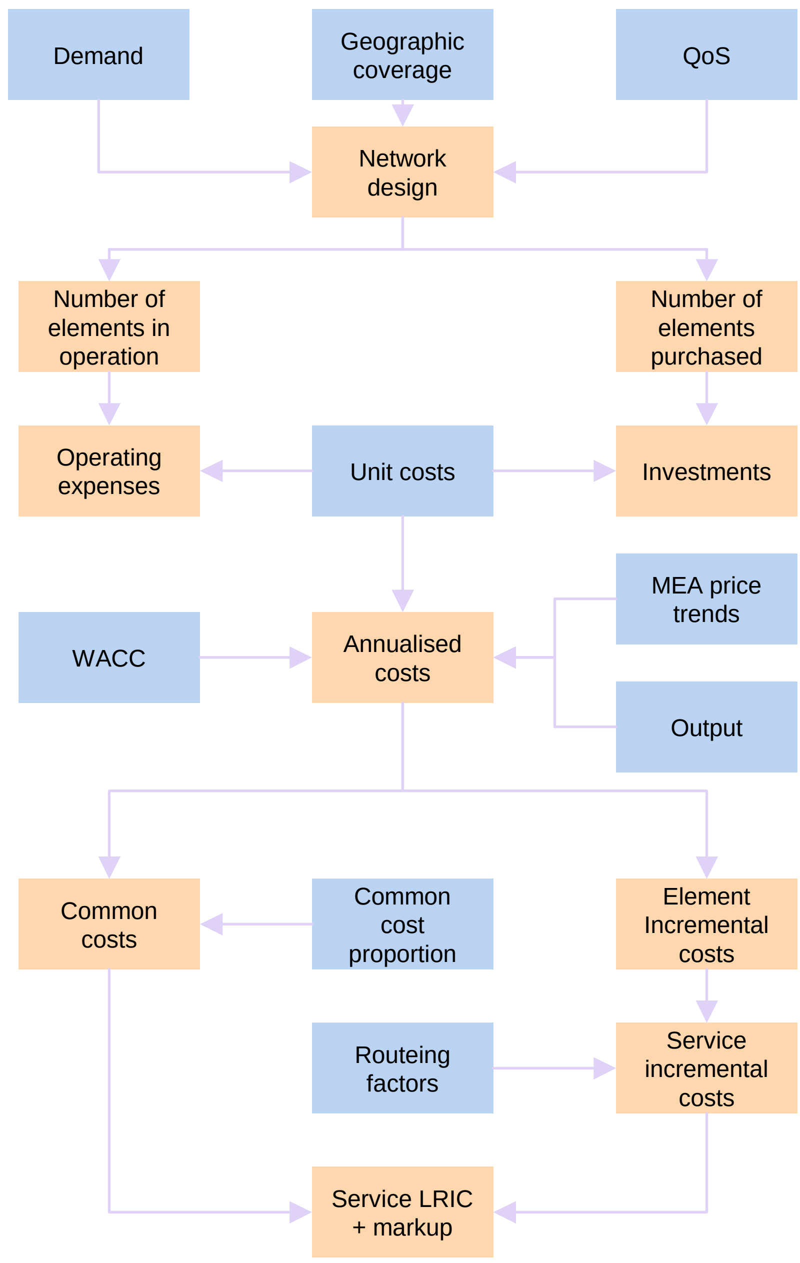


Exhibit 2.2:

Model schematic

[Source: Analysys]

The standard application of long-run average incremental costing (LRAIC, or simply LRIC) is used in regulatory costing of mobile services because it most closely matches the price behaviour of a real, competitive market.

In broad terms, the 'long-run' part assumes that, in a competitive market, operators will take account of more than just the immediate short-term costs of the transaction when considering pricing.

The ‘incremental cost’ part assumes that costs should be recovered on the basis of which service causes the cost. As the LRIC methodology has evolved, more principles have been subsumed into ‘industry best-practice’ implementations, which include:

- choice of increments
- treatment of common costs
- modern equivalent asset pricing
- cost annualisation and WACC
- efficiency and the scorched-node assumption.

The following sections show how each of these principles has been incorporated into the model. A detailed explanation of all the major algorithms used is included in Annex A.

2.3.1 Choice of increments

This model provides the service cost of mobile services, specifically voice termination and SMS termination. Both of these are wholesale services and, as such, do not include retail costs. For this reason the increments chosen include only network costs; all retail costs are excluded. The business overheads which support both retail and network services are included as a 5% mark-up onto the network costs, an upper-bound estimate based on previous experience.

Increments can be defined to be any units of demand on a network that satisfy the condition of being discrete. In this case, a discrete unit would be confirmed in a scenario where reducing the demand associated with that unit to zero, and removing the associated cost of the redundant network elements that were previously used to support that unit, would still allow all other increments offered over the same network to be supported.

Conversely, a service is defined as a unit of demand that does not have to satisfy the condition that is discrete. This means that reducing the demand for a service to zero will not necessarily allow for the removal of the associated cost of redundant network elements, nor will the requirement for all other services to still be supported be necessarily maintained. Under this definition, an increment can contain a number of services, all of which, to some extent, respond to demand in a similar fashion.

As a result of this flexibility in defining increments, a judgement has to be made about the most appropriate size of each increment. At one extreme there could be a different increment for each retail and wholesale product offered; alternatively a single increment can be used for the entire network.

The use of numerous small increments could, in theory, yield a superior method for allocation of costs onto services. However, this would be dependent upon having data of sufficient quality to generate the cost allocation methodology. Exhibit 2.3 illustrates that, the larger the number of increments, the larger the potential number of combinations of shared costs there are between increments. However, the major cost drivers in a mobile network are the volume of traffic and the number of subscribers supported by the network. Establishing more granular relationships between different incremental demands and incremental costs would be a major undertaking that would yield little, if any, improvement in the final result.

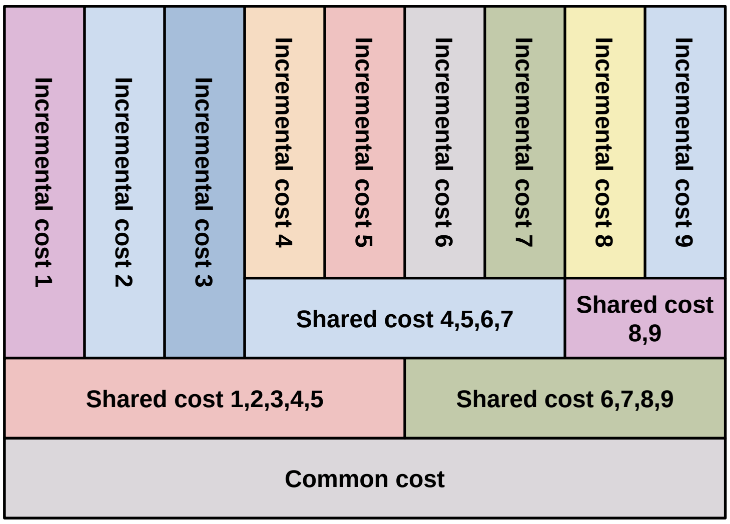


Exhibit 2.3:

Cost structure with small increments [Source: Analysys]

The model uses large increments to minimise the complexity of determining shared and common costs. In line with industry best practice, the following two increments are used:

- **traffic** – those costs which are caused by a change in long-run traffic levels
- **subscribers** – those costs which are caused by a change in the long-run number of subscribers.

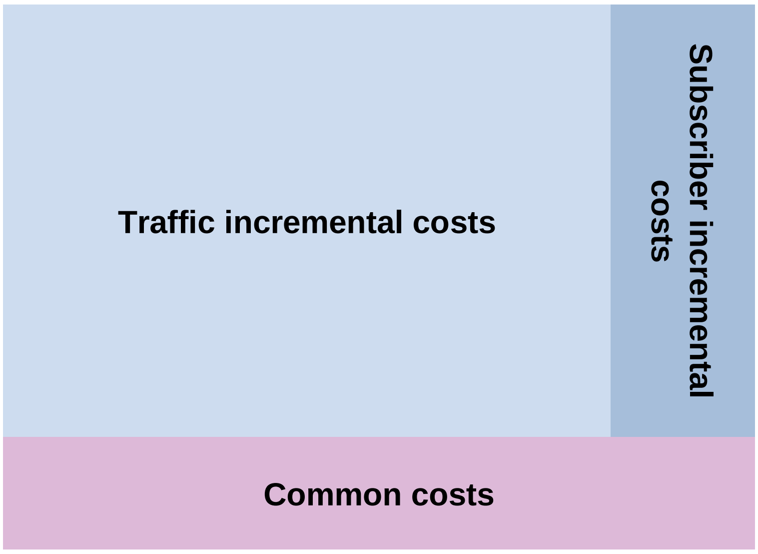


Exhibit 2.4:
Incremental and common costs
[Source: Analysys]

Common costs

Common costs are those costs remaining after the incremental costs have been subtracted. They can also be thought of as those network element costs that are invariant with demand in the long run.

Exhibit 2.5 shows how the cost of a mobile network varies with the volume of traffic upon it, assuming constant returns to scale at high volumes. The common costs in the long-run are those costs that are not recovered using the average cost of the increment at long-run traffic volumes (the y-intercept of the tangent to the cost-volume curve at long-run volumes).

Exhibit 2.5 also illustrates that the common cost is much lower than the cost of the coverage network (the y-intercept of the actual cost-volume curve). Fundamentally, this is because we are considering the costs in the long-run, at long-run volumes, rather than short-run costs incurred at short-run volumes.

