Analysis of Cost Studies presented by Mobile Network Operators

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Contents

List of Figures

List of Tables

1 Introduction

WIK-Consult has been requested by OSIPTEL to review the cost calculations underlying proposals for the mobile terminations charge (MTC) submitted to it by the four mobile network operators (MNOs) in Peru, i.e. Telefónica Móviles, BellSouth, TIM and Nextel. The project consists of two stages of which, however, the second one is optional. During the first stage, on which this is the report, the actual consultancy work has been carried out. The second stage will be called into operation if there is the requirement that WIK-Consult provide responses on comments that the MNOS might submit when being informed of the results of this review.

This review was carried out on the basis of documents and cost models in electronic and hardcopy form that were provided by OSIPTEL to WIK-Consult. This documentation has been declared confidential and WIK-Consult, respectively, the team assigned to this project have strictly adhered to this confidentiality requirement.

The consultancy work was carried out during the period 10 March through 31 May 2005. On 19 April 2005 WIK-Consult submitted an Interim Report that was intensively discussed during a meeting between OSIPTEL and WIK-Consult at the occasion of a visit by the WIK-Consult team to Lima from 17 through 19 May 2005. The present Final Report is the final delivery to the first stage of the project.

2 Methodology

Generally, the perspective to be taken in costing exercises like the present ones is that of a new market entrant who is planning to offer the set of services that the operator in question is in fact providing. This perspective is to assure that the costs to be determined pass the test of the competitive standard. The task then consists, in the first place, of determining the optimized network structure that would enable the market entrant to produce the services at minimum possible cost so that it would be in a position to compete with already established operators. This task normally requires a planning tool, detailed information on demand, its distribution over the area to be served and information on the topology of that area. Once the network structure has been determined, the equipment and facilities that make up the network need to be valued at current prices so that the annual cost of these equipment items, the so-called CAPEX, can be deduced. For this the appropriate rate for the cost of money (in the following called interest rate or, in its specific form of a weighted average of return on equity and interest on debt, WACC) and estimates regarding the economic lifetimes of the various equipment items need to be available. Furthermore, one needs to add the cost for operation and maintenance, commonly referred to as OPEX. As in many instances there is very little information available on the latter, the practice is to model it as a percentage mark-up on the replacement value of the investment. Adding up CAPEX and OPEX gives one the total annual cost of running the network and providing all services. Information gained during the planning stage is then used to determine to what extent the various network elements are on average being used for the delivery of the particular service under study, in our case the termination of calls. This information comes in the form of so-called routing factors where a particular routing factor indicates the degree of use of a network element by a unit of service. Hence the routing factors are the basis for distributing the network cost (CAPEX plus OPEX) to the various services provided. Dividing a particular service's share of cost so derived by the number of units delivered, usually minutes of calling, one obtains the per-unit cost figure for this service. To obtain the price for this service, one needs to add a mark-up to cover common costs, i.e. that part of total cost that is not driven by the volumes of services provided over the network.

The above is the description of the general conditions that must be fulfilled by a forward-looking long-run incremental cost (FL-LRIC) model. The procedure for deriving annualized cost figures from the amounts invested into equipment has been glossed over in this discussion. This annual amount has to be determined for each item in such a way that if it is earned during each year over the equipment item's economic lifetime, the discounted value corresponds to the disbursement at the time of investment and is thus fully recovered. For this transformation one commonly multiplies the value of the equipment item with the so-called capital recovery factor, which is derived as follows.

Let I be the value of the equipment item, A be the amount to be recovered each year over its lifetime, further let q = 1/(1+i) with i the interest rate, and n the length of the economic lifetime, then the following relation must hold for the recovery of the invested capital:

$$I = A * [q + q2 + \ldots + qn] .$$

From the above formula it follows that the value for A is:

$$A = c * I ,$$

where

$$c = 1 / [q + q2 + \ldots + qn] ,$$

which can be shown to reduce to

$$c = (1/q) * [1 - q] / [1 - qn] .$$

The submissions and cost calculations of the four Peruvian Mobile Network Operators (MNOs) will in the remainder of this report be examined against the standard developed in the preceding paragraphs. We will find that their approaches sometimes do, sometimes do not meet its criteria. We did not expect, and have found it to be true, that the submitted models would include the planning procedure for the networks concerned. Since we do not have the necessary information to substitute for this through the use of our own planning instrument, and since the resources in terms of time necessary for this exercise would in any case not have been available, we will make plausibility checks regarding the efficiency of the networks based on our expert knowledge in the matter. To the extent that the models pass this plausibility check we are prepared to take the position that they fulfill the conditions required of FL-LRIC models. We will find, however, that there are deviations from efficient network structures that in the case of Nextel will prove to be serious enough to justify substantial corrections. We also find that two operators (BellSouth and Telefónica Moviles) calculate CAPEX, more specifically the cost of money as part of CAPEX, by a procedure which is not consistent with capital recovery according to the above criterion.

There are three particular instances of procedures by the MNOs that we will explicitly not follow and which need a more detailed discussion already at this point. In the first case, Nextel (through the model of its consultant, Analysys) uses an approach that, although consistent with capital recovery as discussed here, calculates CAPEX and OPEX in an overly complicated fashion which we find not transparent and allows to recover from present services future costs. In the second case it is the practice of including the actual cost of customer acquisition and handset subsidization in the cost of call termination, as done by BellSouth, Telefónica Móviles and TIM. In the last case it concerns the use, followed by TIM, of a top-down fully-distributed cost methodology:

- The approach by the Nextel/Analysis represents a sophisticated way of modelling economic depreciation and is compatible with the capital cost recovery principles developed above. At the same time we consider the attempt to cover with their calculations 50 years of projected operation of the network is infected with such a high degree of uncertainty that the results become implausible. While attempting to provide an estimate of the average per-minute cost of the relevant service over all volumes provided over this time frame, it involves a substantial amount of averaging of costs also between the different time periods. This means for example that the cost of new technology to be implemented in the future is also spread over services in the preceding years and would have to be paid in part by current customers. This is highly questionable. The preferable approach is, as also applied by BellSouth and Telefónica Móviles, to determine costs based on the structure and the size of the network necessary to provide current volumes of services, which in the present case means for the year 2004. There is a disadvantage in this approach as it would not reflect decisions that the operator may already make now because of the anticipation of future developments which in most cases would tend to cause lower costs. For the sake exactly of avoiding the uncertainties regarding the effects of such future developments, and also for the sake of transparency, we recommend the approach as in fact has been applied by BellSouth and Telefónica Móviles.