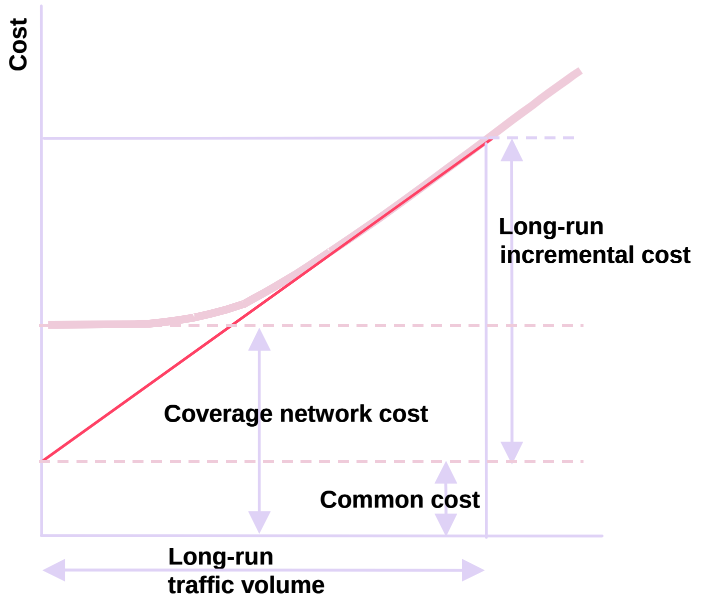


Exhibit 2.5:
Cost-volume relationship for a mobile network
[Source: Analysys]

The value of these common network costs were evaluated directly from the model as follows:

Operator	*Long-run common network cost as a proportion of total network cost*
Partner (GSM)	---%
Pelephone (CDMA)	---%
Cellcom (TDMA, GSM)	---%
Fourth major new entrant (GSM)	2.20%

Exhibit 2.6:
Common network cost results
[Source: Analysys]

The method of calculation of these common costs is performed by determining the number of each network element that is common in the long-run. This is either done by direct inference (e.g. in the case of the network management system) or by sequentially running the model with zero demand for different services to determine the incremental units of each element type and then removing these incremental units from the total units to give common units.

More formally, this calculation can be represented as follows:

$$units_{common} = units_{total} - \sum_{services} units_{incremental\ to\ service}$$

where:

$$units_{incremental\ to\ service} = units_{long-run\ demand\ \ for\ service} - units_{demand\ \ for\ service=0}$$

The results of applying this method to determine the number of units each network element that are common in the long-run are shown in Exhibit 2.7. Only those elements that have units which are common in the long-run are illustrated in this table; all other elements are entirely incremental. For comparison purposes, the number of units installed in the long-run for Partner's GSM network are also included in the table.

Element	*Common units*	*Units installed (Partner)*
Urban macrocell: infrastructure, site acquisition and preparation	1	---
Suburban macrocell: infrastructure, site acquisition and preparation	2	---
Rural macrocell: infrastructure, site acquisition and preparation	1	---
Macrocell: equipment, 3 sectors (dual 900/1800)	3	---
Microwave backhaul link	2	---
LL0: Backhaul link from BTS (per leased 2Mbit/s circuit)	9	---
LL1: Backhaul link to BSC (per leased 2Mbit/s circuit)	9	---
BSC: processor	2	---
BSC: software	2	---
LL2: BSC – MSC link (per leased 2Mbit/s circuit)	34	---
MSC: processor	1	---
MSC: software	1	---
Switching Support Plant	1	---
Buildings (switch building preparation)	1	---
MSC: site lease	1	---
MSC: BSC-facing port increment	68	---
MSC: interconnect-facing port increment	2	---
MSC: switch-facing port increment	1	---
LL3: MSC to MSC link (per leased 2Mbit/s circuit)	18	---
NMS	1	---

Exhibit 2.7: *Number of common units for each element type in the long-run [Source: Analysys]*

These common network costs are small because the majority of network element types deployed in Israel vary in response to traffic in the long run. Elements which are initially deployed as part of the coverage network require additional units to be deployed in the future, and thus are regarded as traffic-driven in the long run and therefore form part of the long-run incremental cost of traffic. This is because Israel is a relatively small, densely populated country with high demand: deployment of network elements tends to be driven by demand in most areas.

Overheads

In addition to those cost elements considered explicitly in the model, there is an allowance for overheads. These overheads are defined as those costs which support both wholesale and retail activities but which cannot be entirely allocated to either wholesale or retail services. They are modelled as a simple percentage mark-up on the service costs of 5%, an assumed value based on Analysys's previous work. They include a proportion of the following costs:

- CEO
- core administrative functions
- finance and legal functions
- central office fixtures and fittings.

Treatment of retail costs

Retail costs are defined as those costs which are caused by, or provide benefit to, subscribers to the network in question. They include such costs as:

- handset subsidies
- marketing
- advertising
- distribution
- billing.

Retail costs are excluded from the cost of termination because they are neither caused by, nor provide benefit to, the consumers of termination (i.e. the subscriber to the originating network). The extent to which the acquisition of new subscribers provides benefit to existing subscribers to other networks is accounted for by an externality value on top of the cost of termination. The externality mark-up on termination is discussed further in section 4.3.

2.3.2 Treatment of common costs

Common costs have to be recovered by the operator through the services they provide. In order to determine service prices, the common costs have to be factored into the service costs in an appropriate manner. There are two principal ways in which this can be done:

- equal proportionate mark-up (EPMU)
- Ramsey pricing mark-up.

The model uses an EPMU approach, in line with all regulators who have adopted a LRIC approach thus far. The alternative Ramsey-pricing method was not implemented due to the highly uncertain assumptions employed, and the consequent uncertainty of the results. Furthermore, there is as yet no industry consensus as to the appropriate application of the theory.

What is clear, however, is that the relatively small common cost, as calculated by the current model, will mean that alternative ways of marking this cost onto services will have relatively little impact on the final result.

2.3.3 Market evolution

Assessing the costs of mobile termination within a long-run incremental framework requires a consideration of the relevant market evolution from a regulatory perspective. This will cover the impact of new entrants, level of market contestability and the nature of forward-looking calculation.

The model considers the full historical evolution of Cellcom, Partner and Pelephone. In order to calculate the long-run cost of the operators' networks, the model also considers a situation where the three main operators above would have an equal 30% of market share each, with MIRS having a 10% market share.

In establishing the costs of Cellcom's network, including the historical investment in their TDMA network, it is assumed that all TDMA subscribers will have transferred to the GSM network by ----[8] and the TDMA network is then turned off. The termination cost for Cellcom, shown in Section 3, includes both TDMA and subsequent GSM investments.

The model is also used to calculate the cost of a major new entrant using either GSM or CDMA only. In this instance, the market is assumed to be a fully competitive four player market, but not fully contestable (i.e. a new entrant is free to enter the market and compete with existing players, but subscribers to existing networks will not immediately switch to the new operator). Thus it is assumed that the new operator would enter the market in 2004 and would take five years to reach a 25% market share which it would then sustain until the end of the model run.

2.3.4 Modern Equivalent Asset (MEA) pricing

An operator in an efficiently functioning market will be forced to price at the price a new entrant can charge. These prices will be based upon the cost of the new entrant's network. Thus, when setting price caps to replicate those of a competitive market, assets should be revalued to those that a new entrant would be able to purchase.

The use of modern equivalent assets trends in the model serves two related functions. The first is that MEA prices are used in the bottom-up model to determine the price paid for equipment when it is purchased. The second is to determine the shape of the cost recovery profile in the economic depreciation calculation, which is covered in more detail in Annex D.

8 The assumption for migration to GSM by ---- is speculative, but the sensitivity of the result to this value is very small. For example, changing it by two years in either direction changes the LRIC of termination by less than 0.5%

The MEA price differs slightly from the replacement cost of an asset in that it does not constitute simply the cost of replacing the asset, but the function that the asset performs. For instance, if the capacity of a switch unit increases 20% from one year to the next then the MEA price of that switch falls by 20%, in addition to any change in the price of the unit. The GSM MEA trends used in 2003 in the model are shown in Exhibit 2.8.

Element	*MEA price change across the year 2003*
Radio equipment	-5%
Cell infrastructure, site acquisition and preparation	0%
Macro/micro/picocell equipment	-10%
Microwave transmission equipment	-10%
Switching	-10%
Software	-5%
Network management system	-5%

Exhibit 2.8: *MEA price change, 2003 [Source: Analysys]*

2.3.5 Annualisation and WACC

The investment costs incurred in the deployment of network elements must be recovered over time (depreciated) according to an appropriate annualisation method. In addition, the total cost must include an allowance for the cost of capital employed, where the cost of capital is specified by the weighted average cost of capital (WACC) applicable to the business in question.

The annualisation method used in the model is economic depreciation, which reflects the underlying costs of production and output over the economic life of assets. This method was chosen because it most closely reflects the cost recovery that would occur in a fully competition and partially contestable market.

Economic depreciation reflects both the underlying costs of production (as unit costs have varied in the past and can be expected to vary in the future) and the output of network elements over their economic lifetimes (output also varies strongly over time from network launch to network maturity). Economic depreciation is a forward-looking method which requires forward-looking forecasts for output (demand) and costs of production (investment and operating cost trends).

WACC

The model uses a WACC value of 12.9%, in real, pre-tax terms. It is based on the following calculation:

Item	*Value*	*Source*
Risk-free rate	4.5%	Report of the April 2003 Commission for the regulation of Bezeq tariffs (second Grunau commission)
Equity premium	5%	Report of the April 2003 Commission for the regulation of Bezeq tariffs (second Grunau commission)
Beta	1.3	UK Competition Commission, mid-point value
Cost of equity (real, post-tax)	11.0%	*Calculation*
Cost of debt (pre-tax)	10%	Partner Annual Report, 2002
Cost of debt (post-tax)	6.4%	*Calculation*
Optimal gearing	60%	Source: MoC/MoF based on actual operator gearing in Israel
Corporate tax rate	36%	
WACC (real, pre-tax)	**12.9%**	***Calculation***

***Exhibit 2.9**:* *WACC calculation [Source: Analysys]*

The sensitivity of the model results to this WACC value is explored in Section 3.2.2 using the high and low WACC values shown in Exhibit 2.10 below.

The value of beta used in the model is taken as the mid-value of the range considered by the UK Competition Commission. An alternative to this would be to use a beta derived from actual market data, which would be achievable for Partner at least. Calculating beta directly from market data is sensitive to a number of inputs, namely:

- the time period over which measurements are taken
- the period between measurements
- the choice of market price against which to regress the change in stock price

Using a recognised standard financial statistical resource (in this case Bloomberg) and choice of market that reasonably represents the breadth of available risky equity investments (in this case the S&P 500 index) the range of different values that can be achieved for beta measuring over the last two years go from 0.4 to 2.0, depending upon the period between measurements that is used. More importantly the coefficient of determination (R^2) ranged from 0.05 to 0.28, meaning that the statistical significance of this value of beta is low and the likelihood of using one of these results as a true value of beta is high.

The calculation of the appropriate WACC is dependent upon a number of inputs which require a degree of judgement and subjectivity.

Item	*Low*	*Medium*	*High*
Risk-free rate	4.5%	4.5%	4.5%
Equity premium	6%	5%	6%
Beta	1.0	1.3	1.5
Cost of equity (real, post-tax)	10.0%	11.0%	13.5%
Cost of debt	10.0%	10.0%	10.0%
Optimal gearing	70%	60%	50%
Corporate tax rate	36%	36%	36%
WACC (real, pre-tax)	**11.45%**	**12.9%**	**15.55%**

***Exhibit 2.10**: WACC comparison [Source: Analysys]*

2.3.6 Efficiency and the scorched-node adjustment

In modelling an efficient new entrant using operators' actual data as a starting point, there is scope to make explicit adjustments in areas where operators are deemed to be acting inefficiently. In a competitive market, such as Israel, there is strong pressure from the retail markets to keep operating costs as low as possible, so no explicit adjustments to operating costs were made as part of the model. However, in order to ensure realistic model results, and to avoid setting an unattainably high target of efficiency for the actual operators, a 'scorched-node' adjustment was made to the network design algorithms.

This adjustment is designed to reflect an assumption that the equipment placed at every node in the network is optimised (using the actual number and layout of nodes), as opposed to a scorched-earth approach which assumes a theoretically optimised layout of nodes in a network in addition to the equipment located at those nodes.

Scorched-node adjustment

The bottom-up model uses network design algorithms to determine the appropriate network to support a given level of demand, coverage and quality of service. It is unlikely that the ideal network for supporting demand at current levels will be perfectly reflected in the actual networks that are currently deployed, although this is not necessarily a sign of inefficiency on the part of the operators. For example, early network deployments are likely to have been made on the basis of forecasts which underestimated future traffic levels, and consequently networks have evolved over time; inevitably current networks will have been affected by legacy decisions about placement of base station sites etc.

To calculate prices on the basis of a 'scorched-earth' network would be to punish existing operators for making efficient decisions in the past that turned out to be less than optimal for the current situation. The alternative, adopted in this model, is to make a 'scorched-node adjustment' to the network design to ensure that the networks that the models produce are an accurate reflection of the real-world networks. This is captured as part of utilisation in the network design algorithms.

The scorched-node adjustment for each operator is an implicit part of the utilisation of the network elements for each operator. The value of this adjustment is based upon a high-level calibration of the number of key network elements present for each operator at the present time. For network elements where information was available for one operator but not the others, the utilisation was assumed to be the same for all operators. The networks in Israel already have a high level of utilisation of their key network elements, so the conservative assumption is made that the utilisation will not increase in the future, implying that the networks are in a mature state and that 2G mobile traffic in Israel is growing at a stable and predictable rate.

2.4 Service costs and routeing factors

The purpose of this model is to produce the costs of different services that are provided on a mobile network, specifically voice and SMS termination. Costs are allocated onto services on the principle of 'cost-causality', meaning that a given cost is allocated onto services to the extent that each service causes that cost to be incurred. The key to this allocation is a table of routeing factors. The table below shows the major routeing factors used in the GSM network model with a simplified set of services for illustration purposes.

Routeing factor table

Elements	*Subscribers*	*Incoming voice minutes*	*Outgoing voice minutes*	*On-net voice minutes*	*SMS messages*	*PS data Mbytes*
Transmission	0	1	1	2	0.0004	12.54
MSC	400	1.43	1	2.43	0.43	0
HLR	0.27	1	0	1	0	0
SMSC	0	0	0	0	1	0
GGSN/SGSN	0	0	0	0	0	1

Exhibit 2.11: *Routeing factor table [Source: Analysys]*

Routeing factors can be more formally considered in the equation:

$$SC = \sum_{1}^{N} C_n \times RF_n$$

Where

SC	Service cost per unit demand
C_n	Cost per unit output of cost category n
RF_n	Routeing factor for cost category n
N	Total number of cost categories

The cost per unit output for each cost category (C_n) is calculated as follows:

$$C_n = \frac{LRIC\ of\ category\ n}{\sum_{1}^{M} D_m RF_m}$$

Where

D_m	Demand by service m
RF_m	Routeing factor for cost category n by service m
M	Total number of services

The routeing factors used in the model were developed by considering both network architecture and the function of the different elements within the network. The clearest demonstration of this is to consider an example, in this case the transmission routeing factor applied to base station transceivers (TRX).

In a GSM network, TRXs have a capacity of eight time-slots, or channels. An outgoing call will occupy one channel, and an incoming call will occupy one channel. An on-net call will occupy one channel for the originator and one channel for the terminator. Thus, an on-net minute uses twice as much TRX resource (and therefore cost) as an outgoing (or terminating) minute. The resulting routeing factor for the transmission is shown in Exhibit 2.11. A full table of the routeing factors used is shown in Annex E.

Conversion factors for SMS and PS data

To evaluate the impact that an SMS message has on the cost of a TRX, it is necessary to compare the loading an SMS message puts on the TRX and the loading that voice traffic puts on the TRX.

SMS messages differ from voice traffic in that they are carried by the channels provisioned for signalling rather than the channels provisioned for traffic. However, SMS messages are competing for the signalling capacity that could otherwise be used by signalling for voice calls. This means that the cost of the capacity on the signalling channel must be allocated between SMS and voice messages by an appropriate method.

The model does not explicitly model SMS and signalling traffic in the network, instead it is implicitly included in modelled radio and switching network elements. This requires converting an SMS message into its equivalent number of minutes so that the extent to which they consume radio capacity (and therefore cost) can be calculated.

The conversion calculation for SMS is shown below:

	GSM	*CDMA*
Average SMS length (bytes)	40	40
Channel bandwidth (bits/s)	14,400	9,600
Equivalent voice minutes per average SMS message	0.00037	0.00056

Exhibit 2.12: *SMS conversion to voice-equivalent minutes [Source: Analysys]*

Packet-switched data traffic also uses capacity on the network which could otherwise be used by voice services and, as such, some of the costs of the network must be allocated to packet-switched data traffic. Again, this requires that the data traffic can be compared directly to voice traffic and is thus converted to voice-equivalent minutes in a similar manner to SMS messages.

	GSM	*CDMA*
IP overhead	12%	12%
CS1 channel rate	0.00905	0.0096
Channel occupancy efficiency	100%	100%
packetization allowance	95%	N/A
proportion of user demand in the downlink	80%	N/A
Equivalent voice minutes per average Mbit/s	12.54	15.56

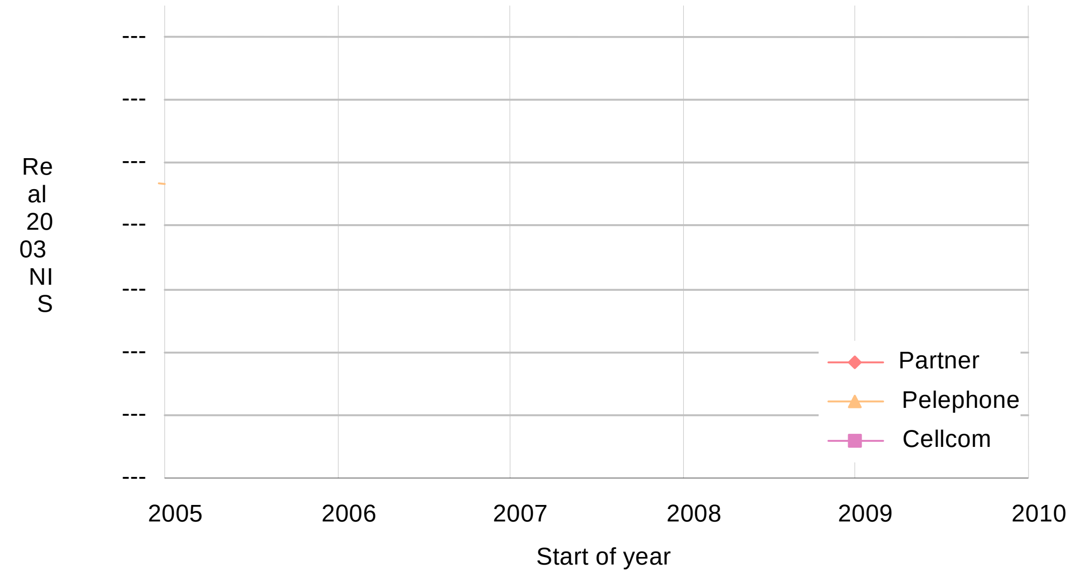
Exhibit 2.13: *PS data Mbytes conversion to voice-equivalent minutes [Source: Analysys]*

3 Model results

This section shows the most important cost results from the bottom-up model for the actual operators (section 3.1) and a major new-entrant operator (section 3.2). All results are shown exclusive of royalty payments (i.e. there is no explicit additional allowance in the cost for royalty payments). The characteristics selected to represent the new entrant are in part a matter of judgement and section 3.2.2 explores the sensitivity of the cost of termination to a number of reasonable alternative parameters. In addition, Section 3.2.3 shows the results for the cost of terminating an SMS message on the new-entrant operator's network. Finally, section 3.3 discusses the method of calculating depreciation that has been used in reaching the LRIC results in this report.

3.1 Actual operators

Exhibit 3.1 below shows the voice termination rates for the three main operators, assuming a long-run market share for each of them of 30% (i.e. assuming 10% is taken by MIRS). As can be seen, the LRIC of terminating a voice minute varies substantially between the three networks. In 2005 the cheapest network is ------- network at NIS----, followed by ------ network at NIS---- and finally, the most expensive, ---------- network at NIS ----. On all networks the LRIC show the normal pattern of behaviour of a stable cost, decreasing as asset utilisation rise and prices fall.