- Customer acquisition and the practice of handset subsidization is not an activity that is driven by network operations and in particular the provision of call termination. These activities are driven by the desire of the MNO to acquire customers and expand its overall business and give therefore rise to a cost at the level of the whole enterprise which means that it belongs to the common cost category. This, as discussed above, is to be added to the LRIC figure as a percentage markup. From a regulatory point of view these activities must obey considerations of efficiency which means that they should only be carried to the extent that customers are effectively being informed of the quality of the services to enable them to make up their mind. Activities that aim with handy subsidization or similar means at luring customers away from competitors, or preventing them to go to a competitor in the first place, do not fall within in this category. The point here is that an adequate amount for the cost of advertising activities are to be covered by the markup, and with a markup of 10 % that we apply this requirement is fulfilled. The cost included by some of the operators for this purpose goes far beyond what would be justified on this count and will therefore not be allowed.

- TIM chose not to back up its calculations with a software-based model but applied a fully distributed cost methodology based on data from its own cost accounting records. It thereby follows the so-called top-down approach to cost determination. Usually such an approach starts from the total pool of actually incurred costs and uses allocation coefficients to break them down according to network elements, i.e. into their CAPEX and OPEX, and into overhead costs. It then derives the cost per each service using routing tables as in the case of bottom-up costing. Although it is difficult and very time-consuming to do and leaves loopholes open to allocate costs arbitrarily or to let inefficiencies go unnoticed, the approach can in principle be equivalent to a bottom-up costing exercise, and the results of such an approach can be reconciled with those of bottom-up costing. To be able to do this, however, one needs to have detailed information about the number and dimensions of the network elements installed and know the replacement values of all equipment items. This information has in the case of TIM not been provided. All that the TIM report includes is a general discussion of how the costs have been derived. There is no detail of data comparable to that in the software-based models of BellSouth, Telefónica Móviles and Nextel.

There is a further general methodological question that has intensively been discussed in the UK and on which there are currently equally intense discussions going on in Australia. This discussion concerns the justification of including in the charge for incoming calls on mobile networks an element that would reflect the benefits to users in other networks, primarily the fixed network, of rapid expansion of mobile networks. This practice would amount to current customers of other networks to pay for part of the cost of mobile networks so that subscription to these networks can be made more attractive and these therefore can expand more widely and more rapidly as they would do otherwise. This discussion is carried on under the heading of “network externality”. We feel that, in principle, there is some merit to this argument. Our position is that the consideration of network externalities in the determination of any interconnection charge would require an integrated and balanced approach that would avoid that the users of any one network are either disproportionately advantaged or disproportionately disadvantaged.

In our calculations we will therefore not allow for any cost element on account of the network externality argument.

In Chapter 3 we will examine the data, information and model software submitted by the MNOs and identify and assess critically the departures from the standard wherever we find them. In Chapter 4 we will recalculate the costs of the four operators’ termination services on the basis of our standard while using the operators’ own models and data to the extent they can suitably be adjusted for the purpose. –

3 Comments on the Models and Proposals Submitted by the Operators

This chapter deals with the proposals and the corresponding models delivered to OSIPTEL by the four MNOs regarding the determination of the costs underlying their proposed Mobile Termination Charges (MTC). It summarises the main ideas on which the calculation of the call termination costs in the mobile networks is based and it provides comments and assessments regarding the acceptability of the model assumptions, values of the input parameters and the corresponding calculations. In the following the submissions of the four MNOs are treated one by one, in an order which is determined by the accessibility of the models and the data and information provided.

3.1 BellSouth

BellSouth (in the following BS) submits and justifies its proposed MTC by way of a document entitled “Response to Resolución de Consejo Directivo No 052-2004-CD/OSIPTEL”, prepared for it by the consulting firm Network Economics Consulting Group[1]. The corresponding calculations are provided in an MS Excel file with several worksheets apparently also provided by this consultant[2]. BS claims that its model calculates the cost of termination services on the basis of a bottom-up cost model[3] under a scorch node assumption[4] and using the FL-LRIC standard[5].

The application of a bottom-up model requires that the LRIC is calculated based on an optimised network structure using the most efficient technology[6]. BS claims that an efficient network architecture has to ignore historical technologies such as analogue systems and to be limited to CDMA1x technology[7] and that the optimal number of mobile switching centers (MSCs) should be four instead of 13 in the current network. We agree with the statement regarding analogue systems but believe that the choice of CDMA technology is intended as an investment to prepare the network for the future provision of third generation mobile services (for a comparison of CDMA with TDMA in this context see the Annex)[8]. We agree that the number of MSCs should be reduced; the document, however, does not provide information about how the optimal number (five MSCs in four locations) was determined. For example, the MSC in Iquitos has a

1 See BSD.
2 See BSM.
3 BSD p. 8.
4 BSD p. 11.
5 BSD p. 14.
6 See DEN, HKG, and, for application to mobile networks, RSS.
7 BSD p. 17.
8 See also QUA.

quite small load factor (4 KBHAC[9]) and it should have been demonstrated that the cost saved in transmission is higher than the cost for providing this MSC location.

As regards transmission, BSs implements most of the links by own installations, using radio links, and relies on leased lines only for a small part, mainly in the backhaul network, see Table 3-1. The intensive use of own transmission systems may result from current economic considerations, or taking into account an expected future expansion mainly due to traffic from new services like mobile multimedia. When we calculated the share of the cost of transmission per minute over all traffic we obtained an annual cost value per minutes of 1.77 US cent. Comparing this value with that from the network of Telefónica Mobile we find that it is 92 % higher. The actual figure is approximately 38 % considering that TM has a higher traffic values and hence a larger cost reduction due to economies of scale effect[10]. First estimations shows that the installation of an own transmission infrastructure is not necessarily optimal in the current network of BS and that this decision was probably arrived at considering a future service and network expansion.

Table 3-1: Share of own transmission infrastructure in relation to total (by amount of investment)

Item	Annual cost (in US$)*
Own transmission	10.513.825
Transmission through leased lines	783.491
Total	11.297.316

* BSM worksheet Element costing cells G9:G33.