Termination rate	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Partner	---	---	---	---	---	---
Pelephone	---	---	---	---	---	---
Cellcom	---	---	---	---	---	---

Exhibit 3.1: *Termination rates, Real 2003 NIS [Source: Analysys]*

The rationale behind the observed differences in prices between the networks is clearly demonstrated by considering what costs contribute towards the termination rate. This is shown in Exhibit 3.2 below.

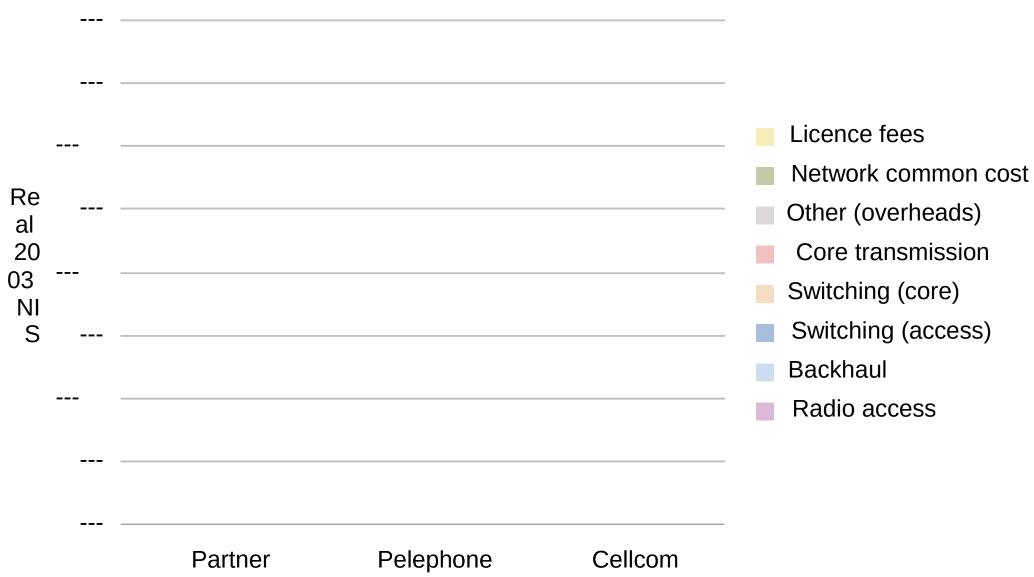


Exhibit 3.2: *Contribution to termination rates for each operator in the start of 2005, Real 2003 NIS [Source: Analysys]*

For all three operators, the largest single contribution to the termination rate comes from the cost of their radio access network. -------- has the most expensive radio network --------- --, although over time --------- cost per minute falls to the same level as -------------------------- -------------.

------------- radio access network is more expensive than ----------------- radio access network because the unit cost of ------------ radio equipment is more than the equivalent ---------------- (on a per-unit-capacity basis).

--------- has the cheapest radio network, but still has a LRIC of termination in excess of ------------. The primary reason for this is -- --- and this contributes an additional NIS------- to the cost of termination for --------------- (in real 2003 terms).

3.2 Fourth major new-entrant operator

The results shown in this section are for a new-entrant operator using GSM technology achieving a market share of 25% in the long-run. The figures are based on the level of network utilisation and prices that the existing operators are actually achieving; this is necessary to ensure that the prices are set at a level that will allow operators to make a reasonable return on their investment. The rationale behind the assumptions regarding the new entrant is explained in detail in Section 3.2.2.

3.2.1 Voice termination

The voice termination costs for the new entrant are shown in Exhibit 3.3 and Exhibit 3.4, below.

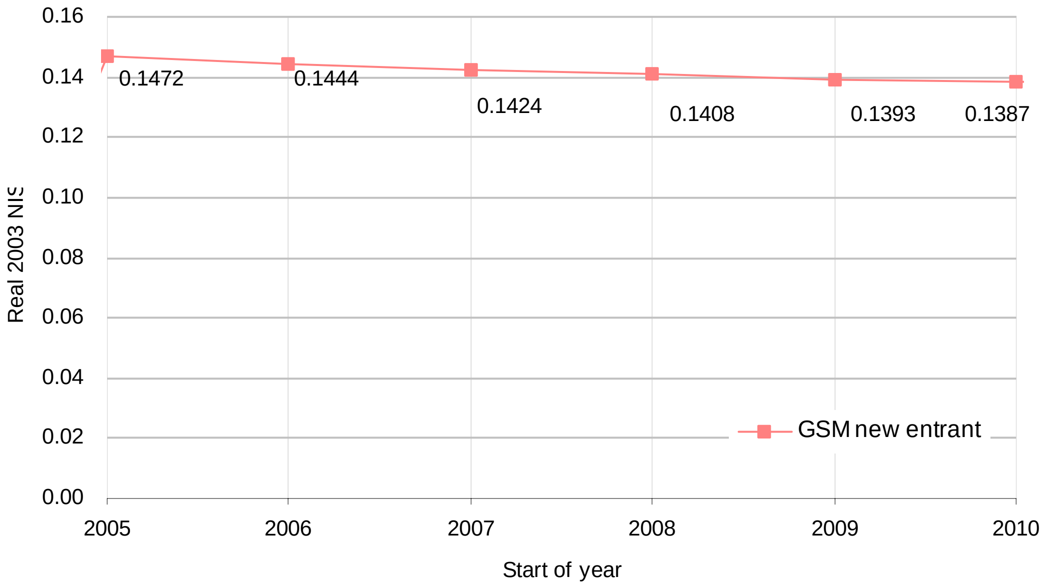


Exhibit 3.3: *Termination cost of fourth major new entrant [Source: Analysys]*

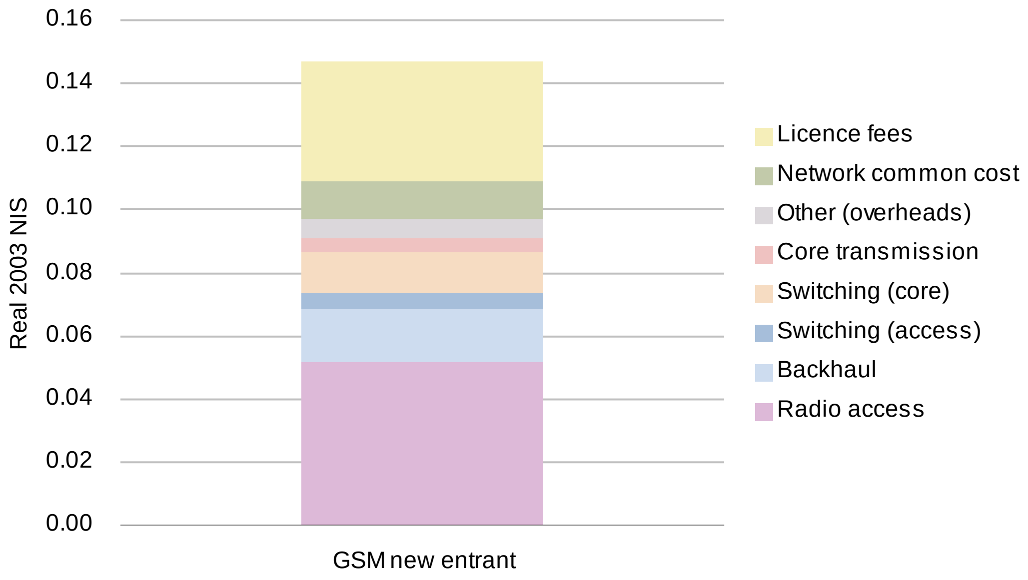


Exhibit 3.4: *Contribution to termination rates for new entrant operator in the start of 2005, Real 2003 NIS [Source: Analysys]*

The cost of termination for the new entrant is very similar to that of Partner (Exhibit 3.1), which is unsurprising given the fact that Partner was a new-entrant GSM operator in 1999. The new entrant is slightly more expensive because its network would be less well utilised for the first few years as it increases its market share.

It is assumed that the new entrant pays the same initial licence fee in real terms as Partner (USD400 million) since this is the most recent price paid for a licence in a competitive tender, and constitutes a reasonably conservative assumption give the lack of tangible alternative assumptions.

3.2.2 Sensitivities on new-entrant operator

Base case

The new-entrant operator should reflect both regulatory aims and realistic forecasts of the market in Israel. Exhibit 3.5 shows the chosen value for a number of key parameters which were then varied in order to explore the sensitivity of the cost of termination for the optimised operator to these assumptions.

Item	*Value for optimised Scenario*
WACC	12.88%
Market share	25%
Packet-switched data demand	4 Mbytes per sub per month
SMS demand	30 messages per sub per month
Long-run MEA trend	0%

***Exhibit 3.5**: Parameters used for new-entrant base case scenario [Source: Analysys]*

WACC

The WACC is the return required by investors, of both equity and debt, in exchange for the provision of capital to the company. It reflects the investors' expectations of both risk and return from the company and is used as the discount rate in the economic depreciation algorithms. The WACC can be calculated in a bottom-up manner, as shown in Exhibit 2.9 on page 26 above.

WACC value	*Termination rate in the start of 2005 (Real 2003 NIS)*
11.45%	0.136
12.88%*	0.147
15.55%	0.171

* Base case assumption

***Exhibit 3.6:** WACC sensitivity table [Source: Analysys]*

Market share

The market share for the new entrant should be based on the optimum number of players desired in the Israeli mobile telephony market. Allowing too many players reduces the economies of scale available to each player and thus pushes their costs up. Conversely, basing a price on the cost of an operator in a market with too few players, with accordingly greater economies of scale than would be achievable by the actual operators in Israel, will result in prices being set below the actual cost incurred by the actual operators. The price recommendations in this report are based on a market with *four* equal players. This is based upon the fact that Israel currently has four cellular operators, all competing for the mass market. Ultimately, however, the decision on the optimum number of players is a judgement for the MoC and MoF based on their regulatory objectives.