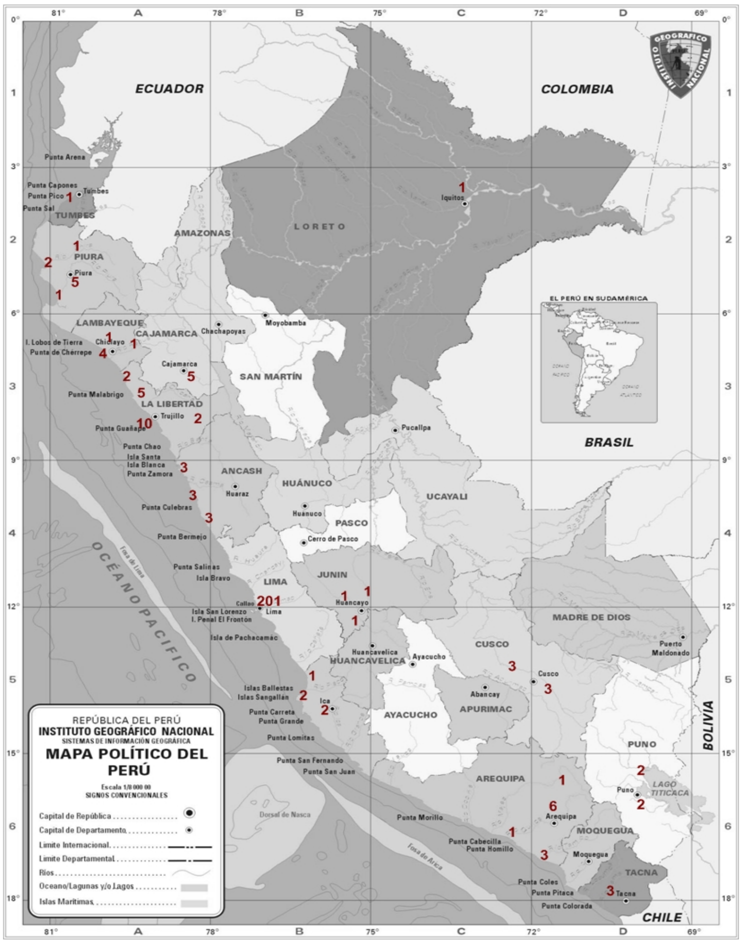
As regards BTSs, the model shows 284 locations[11] from which 66 are repeaters. Considering that BS had approximately 760,000[12] customers in 2004, this implies an average number of 3486 customers per BTS which in turn implies 1162 users per sector assuming three sectors per BTS. Given the traffic figures provided by BS and, the installed number of CDMA2000 1x BTSs can provide 1.6 times the required capacity. Our assessment, based on load factors and interference equations provided in the literature[13], shows that a single sector can provide coverage for up to 1900 users per sector with the BellSouth traffic figures[14], hence, on average, there are no capacity constraints in the cell deployment of BellSouth. Therefore the range of each BTS will be limited by the radio propagation, even in the region of Lima where the number of

9 BSM worksheet switching cell E50.
10 We calculated this figure considering that the cost per minute decreases by the square route of the traffic.
11 BSM worksheet BTS row 24 until 308.
12 Deduced from BSD p. 23.
13 See VIT.
14 See BSM.

BellSouth users per sector increases to nearly 1000 users, which is always lower than the 1900 value calculated[15].

The BTS distribution in the BS network is shown in Figure 3-1.

Figure 3-1: BTS distribution in the BellSouth network*



* The numbers in the map indicate the number of BTSs in the corresponding province, as derived from BSM.

Table 3-2 shows the total replacement values of the facilities for the three broad functions of backbone transmission, switching and BTS. According to our experience a share for BTS in the total replacement value of network assets, as indicated in the table,

15 These calculations were performed using the values of Lima under CDMA formulas. The result is that the cell radius is always limited by propagation and not by capacity.

is quite high. We estimate that this results from the low market penetration where the number of BTSs is determined by the geographical coverage.

Table 3-2: Characteristics cost values for the BS network

Type of equipment	Replacement values (in US$)*	Relative share (in %)	Annual cost (in US$)**	Relative share (in %)	Annual cost/min (in US cent)
Transmission	23,427,022	21.0	11.297.316	19.3	1.77
Switching	15,944,400	14.3	7.095.258	12.2	1.11
BTS	72,264,296	64.7	40.062.115	68.5	6.28
Total	111,635,718	100.0	58.454.689	100.0	9.16

* This follows form BSM worksheet “Element costing”, column C and does not include leased lines.
This follows form BSM worksheet “Element costing”, column G and includes leased lines.

The model determines the annual CAPEX, i.e. the sum of depreciation and interest on invested capital, on the basis of the replacements values of the installed facilities and equipment. The network structure and therefore the corresponding number of equipment items is not determined by the model itself but imposed from outside. Depreciation is calculated as a linear function of these replacement values. The economic lifetimes of the different items of equipments are fixed at 10 years for transmission and switching and at 5 years for BTS and IT[16]. We agree with these values for the actual equipment but not for the corresponding civil work, the asset value of which is lumped together with that of the equipment. For our own cost estimate we will assume for civil work a higher value which is particularly import for the BTSs. The cost of money is calculated as the product of the replacement values of the facilities and the WACC. This approach is erroneous because it does not take into account the fact that the value of the equipment is continuously being amortized as the equipment gets closer to the end of its economic life, and therefore the average amount of invested capital is lower than the replacement value. We should correct this by applying the capital recovery factor as presented in Chapter 2. The model uses a pre-tax WACC value of 19.5 %[17] which should be replaced with a value provided to us by OSIPTEL.

Annual OPEX values are fixed at 15 %[18] of the facilities’ replacement values; we consider this as an acceptable value at the upper limit.

The model considers the sum of annual CAPEX and OPEX as the total annual network element cost[19]. In our terminology it would, if determined correctly, correspond to the LRIC resulting from operating the BS network.

16 BSM worksheet “Assumptions and sensitivity”, row 8.
17 BSM worksheet “Assumptions and sensitivity”, cell H8.
18 BSM worksheet “Assumption and sensitivity”, cell F8.

The model distributes total annual costs to the various services provided by BS by means of routing factors[20]. These routing factors for both incoming and outgoing traffic are the same and the routing factors in the backbone links which connect two MSCs. are set to a value of one. If we assume, that each MSC has an Gateway named network interface (NNI) to each other network for interconnecting traffic then this is not completely correct because an incoming call interconnects at the nearest NNI to the origin mobile network and hence must be routed in some cases over a backbone link between two MSCs of the destination network; inversely an outgoing call is also interconnected at the nearest NNI and hence never requires any backbone links between MSCs. We assume that all MSCs have an NNI towards the fixed network but this will not be the case for the other mobile networks (in this case toward the TM, TIM and Nextel networks), therefore the traffic can not be interconnected in the nearest MSC and has to travel towards the interconnection point. In that case both incoming and outgoing traffic must be routed sometimes on a backbone link. However this situation is not always required, and the routing factor for incoming traffic and outgoing traffic can be different and less than the unit of one on each backbone link. On the other hand, it is quite difficult to estimate correctly the real routing factors for each backbone link without detailed knowledge over the corresponding traffic pattern. As a consequence we accept for incoming traffic the routing factor of one on backbone links as a conservative estimate.

Finally, the model determines the network cost per minute on the basis of the usage of each network element according to routing factors and the relation of incoming to total minutes of traffic, from which follows the corresponding LRIC for each network element in each location[21]. Adding additional cost elements due to IT, handset subsidy, customer acquisition and administration overhead[22] leads to the proposed value of 17.1 US cent per minute for the MTC. Two of the additional cost elements (handset subsidy, customer acquisition) wholly relate to retail activities and are, according to the standard set out in Chapter 2, not a cost driver in the provision of the wholesale service termination. In addition, most of the positions in the item IT[23] also relate to retailing (e.g. billing, prepaid) which is therefore also not a cost driver for termination. When deriving our alternative cost estimate in Chapter 4, these items will be completely left out, only an appropriate mark-up for common cost will be allowed.

As a summary we conclude that the BS cost model represents a methodological approach with which we agree. There appear to be inefficiencies in the network that, however, do not appear to be grave enough to reject the network structure as a basis for the calculations. Due to incorrect assumptions regarding input values (e.g. lifetime of

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19 BSM worksheet “Element costing”.
20 BSM worksheet “Routing Factors” provides these values in form of a routing matrix for the set of all types of services at the origin in the rows and the corresponding destination at the columns.
21 BSM worksheet “Unitisation”.
22 BSM worksheet “Unitisation”, rows 222, 227 and 232.
23 BSM worksheet “IT”.

equipment), the wrong determination of CAPEX, and the inclusion of cost items that are not part of the LRIC of incoming calls, the cost of termination is shown to be higher than would be obtained using standard principles. After introduction of the appropriate corrections, the BS model allows the calculation of a correct estimate of the LRIC for termination services, as we will show in the next chapter. Adding a mark-up for common cost, one thus arrives at a cost figure that can serve as basis for the MTC.

3.2 Telefónica-Móviles

Telefónica-Móviles (in the following TM) submits and justifies its proposed MTC by way of a document entitled "Response to Resoluión de Consejo Directivo No 052-2004-CD/OSIPTEL", prepared for it by the consulting firm Charles River Associates[24]. The corresponding calculations are provided in an MS Excel file with several worksheets[25]. The model of TM is the same as the model used by BS[26], so the same claims regarding the modelling approach are advanced as for model used by BS. TM claims, as does BS, to have carried out a cost calculation for termination using an bottom-up model[27] under a scorched-node approach[28] and applying for costing the FL-LRIC standard[29].

TM also states that the LRIC under a bottom-up model has to be based on an optimal network configuration and that the chosen architecture must be the currently most efficient one. TM bases the calculations on the currently implemented mobile network but takes into account, similarly to BS, a reduced number of MSC equipment as shown in Table 3-3.

Table 3-3: Location of the current and reduced MSCs in TM network

Current			Optimized		
Location	Number of Switches	kBHCA	Location	Number of Switches	KBHCA
Lima	2	572	Lima	3	517
Lima	4	670	Arequipa	1	284
Trujillo	1	88	Iquitos	1	25
Trujillo	1	211	Trujillo	1	374
Arequipa	1	78	----	0	0
Arequipa	1	150	----	0	0
Total	10	4350	Total	6	2234

24 See TMD.
25 See TMM.
26 We observed, that the text of the document TMD is the same as that of BSD, only figures are different.
27 TMD p. 7.
28 TMD p. 10.
29 TMD p. 14.

From these figures follows a reduction of the number of locations for switches from six to four and a more equilibrated load factor with a reduction in the mean value and the standard deviation[30]. We conclude from this value that the network considered for LRIC calculation is at least improved in comparison with the current one, but that the installation of an MSC in Iquitos might be justified mainly by geographical reasons but not from the load.

With respect to transmission equipment, the TM network is based exclusively on a leased line infrastructure and therefore the model does not show any own transmission installation. This is in contrast to the BS model where a large number of transmission lines are implemented by radio links. A similar calculation as in the case of BS leads to $11.390.740 for the annual cost and, considering the amount of total traffic, to a cost value per minute of 0.92 US cent. A comparison with the BS value of 1.77 US cent shows a substantially lower value from which we conclude that realizing transmission on the basis of leased lines should in general be a cost-effective option.

Concerning the number of BTSs, the model indicates 342 locations[31] (excluding repeaters). Considering that TM has in 2004 approximately 2 million[32] customers this results in a mean value of 5848 customer per BTS and 1949 users per sector considering three sectors per BTS. Under the traffic figures provided by TM[33] a CDMA BTS can provide service to more than 2500 users per sector, hence, on average, there is no capacity constraints in the cell deployment of Telefónica. Therefore the range of each BTS will be limited by the radio propagation, also in the region of Lima.

Figure 3-2 shows the BTS distribution of the TM network.

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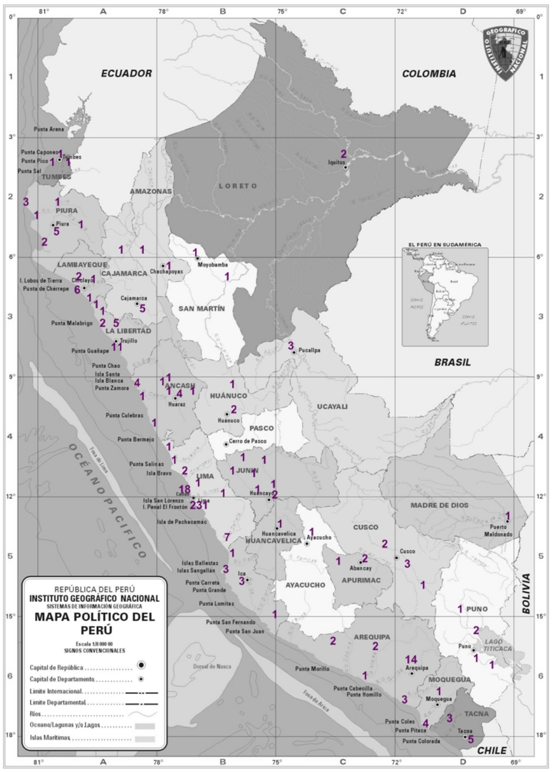
30 From the values of the table results a mean load factor of 435 kBHCA and a standard deviation of 1.6 for the current optimisation in contrast to 372 kBHCA for the mean load factor and a standard deviation of 1.01.