Two alternative scenarios are also considered here: three equal players with 33% market share each; and three equal major players with 30% of the market each together with one sustainable minor player with 10% of the market. This last scenario is designed to be similar to the current reality (with MIRS as a minor player) being perpetuated into the long run.

Market share	*Termination rate in the start of 2005 (Real 2003 NIS)*
25% in the long run*	0.147
30% in the long run	0.136
33% in the long run	0.132

* Base case assumption

Exhibit 3.7: *Market share sensitivity table [Source: Analysys]*

Packet-switched data demand

The greater the volume of data loading the network, the greater the proportion of the cost of both voice and data services that is recovered through data services. As explained in Section 4.2, only packet-switched data carried over GPRS is considered for the new entrant, and not data that is carried over UMTS or other future technologies. The effect that packet-switched data volumes have on the LRIC of termination is minimal. As can be seen in Exhibit 3.8, doubling or halving the packet-switched data demand assumed in the base case produces a negligibly different result.

Packet-switched data demand	*Termination rate in the start of 2005 (Real 2003 NIS)*
Base case (4Mbytes per sub per month in the long run)	0.147
High (200% of base case)	0.147
Low (50% of base case)	0.148

Exhibit 3.8: *Packet-switched data demand sensitivity table [Source: Analysys]*

SMS demand

Much like packet-switched data, SMS traffic occupies very little capacity on the network, so changing the volume of SMS (within reasonable limits) has a very small effect on the LRIC of termination.

SMS demand	*Termination rate in the start of 2005 (Real 2003 NIS)*
Base case (30 messages per sub per month)	0.147
High (200% of base case)	0.146
Low (50% of base case)	0.148

Exhibit 3.9: *SMS demand sensitivity table [Source: Analysys]*

Long-run MEA trends

The modern-equivalent asset trends partly determine the profile of cost recovery. They also determine the prices at which equipment will be purchased in the future. A steeper decline in MEA prices means that costs will be recovered earlier in the network's life (increasing the termination rate in 2005) but that future equipment prices will be lower (lowering the termination rate in 2005). The new-entrant case assumes that in the long run, the cost of equipment will eventually stabilise in real terms after 2010, after which the MEA trend is assumed to take a constant long-run value of 0% in every year.

Long-run MEA trend	*Termination rate in the start of 2005 (Real 2003 NIS)*
0%*	0.147
-2%	0.156
-5%	0.169

* Base case assumption

Exhibit 3.10: *Long-run MEA trends sensitivity table [Source: Analysys]*

Exhibit 3.10 shows that the termination rate in 2005 increases as long-run prices decline faster, and decreases as prices decline more slowly. This may at first seem counter-intuitive since it appears that the cost of a service is rising as the cost of the assets used to support that service are falling. It is indeed the case that expenditure in the future will be less because the price of equipment is falling; however, the MEA price trends are also used to determine the shape of the cost-recovery profile in the economic depreciation algorithm: with lower prices for equipment in the future, economic depreciation will recover less cost of the equipment in the future, which in turn means that more cost must be recovered earlier in the network's life and thus the cost of termination in 2005 rises. So the change in

MEA price trend effects not only the total amount of expenditure but also the timing of the recovery of that expenditure.

Compounded sensitivities

By applying all of the above sensitivities to produce the most extreme effects on termination costs, the following results can be achieved. Approximately 50% of the difference can be accounted for by the choice of WACC alone.

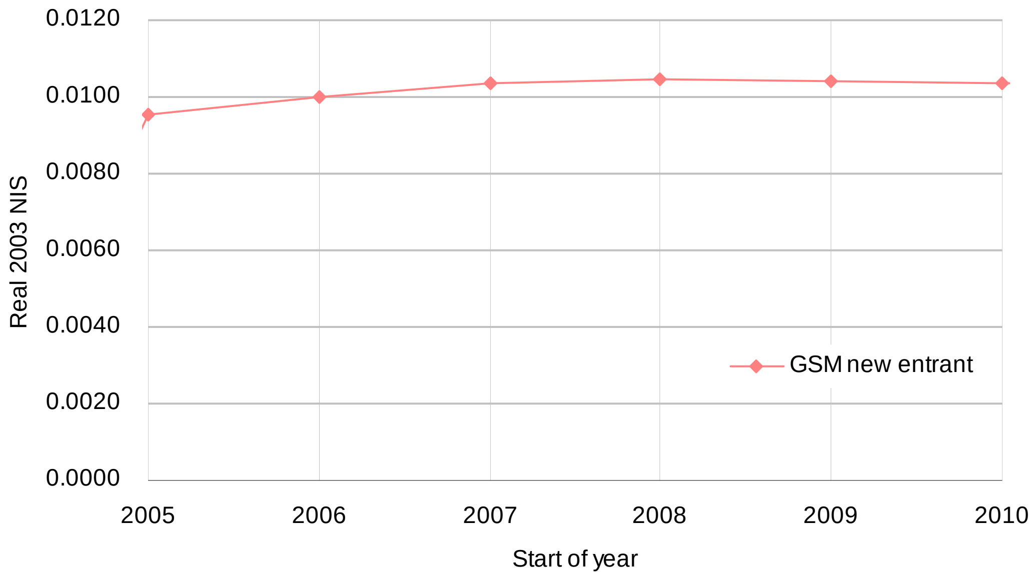
Compounded sensitivities	*Termination rate in the start of 2005 (Real 2003 NIS)*
Highest	0.194
Optimum*	0.147
Lowest	0.122

Exhibit 3.11: *Compounded sensitivity table [Source: Analysys]*

* Base case assumption

3.2.3 SMS termination

As shown in Exhibit 3.12 below, the LRIC of an SMS message on the new entrant’s network can be seen to rise from approximately NIS0.0096 in the first year of operations before stabilising at around NIS0.0104. The true cost of terminating an SMS message is extremely small when compared to voice traffic, due to the size of the message and the low latency requirements. The small size of this cost makes it more sensitive to input assumptions than the cost of voice termination. Also, the exact manner in which a given cellular network terminates an SMS message is highly dependent on the specific set-up of the hardware on the network and the nature of the interaction with the SMSC on any interconnected networks.



	2005	*2006*	*2007*	*2008*	*2009*	*2010*
Real 2003 NIS	0.0096	0.0100	0.0104	0.0105	0.0104	0.0103

Exhibit 3.12: *SMS termination cost of fourth new-entrant operator, Real 2003 NIS [Source: Analysys]*

If the general principle of SMS contending with signalling capacity for voice calls is accepted, then the main driver of sensitivity for the cost of terminating SMS is the way the switching network responds to each SMS message in comparison to each voice minute. In the model, the vast majority of SMS cost is in the switching network and, as such, the cost is mostly driven by the number of SMS messages (rather than the total size of the SMS messages, which drives the radio network). Thus, the assumptions in the conversion from SMS messages to equivalent voice minutes given in Exhibit 2.12 above is not major driver of sensitivity.

The key assumption is the routeing factor used to compare the effect that a voice minute has on the switching network as compared to an SMS. The routeing factors for this are based on similar work Analysys has conducted in the past on similar networks. The values are given in Appendix E, and repeated in Exhibit 3.13, below with sensitivities showing how only the small part of the cost that is allocated to the radio network is sensitive to the length of the message.

Average length of message	*Routeing factor, radio network*	*Routeing factor, BSC*	*Routeing factor, MSC*	*SMS cost per message, 2004 (NIS)*
20 characters	0.000185	1	0.428571	0.00954
40 characters*	0.000370	1	0.428571	0.00957
80 characters	0.000741	1	0.428571	0.00961

* Base case assumption

***Exhibit 3.13:** Routeing factors for SMS [Source: Analysys]*

3.3 Choice of depreciation method

All LRIC results presented in this report are calculated using economic depreciation to annualise capital expenditure. This is a more complex method than conventional straight-line accounting depreciation, based on historical cost. Economic depreciation is favoured for regulatory purposes since it more accurately matches the costs of assets to the revenues they support. Exhibit 3.14 provides a sample comparison of how using the termination rate calculated using straight-line historical costs (HCA) depreciation for price setting would result in an unreasonably high price in early years falling to a very low price in future years.

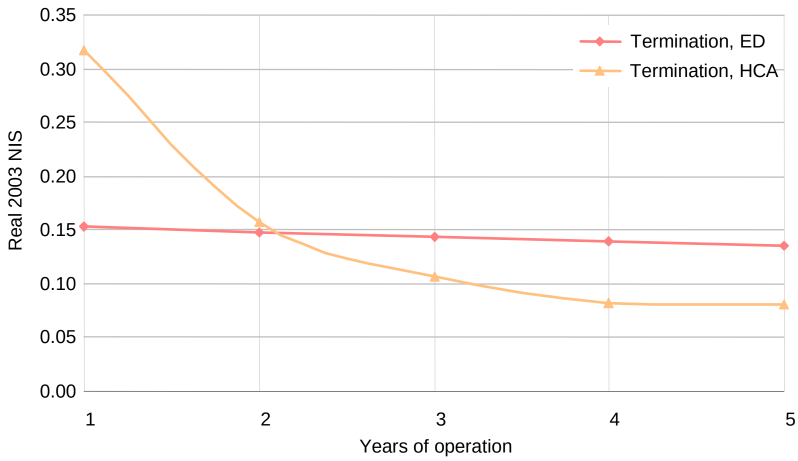


***Exhibit 3.14:** Sample comparison of termination rates calculated using economic depreciation and historical costs [Source: Analysys]*

The rapid growth in traffic volumes in early years of the networks in Israel mean that termination rates based on historical cost become cheaper than those based on economic depreciation very rapidly – after between one and two years in operation.

It is worth pointing out that both types of depreciation recover exactly the same costs in present value terms, the only difference being in the timing of that cost recovery.