31 TMM worksheet “BTS”, cell C31. Note that the actual number of sites is 409, but it includes the “repeater” equipment which does not provide additional capacity. Therefore it is not taken into account in this calculation. Nevertheless, they are shown in the corresponding map.

32 See TMD p. 26.

33 See TMM and the load equations of the literature.

Figure 3-2: BTS distribution in the Telefónica mobile network*



* The digits in the figure indicates the number of BTS in the corresponding province deduced from TMM.

The model calculates the annual CAPEX as in the BS model on the basis of the replacement values of the installed facilities and equipment. The network structure and therefore the corresponding number of equipment items are not determined by the model itself but introduced from outside. Depreciation is calculated as a linear function of these replacement values. The economic lifetimes of the different items of equipments are fixed at 10 years for transmission and switching and at 5 years for BTS and IT[34]. We agree with these values for the actual equipment but not for the corresponding civil work, the asset value of which is lumped together with that of the equipment. For our own cost estimate we will assume for civil work a higher value which is particularly important for the BTSs. The cost of money arrived at by multiplying the replacement values of the facilities with the WACC. This approach is erroneous because it does not take into account the fact that the value of the equipment is continuously being amortized as the equipment gets closer to the end of its economic life, and therefore the average amount of invested capital is lower than the replacement

34 TMM worksheet Assumption and sensitivity row 8.

value. We will correct this in our own cost estimate. The model uses a pre-tax WACC value of 15 %[35] which should be replaced by a value provided to us by OSIPTEL.

Annual OPEX cost values are fixed at 15 %[36] of the facilities' replacement values; we consider this as an acceptable value at the upper limit.

The model considers the sum of annual CAPEX and OPEX as the total annual network element cost[37]. In our terminology it would correspond, if calculated correctly, to the LRIC resulting from operating the TM network.

Table 3-4: Characteristics cost values for TM network

Equipment Item	Replacement values* (in US $)	Relative value (in %)	Annual cost** (in US $)	Relative value (in%)	Annual cost/min (in US cent)
Transmission	0	0.0	11.390.740	12,9%	0,92
Switching	41,605,891	25.7	16.642.357	18,8%	1,34
BTS	120,578,494	74.3	60.289.247	68,3%	4,87
Total	162,184,386	100.0	88.322.343	100,0%	7,13

* This follows from TMM worksheet "Element Costing", column C and does not include leased lines.
** This follows from TMM worksheet "Element Costing", column G and includes leased lines.

As in the BS model, the TM model distributes total annual costs to the various services provided by TM by way of routing factors[38]; for details we refer to the relevant comment in Section 3.1 regarding the BS model.

Finally, the model determines the per-minute cost of termination on the basis of the usage of each network element according to routing factors, and the relation of incoming to total minutes of traffic, from which results the corresponding LRIC for each network element in each location[39]. Adding, as in the BS model, additional cost elements for handset subsidy, customer acquisition and administration overhead[40], the proposed per-minute value for the MTC of 17.4 US cent is arrived at. Again as in the BS model, two of the additional cost elements (handset subsidy, customer acquisition) relate to retail activities which are not a cost driver in the provision of the wholesale service termination. We find here, too, that most of the positions in the item IT also relate to retailing (e.g. billing, prepaid) which are not cost drivers for termination

35 TMM worksheet "Assumptions and Sensitivity", cell H8.
36 TMM worksheet "Assumptions and Sensitivity", cell F8.
37 TMM worksheet "Element Costing".
38 TMM worksheet "Routing Factors" provides these values in form of a routing matrix with the set of all types of services at the origin in the rows and the corresponding destination in the columns.
39 TMM worksheet "Unitisation".
40 TMM worksheet "Unitisation", rows 276, 281 and 286.

services[41]. We also consider the mark-up for administrative overhead with 15 % to be relatively high. Considering for LRIC only the three basic functions shown in Table 3-2 leads to a much lower per minute cost figure.

Our summary is identical to that regarding the BS model. The TM model represents a methodological approach with which we agree. Instances of inefficiency in the network structure are relatively insignificant so that this structure, as represented in the model, can serve as basis for determining the relevant cost figures. However, due to incorrect assumptions about input values (e.g. lifetimes of facilities), the wrong determination of CAPEX, and the inclusion of cost items that are not cost drivers for the termination of incoming calls, the relevant cost is shown to be higher than would be obtained using standard principles. After introduction of the appropriate corrections, the TM model, however, allows the calculation of a correct estimate of the LRIC for termination services. Adding a mark-up for common cost, one thus arrives at a cost figure that can serve as a basis for the MTC. Whether a higher mark-up covering part of the cost of retail activities might be advisable, will then be discussed in the last section of this chapter.

3.3 Nextel

Nextel (in the following NX) submits its proposal for its MTC in a document entitled “Maximum Interconnection Rate for the Termination of Calls on Mobile Networks”[42]. In addition, the operator submitted a report with the results of a study on the cost of termination prepared by the consulting organization Analysys together with a softwarebased model[43].

Our study of the documents shows that Nextel implements a network based on the Motorola system iDEN[44] which is very specific and not comparable with a 2G mobile system for general voice and data services. We estimate that the system was chosen in order to optimally fulfil the traffic requirements of their “Direct Connection Nextel®” service [on-net dispatch service which only requires operation in half duplex (simplex) form]. In contrast to general purpose 2G systems, the iDEN system offers the facility to operate in both the half-duplex and full-duplex modes which assures a better use of the system capacity when a significant half duplex traffic is realized. Nextel also points out

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41 TMM worksheet “IT”.
42 See NXD.
43 See AND and AN-M and AN-E.
44 iDEN (Integrated Digital Enhanced Network) is a wireless technology from Motorola combining the capabilities of a digital cellular telephone, two-way radio, alphanumeric pager, and data/fax modem in a single network. iDEN operates in the 800 MHz, 900MHz, and 1.5 GHz bands and is based on time division multiple access (TDMA) and GSM architecture, see iDEN.

that it considers future service extension in the direction of mobile multimedia services (MMS) and to “Push-to-Talk over Cellular” (PoC), a form of mobile voice chat service[45].