4 Pricing

This section recommends a single cost-orientated price for mobile termination based on the results in Section 3, and proposes a two-stage cut from the current price to the cost-orientated price. This process is broken down into a series of logical steps, as summarised in Exhibit 4.1:

- determining the appropriate cost that should be used as the basis for price setting (section 4.2)
- adding in any externality value to the cost (section 4.3)
- determining the appropriate path from the current price to the cost-orientated price (section 4.4).

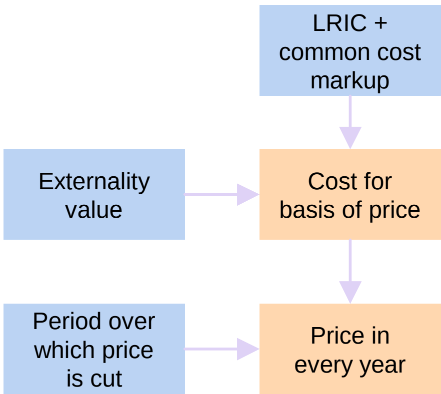


Exhibit 4.1:
Path from cost to price [Source: Analysys]

4.1 Summary of recommendations

As shown in Exhibit 4.2 below, the results from the model clearly show that the cost of voice termination is significantly lower than the price cap of NIS0.45 that is currently in place.

Operator	*Termination cost at the start of 2005 (Real 2003 NIS)*	*Termination cost at the start of 2007 (Real 2003 NIS)*
Partner (GSM)	---	---
Pelephone (CDMA)	---	---
Cellcom (TDMA, GSM)	---	---
New entrant (GSM)	0.147	0.142

Exhibit 4.2: *Cost model results [Source: Analysys]*

The results from Section 3 and Exhibit 4.2show that each network in Israel has a LRIC cost of voice termination and each LRIC cost is based upon a number of assumptions. The question is then which of these costs is the appropriate basis for the setting of interconnection prices.

The appropriate policy choice in Israel is for a single price for termination on all mobile networks, set on the basis of efficiently used second-generation technology.

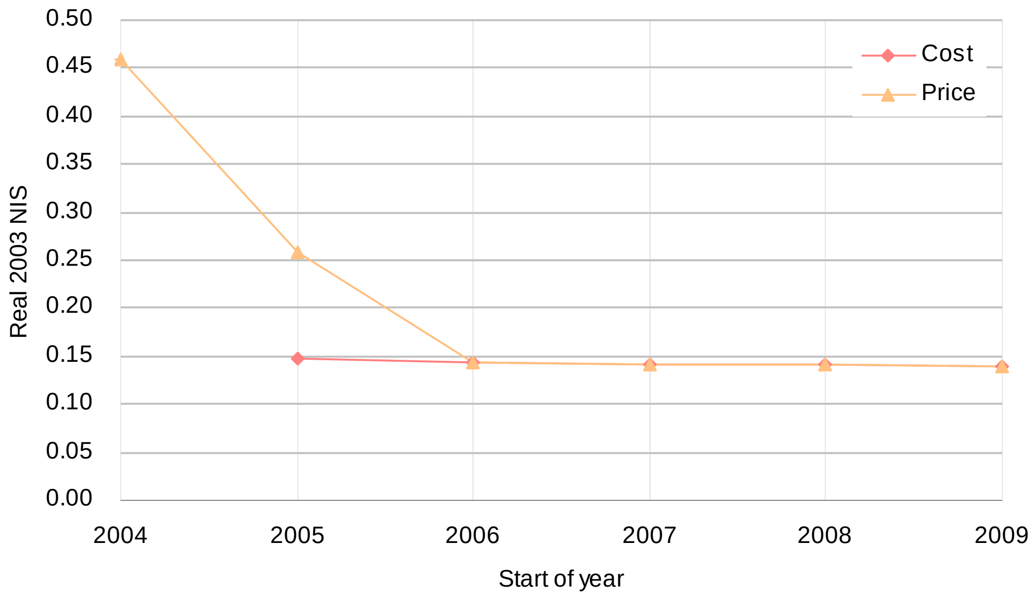
This assertion is justified by the analysis in section 4.2, which examines all the relevant pricing issues.

The existing subscribers to a network gain a benefit from a new subscriber joining the network as they can call and be called by that new subscriber. The value of this benefit, called the ‘network externality’, needs to be taken into account.

The high penetration and high usage of mobile telephony in Israel means that the value of the network externality subsidy per minute is negligible.

This conclusion is discussed in section 4.3.

In considering the timing of the price reduction, Analysys recommends imposing a new price cap in each of the years 2005 and 2006 to bring the price in line with the cost over that period, so that from the beginning of 2006 onwards the price and cost are equal. This two-stage cut to cost is shown in Exhibit 4.3 and described in more detail in section 4.4.



Price	*2004*	*2005*	*2006*	*2007*	*2008*
NIS (Real 2003)	0.458	0.257	0.144	0.142	0.141
X		44%	44%	1.4%	1.1%

[1] effective price per minute less royalty payment of 3.5% in 2004.

[2] All prices shown are as at start of year.

Exhibit 4.3: *Recommended price cap at year beginning [Source: Analysys]*

4.2 Appropriate cost for use as basis for price setting

In considering which cost is appropriate to use as the basis of price-setting, this section addresses the following issues:

- should costs be included that are the result of different choices of network technology?
- should costs be included that result from choosing to change from one technology to another, more efficient technology?
- should different prices be set for different operators, or are their differences due to costs that they incur when acting in an economically inefficient manner?
- should the recovery of investment in third-generation networks be included in the price?

The price should be based on the cost of a competitive new entrant

The basis for resolving these questions should consider the regulatory objective in Israel of "quality modern telecommunications services, at reasonable tariffs, to all citizens, throughout the country [… through the …] enhancement of competition"[9] These objectives imply that the price charged should be based on the cost of a *competitive new-entrant operator*. In a perfectly competitive market, an existing operator charging a price above this point would be forced to decrease its prices or risk being replaced by a new entrant which could offer a lower price and still make normal profits. Thus, in a non-competitive market, such as the Israeli mobile termination market, the correct price should be based on an efficient new entrant.

The question of whether to include costs that are the result of different technology choices is a complex one

In Israel, different operators have employed different mobile technologies, and it can be argued that any differences in costs that result from these *different network technology choices* should be included in the prices set. From the model results it can be demonstrated that CDMA would allow a new entrant to provide termination at a lower cost than if it chose to deploy a GSM network. GSM could thus be regarded as an inefficient choice of technology.

However, this does not take into account any licence provisions that would restrict the technology choice, or the fact that the termination service is indivisible from the other services provided by the operator, for instance the ability to offer roaming to subscribers from other GSM networks and the ability to offer GSM rather than CDMA handsets. This means that GSM might be the most efficient technology for the business as a whole, whilst CDMA is the most efficient technology for termination of voice minutes.

If, therefore, it is decided to use a single technology for setting termination prices, the conservative assumption should be made of

9 *Liberalization of Markets and New Regulatory Framework: The Israeli Case*, Daniel Rosenne, Director General, Ministry of Communications, Israel. Available at http://www.moc.gov.il/new/documents/article_25.04.01.pdf

using GSM, so as not to set unattainable efficiency targets for the operators.

Costs incurred solely for the benefit of an operator's own subscribers should not be included in the cost of termination

The general approach that costs incurred solely for the benefit of an operator's own subscribers should not be included in the cost of termination, can also be extended to Cellcom's situation with regard to technology choice. The operator originally offered mobile services over a TDMA network and then in 2002 chose to offer a GSM service, migrating its customers from one technology to the other. This choice puts Cellcom in the current position of running two parallel networks, albeit with some shared infrastructure.

It is unlikely that choosing to operate two different technologies in parallel can be described as an efficient choice. Looked at from Cellcom's perspective, however, it might be that TDMA was the efficient technology to choose in 1994 when it started offering service, while in 2002 the efficient choice was GSM. Argued in this way, the additional costs of running two networks in parallel for a period was actually inherent to being an efficient operator.

In this case, there is still the question of whether these costs should be recovered through extra termination payments to Cellcom. One way to address this question is to consider whether the subscribers to other networks (who pay Cellcom for termination) gain additional benefit from this additional cost. The answer to this is no: subscribers to other networks are still able to have their calls terminated on Cellcom's network irrespective of the underlying technology, and thus gain no additional benefit from the operator's migrating to GSM.

Operators should be allowed to recover only costs that are efficiently incurred

An additional implication of the MoC and MoF's regulatory objectives is that existing operators should only be allowed to recover the costs that they incur when acting in an *economically efficient* manner. In a perfectly competitive market, an existing operator that is operating in an inefficient manner will not be able to offer services at a price as low as an efficient operator, and will be forced to increase efficiency or risk losing subscribers. Thus all non-efficiently incurred costs should be excluded from the price cap on termination rates.

Clearly, some costs are beyond the control of even the most efficient operators. For example, if the first operator to market secured long-term leases for its base station sites with lower rent than could be achieved by subsequent players, it would be unreasonable to set prices on this basis as it would offer the first operator an unmatchable advantage, regardless of how efficiently the new entrants operate their business. Thus, those costs which are *beyond operators ability to control* should be included in their termination rates.

The principle of cost-orientation suggests different prices should be charged for different operators

While the regulatory objectives in Israel support a single cost-oriented price based on the cost of a competitive new entrant, there are arguments which support the charging of different prices for different operators.

The main argument supporting the charging of different prices is strict adherence to the principle of cost-orientation: if termination costs one operator a different amount, then its price should be correspondingly different.

Differences in cost between mobile operators can arise from a number of different sources, some of which they have control over and some of which they do not. Typical examples are:

- network coverage
- quality of service of network
- services offered

- network technology used
- owned vs. leased transmission network
- economies of scale
- shared infrastructure (e.g. with the fixed incumbent)
- timing of market entry (e.g. the first operator will secure the best cell site locations).

However, in considering this argument from cost-orientation, there are a number of additional questions that need to be examined:

- do certain differences in costs between the operators arise from inefficient operations?
- do some differences result from the historical use of different technologies, and would a new entrant be bound by these constraints?
- should these cost differences be recovered through termination rates?
- is asymmetric pricing in accordance with regulatory objectives?