In contrast we observe that although most mobile operators already implement the MMS service, this is not the same with respect to the PoC, Although the telecommunications market is looking to it with high hopes there is an initial layer of scepticism[46].

Nextel offers five types of basic services, which are:

- i Digital trunk radio (Direct Connection Nextel®),
- ii Telephone interconnection and voice on-net,
- iii Transmission of text messages (SMS),
- iv Data transmission by circuit switchover (9,600 Kbps), and
- v Data transmission by package switchover (19,200 Kbps).

In addition it offers value added services as voice-mail, call alert and related services.

Nextel offers its services to both prepaid and post-paid customers, where the latter, however, make up the by far largest share. The current number of prepaid clients is 6267 and the one for post-paid 163,789[47]. In combination with the types of services offered this leads to the conclusion that the market segment of Nextel consists mainly of corporate and professional clients. This assessment is supported by the corresponding traffic values which indicate a clear dominance of the digital trunk radio service (on-net dispatch calls). See on this Figure 3-3 which shows clearly the dominance of the corporative dispatch service in both on-net traffic and total traffic. The on-net voice traffic is relatively insignificant and the outgoing voice traffic is substantially larger than the incoming traffic. From this fact we conclude that Nextel is not a typical mobile network operator but more a trunking network operator for corporative clients with additional mobile voice service facilities. This, however, does not preclude that, due to relatively heavy use by the subscribers that it has, Nextel has a total volume of voice services comparable to the volumes of two of the other MNOs.

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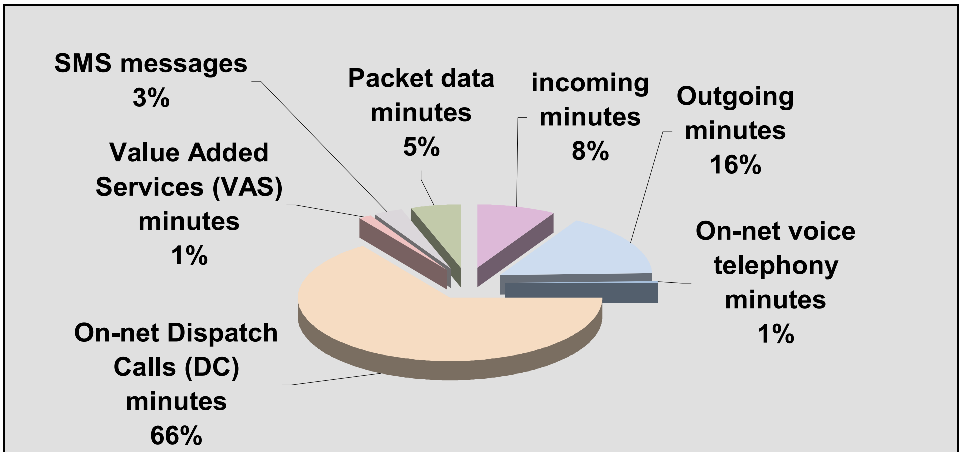
45 See MOT.
46 See B2B.
47 ANM, Excel file “model.xls”, worksheet “Evolucion traf. Prom, usuario”, cells J66 for PostPaid Customers and J67 for Prepaid Customers.

Figure 3-3: Distribution of Nextel traffic by type of service*



* These traffic values correspond to the year 2004. AN-M, worksheet "Evolucion traf Prom usuario", cells J11-J17.

As regards geographical coverage, Nextel model shows that the company offers its services currently in nine of the 24 departments of Peru and then mainly in the metropolitan area of Lima. In Table 3-5 the corresponding coverage percentages[48] are presented, and Figure 3-4 shows the coverage graphically.

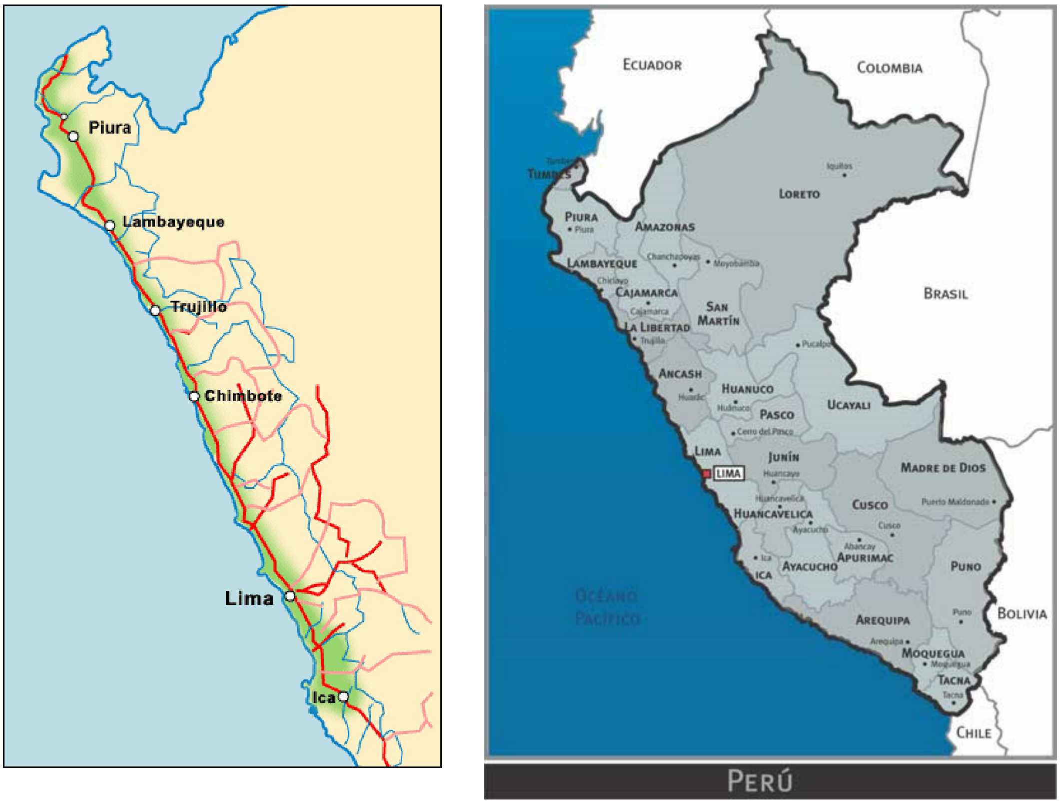
Table 3-5: Geographical coverage of the Nextel network