Exclusion of 3G investments is a conservative assumption

When we consider the long-run incremental cost of voice termination, this should include forecast changes in technology. Investments in third-generation technology and licences will form an increasingly significant part of all the operators' expenditure in Israel. These networks will, of course, offer voice services and are expected eventually to replace the existing second-generation infrastructure. However, the model upon which this report is based excludes all third-generation investments on the grounds that this is a conservative assumption and likely to yield higher termination rates than if 3G investment were included.

There is significant uncertainty over the forecast take-up of data services on 3G networks. In the event of a high level of take-up, and a resulting well-utilised network, the cost of terminating a voice minute will almost certainly be lower on a 3G network, in the long-run, thus lowering the termination rate. If the level of take-up is so low that the cost of termination on a 3G network is higher than on a

2G network (in the long run) then it would not constitute an efficient technology choice and should not be included in the cost of termination by the MoC/MoF for that reason.

Although there has been little publicly available empirical evidence about the cost of terminating a voice minute on a 3G network, plenty of expert opinion, theoretical analysis is available to support this opinion. A selection is quoted below:

"UMTS provides capacity at a significantly lower cost per minute compared to 2G" Arthur D Little (Telecom Finance, March 2003)

"The theoretical cost per minute is eight times lower on UMTS [than GSM]" Cambridge Consultants (3GNewsroom, June 2003)

"3G can potentially offer an access cost per minute one fifth that of GSM" Analysys Research, The Road to Fixed-Mobile Substitution Starts with 3G, April 2004

4.3 Value of network externalities

4.3.1 The network externality in theory

In adding a new subscriber to a network, people other than the new subscriber and the network benefit

The network externality is the benefit gained by existing subscribers to a network from a new subscriber joining the network: they can call and be called by that new subscriber. In the case of a mobile network interconnected with other mobile and fixed networks, the externality benefits all subscribers to all the interconnected networks and also those existing subscribers on the same network.

The socially optimal level of penetration includes this external benefit

In any unsaturated market, there will be a proportion of non-subscribers who are price-sensitive and would take a mobile service if the price were lowered. Recognising that existing subscribers would benefit from these so-called 'marginal subscribers' joining a mobile network, if the value of that benefit were used to subsidise the acquisition of the marginal subscribers, then they would join the mobile network, up to the point at which the marginal social benefit to a new subscriber is equal to the marginal cost of acquiring that subscriber. This is the socially optimal level of service penetration, where total benefits to producers and consumers are maximised.

The socially optimal price includes a subsidy equal to the value of this external benefit

This idea is illustrated in Exhibit 4.4, where the penetration of the service without factoring in the externality in to the price, C, would be S_1. When the externality value is considered then the socially optimum penetration is where the marginal cost and marginal social benefit intersect, leading to a penetration of S_2. In order to reach this level of penetration, the price of subscription would have to be lowered to P, with existing subscribers (i.e. those benefiting from the externality value) paying the subsidy required to bring the marginal cost of subscription down to P.

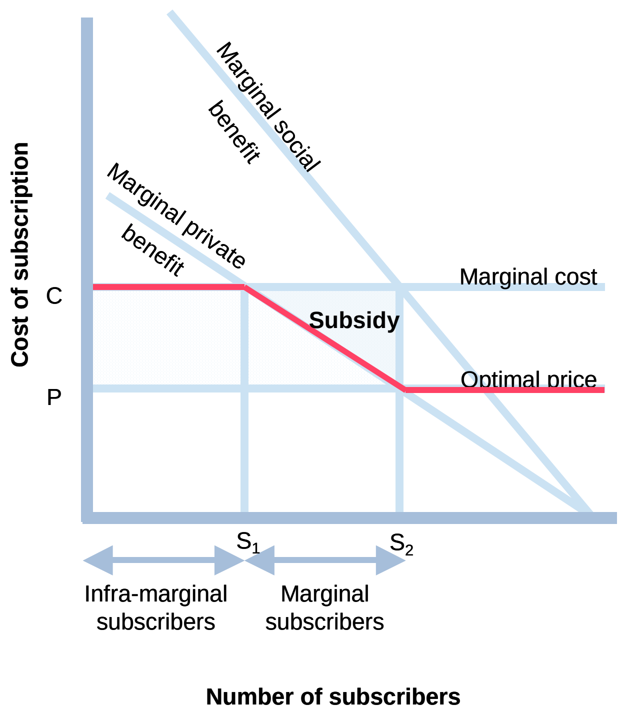


Exhibit 4.4:
Network externality [Source: UK Competition Commission, 2003]

4.3.2 The network externality in practice

The concept of an externality is recognised, but the value is not easily quantified

The previous section shows that, conceptually at least, there is a network externality and that it can have a value. The difficulty arises in trying to quantify that value in a meaningful way. Referring to Exhibit 4.4, in order to evaluate the size of the subsidy required, all the lines shown on the graph have to be known. For some this is trivial: the points S_1 and C, and thus the marginal private benefit at their intersection can all be easily measured. However, the marginal social benefit line and the number of marginal subscribers (S_2) are much harder to quantify.

The most recent investigation in the UK yielded an externality surcharge of 7% of the cost of termination

The UK is the only country to have had a full public consultation process on the value of the network externality. The value that was eventually agreed upon by the Competition Commission of GBP0.0045 per minute in 2003, was based upon a simple model which used the following key assumptions, which again relate to Exhibit 4.4:

- A Rohlfs-Griffin (RG) factor of 1.5 (this defines the ratio of the marginal social benefit to the marginal private benefit)
- 2.9 million existing subscribers who become marginal every year (i.e. who reach the end of their natural customer lifetime and choose not to resume service)
- 1 million marginal new subscribers who are subsidised every year (marginal existing subscribers and marginal new subscribers gives the marginal subscribers, S_2-S_1 in Exhibit 4.4).

These key assumptions, together with a number of less important assumptions, lead to a subsidy of GBP0.0041 (or approximately 7% on the cost of termination).

4.3.3 The value of the network externality in Israel

High mobile penetration implies a lower number of new marginal subscribers

The Israeli mobile market has a number of interesting characteristics that affect the value of the network externality. The first is the very high level of penetration: over 95%.[10] This means that, in comparison to the UK, say, the number of potential new mobile subscribers is much smaller, and a larger proportion of these non-subscribers are highly price-insensitive and thus unlikely to be marginal non-subscribers.

The Israeli census for 2002 gives the proportion of the population of Israel aged over 15 as 73%. Even using the MoC and MoF's conservative estimate of penetration for 2002 of 85%, it is clear that already only the very young do not have a mobile phone.

Applying the analysis used by the UK Competition Commission, this would imply that the marginal subscribers consists only of existing marginal subscribers and that existing marginal non-subscribers would be practically zero.

High penetration and high usage implies a lower number of marginal existing subscribers

The marginal existing subscribers are those who would not renew their handset or contract when it reaches the end of its lifetime. In the UK, this value was determined to be 34%, the high value being justified in part by decreasing handset subsidies in the UK. Israel is characterised by very high penetration and very high minutes of use (compared to the UK and many other European markets). These two factors taken together would imply a higher value being derived from mobile phone ownership in Israel than in the UK, and accordingly a higher propensity to replace the mobile phone at the end of its life.

The UK Competition Commission calculation is further based on the subsidy required to get the most basic prepaid package available. This ignores the market for second-hand handsets, either purchased or

10 Source: ITU, 2002. There is likely to be some double-counting in this value due to individuals who subscribe to more than one network and are dependent on the operators' criteria for dropping lapsed pre-paid subscribers. The Ministry of Communications value of 85% for 2002 may be more appropriate.

simply given (a parent giving their old phone to a child when they upgrade their own phone, for example). This would lower the subsidy required per subscriber to continue mobile service.

Furthermore, the high usage in Israel, resulting in a high number of terminating minutes, means that the externality subsidy per minute would be substantially smaller than in the UK.

Internalisation of the externality value leads to a low RG factor

As mentioned in Section 4.3.1, the value of the externality accrues to all network subscribers as they have the ability to call, and be called by, the new subscriber. This assumes that the transaction between the new subscriber and the network is entirely private (i.e. the new subscriber pays entirely for their subscription) and that all interconnected network subscribers benefit equally. Both of these assumptions are, to an extent, flawed.

The common example of a parent buying a mobile phone for their children is a situation where someone other than the new subscriber and the network perceives value from being able to call, and be called by, the new subscriber and pays for that value. This is an example the externality being internalised. Another example would be a company providing its employees with mobile phones, thus internalising the externality value.

The RG factor, which determines the marginal social benefit, has two intuitive limits, according to the consultation in the UK. The first is that there is a social benefit beyond the private benefit of securing a marginal subscriber (implying the RG factor is greater than 1). The second is that the benefit to the public is less than the benefit to the new subscriber (implying the RG factor is less than 2). In the UK, the value of 1.5 was chosen. In Israel the high penetration and high usage means it is likely that the RG factor should be closer to 1 than in the UK.

Network externality value is estimated to be negligible

The high penetration, high usage, and low RG factor will all act to lower the network externality value in Israel. In Appendix C there is a calculation replicating the one used by the Competition Commission in the UK, using Israeli data, and the value of externality subsidy per terminating minute is calculated to be a maximum of USD0.00013 (NIS0.0007) which is negligible in comparison to the termination rate of NIS0.138 and falls within the error bounds of the calculation.

4.4 Price recommendation

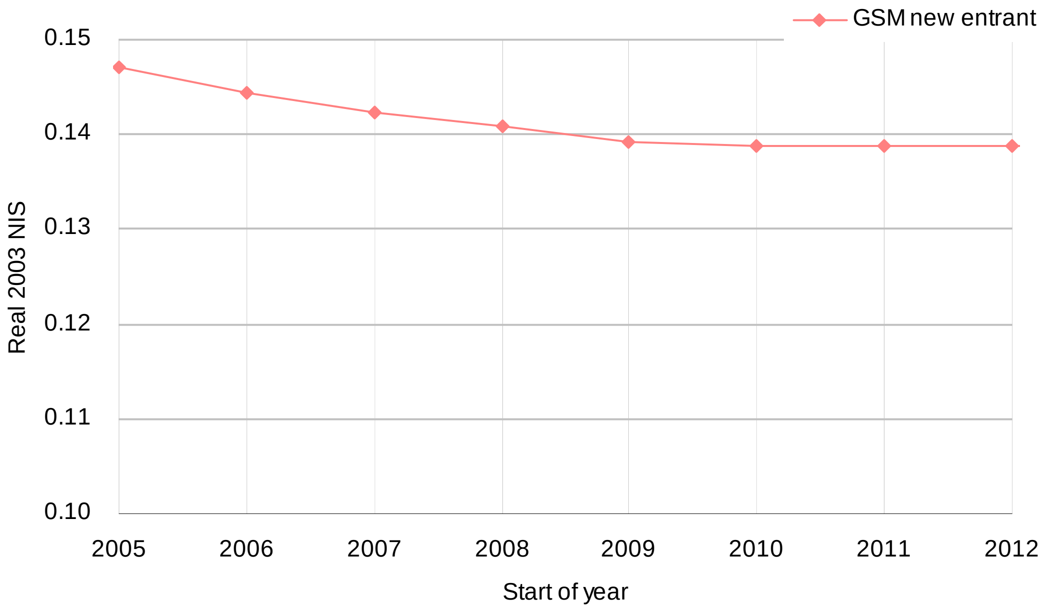
Before September 2000, the mobile operators in Israel set their own termination rate, but since then a single rate has been set by the MoC and MoF for all operators. The changes in termination price are summarised in Exhibit 4.5 below.

Operator	*1999-Oct 2000*	*Oct-Dec 2000*	*Jan-Dec 2001*	*Jan-Dec 2002*	*Jan-Dec 2003*
Pelephone	0.72	0.54	0.50	0.50	0.45
Partner	0.54	0.54	0.50	0.50	0.45
Cellcom	0.49	0.49	0.50	0.50	0.45
MIRS	NA	NA	0.50	0.50	0.45

Exhibit 4.5: *Termination rate, nominal NIS [Source: Israel Ministry of Communications, Ministry of Finance]*

The cost of termination in Israel has been previously calculated by the MoC and MoF to be NIS0.25, based on the published Analysys LRIC model used as part of the process in the UK.

Analysys's model for Israel, based on the cost of a efficient new entrant in 2004 using a GSM network and gaining a long-run 25% market share after five years, shows the appropriate cost of termination for the next five years to be as shown in Exhibit 4.6. It is worth noting that by 2007 the price of NIS0.142 is still in excess of the cost of the most expensive network actually operating in Israel (-----------------------------------).



Cost	*2005*	*2006*	*2007*	*2008*
NIS (Real 2003)	0.147	0.144	0.142	0.141

Exhibit 4.6: *Cost of termination for price-setting in Israel [Source: Analysys]*

Two-stage cut to cost

The current price of termination is more than triple the actual cost in 2004. Although this is clearly a significant difference, it may prove detrimental to the market as a whole to correct this discrepancy in a single step. Accordingly, a decline over two years is recommended for the transition from the current price to cost-based prices. The argument for this is given below.

An instantaneous cut to cost might prove disruptive to industry, reducing the expected consumer benefit

The alternative of an *instantaneous* cut to cost might appear to have the advantage of maximising consumer benefits. However, in reality, the underlying relationship between consumer benefit and the state of the industry is not as straightforward as this. If a high level of industry disruption is introduced, this might to a greater or lesser extent be to the detriment of the consumer (hence reducing the benefit). This would happen if the mobile operators passed on the disruption that they experienced to the consumer, for example, by reducing handset subsidies or changing prices rapidly.

The reaction of the mobile operators will determine the level of disruption

In reaction to the fall in termination revenues, the mobile operators have three possible responses:

- *maintain prices* at current levels and absorb the impact of reduced revenues, at the cost of reduced profitability
- *increase other prices* (e.g. mobile call *origination* tariffs) to restore profitability, resulting in increases in end-user bills and pre-paid charges for mobile consumers. This could result in marginal subscribers not being able to afford to continue using mobile services
- *reduce costs* (e.g. handset subsidies) to restore profitability, resulting in reduced growth in the overall market, reduced handset replacements and decreased levels of churn. In addition this could result in new and existing marginal subscribers being unable to afford or replace a handset.

A two-stage cut to cost offers a balance between consumer benefit and industry disruption

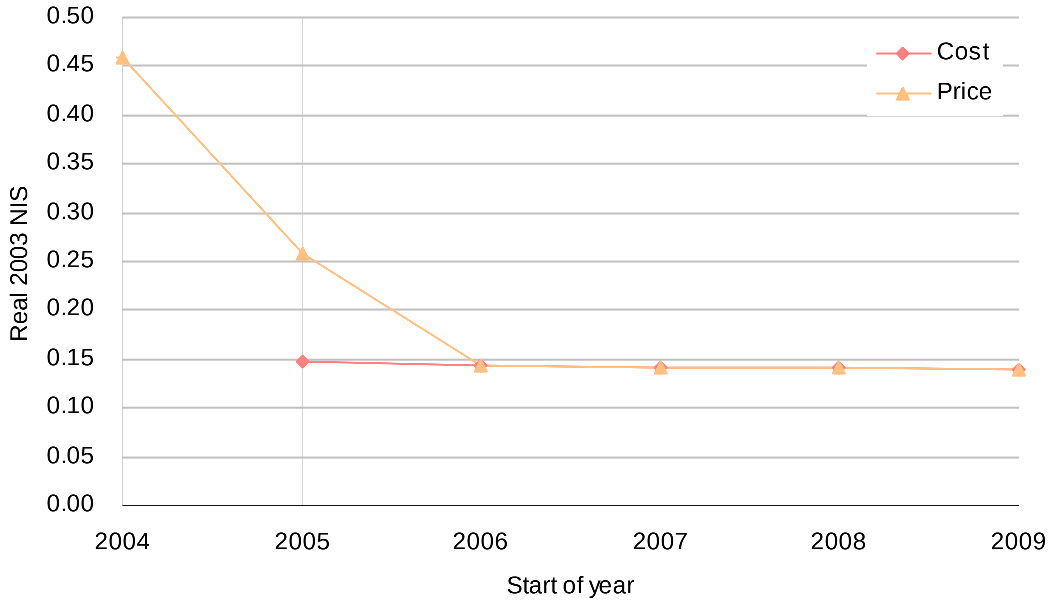
The second of the three possible responses from the mobile operators – raising prices – could be carried out relatively quickly. Cutting costs, however, whilst the more desirable option from a regulatory perspective, may take time.

An advantage of the two-stage cut approach is that it gives operators the time they need to adjust their costs (or increase their productivity) to an efficient level. It also offers a degree of certainty over future revenues which removes some risk from their future planning. Additionally, this approach allows operators to continue to make supernormal profits for an extended period, again acting as an incentive to reduce costs as quickly as possible.

This termination price should apply to all voice calls terminated on mobile networks

Currently in Israel, international calls terminated on mobile networks pay NIS0.25 per minute. Since the cost of the terminating leg of a voice minute on a mobile network is the same, regardless of the point of origination, the same price controls should apply to any voice minute terminated on a mobile network in Israel, including international traffic.

international traffic.



Price	*2004*	*2005*	*2006*	*2007*	*2008*
NIS (Real 2003)	0.458	0.257	0.144	0.142	0.141
X		44%	44%	1.4%	1.1%

* effective price

***Exhibit 4.7**:* *Price cap recommendation [Source: Analysys]*

Therefore, we recommend a RPI-X price decline in termination rates from their current quoted price of NIS0.45 to the LRIC cost at the beginning of 2006 of NIS0.144 (expressed in real NIS at 2003). This represents a constant value of X of 44% in each year, with the first change to be implemented at the beginning of 2005. In 2007 and 2008 price declines of approximately 1% should be implemented.

5 The immediate impact on the mobile industry and consumers

Reducing the price of termination will have an immediate impact upon the operators' net interconnect revenues, and the possible responses of the operators have been described in section 4.4. The present section examines the immediate impact of a cut in termination rates at the start of 2005 to NIS0.257 followed by a further cut to NIS0.144 at the start of 2006.

The price cap will result in a 10% drop in revenues for mobile operators in the first year

By cutting from NIS 0.45 to NIS 0.257, and assuming no change in traffic patterns or volumes on traffic services, the overall reduction in termination payments made in the first year is predicated to be NIS 1.50 billion, which assuming these are reflected entirely in the retail prices, will be entirely born by the operators. In the second year there will be a further fall in total interconnection payments of NIS 850 million.

These numbers should be considered in light of the total revenues made by the three major mobile operators in Israel in 2003 of NIS 13.7 billion and the resulting operating profit of NIS 1.9 billion.

At least part of this loss could be compensated by increasing on-net tariffs

It is worth re-iterating that this loss of revenues to mobile operators assumes that the current prices and volumes of other traffic services remain constant. However, this is unlikely to be the case following an approximate halving of termination revenues. For example, one option for the operators will be to increase the price of on-net calls, and recover some of their lost termination revenues in that manner.

Given that the current price of on-net calls (relative to its cost) in Israel is very low in comparison to the price of an outgoing call to another network, this would seem a likely response, and would possibly even be favourable in terms of encouraging competition.

The price reduction may lead to a NIS1.35 billion benefit to consumers in the first year

Of course, the loss to mobile operators may be entirely absorbed by their shareholders as lower returns on their investment, and the prices of other services may not be increased to compensate. Assuming, then, that the drop in termination price is reflected entirely in the retail prices then the benefit to consumers in terms of lower prices in the first year is calculated to be NIS --- billion, of which NIS --- million would accrue to fixed network subscribers and NIS --- million to mobile network subscribers. In the second year, the benefit to consumers from lower prices would be NIS --- million of which NIS --- would accrue to fixed network subscribers, NIS --- to international calls and NIS --- would accrue to the mobile network subscribers.