Department	Coverage (%)	Department	Coverage (%)
Amazonas		Lambayeque	55
Ancash	100	Lima	65
Apurimac	0	Loreto	0
Arequipa	**35**	Madre de Dios	0
Ayacucho	0	Moquegua	0
Cajamarca	0	Pasco	0
Cusco	0	Piura	30
Huancavelica	0	Puno	0
Huanuco	0	San Martin	0
Ica	70	Tacna	**80**
Junin	0	Tumbes	20
La Libertad	100	Ucayali	0

48 AN-M, worksheet "I_coverage_Nextel", cells I6 to I28.

WIK-Consult has, however, been informed by OSIPTEL that Nextel has currently coverage only in seven departments. To take account of this fact, we will remove from the list the percentage values for Arequipa and Tacna (values marked in red-bold in Table 3-5), i.e. change them to 0 %. Both departments are in the Southern part of Peru and are the most distant to the theoretical coverage range shown in the map of Figure 3-4. Concerning the number of Nextel users, we consider that all of them are located in the seven departments where Nextel provides coverage.

Figure 3-4: Nextel coverage map*



Nextel Coverage Map, source Nextel

Peruvian Geo-Political Structure, source http://www.blogsperu.com/

* See Nextel web page, coverage map in section "Nextel On Line" http://www.nextel.com.pe/productos/cober.html

Analysys carried out a study to determine the cost of termination in the Nextel network, using a model implemented on two MS Excel files[49] where the one contains the input data and the other carries out the calculations. Analysys claims that the calculation is based on a calibrated and reconciled bottom-up model using the total element long-run

49 See AN-M and AN-E.

incremental cost (TELRIC) approach[50]. This approach is in general consistent with the standard that we proposed in Chapter 2.

Analysys' network model is based on the architecture of the iDEN system used by Nextel. As already indicated, this system is optimal for the dominant dispatching service offered by Nextel and allows the common production of the different services in the network. After evaluating the network model, we find the crucial aspects to be:

- i The number and load for the switching systems;
- ii The cell radios in the metropolitan area; and
- iii The blocking probability for the different services.

Concerning the number of switching systems, we find that it is higher than in the case of applying a GSM system but allows an intensive common production with the high traffic volumes from the dispatching service.

Our own estimate of cell radiuses using the Okumura-Hata model, with the modifications of the COST 231 for frequencies higher than 1500[51], leads to larger cell radiuses than estimated in the Anaylsys Model. We estimate that over the various years considered approximately constant radius of 1.5 km is warranted, while the Analysys model shows radiuses that decrease from initially 3,2 km in 1998 to 1,1 km in 2004 to 0,5 km in 2020. Taking into account the corresponding traffic volumes from the different services and the capacity of the EBR[52], we cannot find any reason for a reduction of the radiuses, therefore we will use 1.5 Km as final value for the cell radius. With the traffic figures provided by the Nextel model, and the capacity of the EBR, there follow no capacity constraints in the cell deployment and hence we assume that the capacity reserve considered in the model calculations is due to the expected future provision of new service categories not yet considered.

Analysys uses as blocking probability for the dispatch service a value of 5 % and for the voice service a value of 2 %. We estimate these values as too high and assess that values of 2 % and 1 %, respectively, are adequate leading to higher capacity values in the required equipment. A sensitivity analysis with the model shows that the proposed stronger blocking probabilities neither significantly change the costs of services nor leads to capacity bottlenecks. We assume that this is due to the capacity reserve in the different network elements which allow a stronger occupation under smaller blocking probabilities values without any additional investment.

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50 AN-M p. 3.
51 See OKU, HATA, and COST.
52 EBR corresponds to the BTS in a general public mobile network.

Concerning the voice switching device of Nextel, the MSC they describe in the model has a capacity of 20 000 BHCA[53], and the cost of this basic equipment is 13 million USD in the year 2002. In addition, Nextel provides for the installation of an upgrade of this basic equipment to reach a capacity of up to 85 000 BHCA, with an additional cost in 2002 of 10 000 USD. The total investment outlay appears to be too high when compared to the investment for the MSCs of BS and Telefonica. Table 3-6 provides a comparison of the three MNOs' switching machines for the area of Lima which supports our assessment of very elevated Nextel figures.

Table 3-6: Comparison of the MSC investement in the Nextel, BellSouth and Telefónica Móviles networks

Mobile Operator	Nextel	BellSouth	Telefonica
KBHCA	85	153	517
Cost (Millions USD)	23	4	10
Ratio Cost/KBHCA	0.270	0.0261	0.0193
Ratio Between MNO	13.98	1.35	1

Note that the cost/KBHCA in Nextel is near 14 times higher than the cost/KBHCA of the two other operators. As conclusion of this part we think that the size of Nextel's MSC reflects an inefficiency so we will use the cost of the MSC of BellSouth (4 USD Millions) as a total cost of the MSC for the calculations of the cost of termination in the Nextel network.

For the costing exercise, Analsys divides the direct cost and the corresponding network increments into three categories[54]:

i Transmission;

ii Switching; and

iii Retail.

Each of these categories is subdivided into subcategories where each equipment type corresponds to a subcategory. For assigning the cost increment to the different types of service, Analysys applies routing factors[55]. In the transmission category for each half duplex communication which uses a corresponding network element, a routing factor of one is used. In contrast, for an on-net voice communication a routing factor of four is applied for each transmission element while a connection for call termination requires a routing factor of two.

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53 See AN-M, worksheet, "I_Network_Nextel".
54 AN-M, worksheet "I_Network_Nextel".
55 Note that these routing factors are not comparable with those applied in BSM and TMN.

For a full duplex connection the model specifies a “service demand routing” of one for both incoming and on-net voice calls. For on-net traffic and incoming traffic this is generally correct only in case of a single MSC but in case of more than one MSC the factor will be larger than one. This follows because some of the calls are routed over two MSCs when the destination is situated outside of the MSC cluster from where the call originates or interconnects.

Different than BS and TM, whose models determine the costs on the basis of their investments for the network in the current year, the Nextel model bases its calculation of the cost of termination services on a vision of the development of Nextel’s network and services over a period of 50 years, i.e. from 1998 to 2047. The year 2002 is chosen as the point in time the price level of which determines the price level for calculating the cost of termination; in other words the calculations are based on the replacement values of equipment and costs for operations and maintenance as valid for 2002[56]. The model calculates the CAPEX from the replacement values of the equipment items where the number of equipment items is introduced from outside, and not as a result of a network optimization. A WACC value of 14.4 % is used which should be replaced with a value provided to us by OSIPTEL. OPEX appears in most cases to assume a value of between 5 and 7 % of the assets’ replacement values in 2002. We consider this a low percentage for the operation of mobile networks, especially when it is compared with the other operators. The per minute cost determined this way is 13.45 US cent per minute[57].

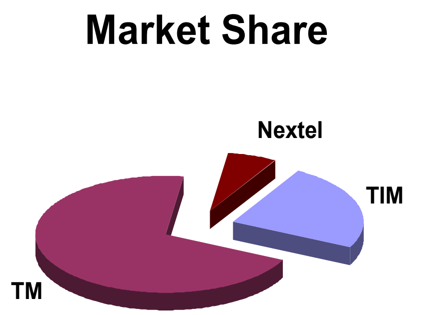
As we discussed already in Chapter 2, the approach by the Nextel/Analysis covering with their calculation 50 years of projected operation of the network is in our opinion overly complicated. It attempts to provide an estimate of the average per minute cost of the service over all volumes provided over this time frame involving a substantial amount of averaging of costs also between the different time periods. For example, the cost of new technology to be implemented in 2006, in an amount of about 200 million US $, is also spread over services in the preceding years which, as we noted, should not be allowed. In addition, the cost is expressed in terms of the price level of 2002. In contrast, we should apply a costing approach as represented by the models of BS and TM. We will apply this approach by introducing it into the Nextel model thereby basing the calculations on Nextel’s current network structure, the corresponding assets and routing factors.

56 See AN-M worksheet “unit_costs_Nextel, column G.
57 AN-M Excel file “model.xls”, worksheet “Results Nextel”, cell E46.

3.4 TIM

TIM Peru S.A.C. (in the following TIM) submits its proposal for its MTC in the document entitled "Propuesta de Regulación de Cargas de Interconexión Tope por Terminación de Llamadas en las Redes de los Servicios Móviles"[58]. TIM proposes an asymmetric regulation for the MTC, i.e. regulation which is to be applied only to Telefónica Mobile[59]. TIM states that it provides in its proposal a calculation of its cost for termination only to contrast its situation with that of Telefónica Moviles and to justify the proposal for an asymmetric regulation. It argues for its position mainly on the ground of the merger between BS and TM resulting in a market share for TM of 70 % which TIM considers as dominant, see Figure 3-5. It further argues that TIM has a client profile with a dominance of prepaid customers and that its network mainly receives calls from other networks.

Figure 3-5: Market share for the different mobile operators in Peru after TM and BS merger*



* See: TIM, p. 36.

The mobile network of TIM is based on the European standard GSM and operates under a frequency license in the bandwidth of 1900 MHz. The advantage of using GSM is to allow the use of low cost terminals which is mainly important for prepaid use with subsidized handsets. On the other hand the frequency of 1900 MHz has less advantageous propagation conditions and therefore leads to substantially lower propagation radiuses than using 800 MHz[60]. From this follows a higher number of BTSs than in the case of 800 MHz frequency and therefore a higher cost for the cell deployment. Based on current demand, TIM is comparable to BS but offers its services, like TM, in all 24 departments in contrast to the BS network which covers only 16

58 See TIM.
59 TIM, p. 1.
60 This can be directly be calculated from the Okumura Hata-Cost 231 Model, see COST.

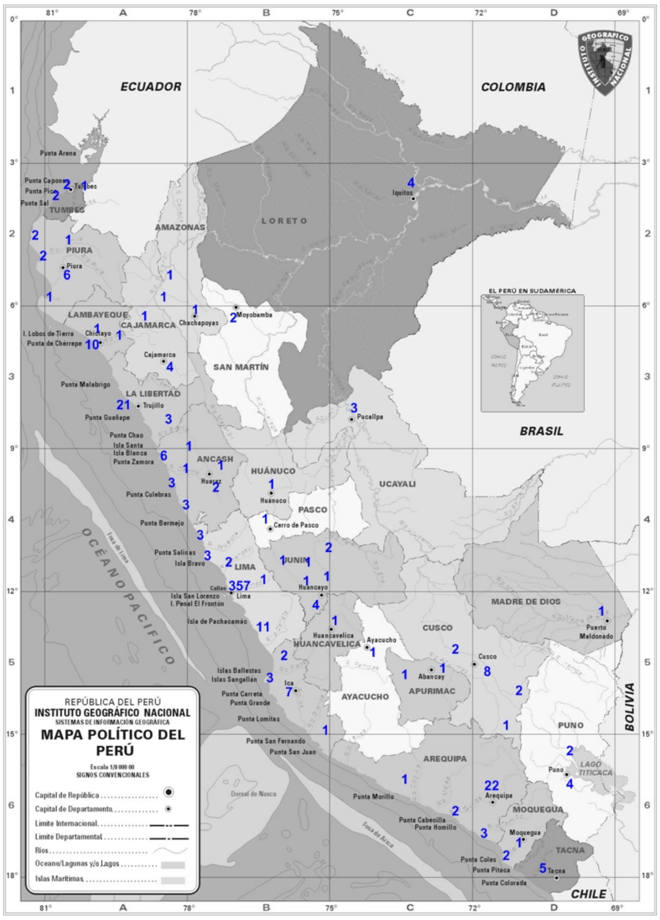
departments[61]. Comparing the number of BTSs from TIM with those of the TM network, we find for TIM 581 BTSs and for TM 370[62]. This higher number of BTSs in the TIM network is strongly related to the already mentioned disadvantageous propagation properties of the frequency accorded TIM and the fact that TIM provides a similar coverage than TM. Figure 3-6 shows the corresponding BTS distribution. Different from the cases of BellSouth and Telefónica Móviles, we cannot make any assessment of capacity relative to demand, as for this the available information is not sufficient. Regarding the implications of the use of the TDMA instead of the CDMA technology used by the other two operators, we provide an assessment in the Annex.

TIM applies a top-down approach based on values of its cost accounting system to justify its proposed MTC. The corresponding data can not be traced back to the underlying network structure. There are no plausible relationships shown between the cost per minute and the corresponding cost categories. TIM claims that its study results in a cost of termination of 28 US cent per minute which would justify a corresponding MTC. Further it claims that based on simulation results, doubling the number of users would lead to a cost of 20 US cent and trebling that number would lead to 18 US cent per minute. What we did note from the information submitted is that a very high up-front cost for the license is assumed and, as in the case of BS and TM, cost elements for retail operations are included that are not cost drivers for the provision of the wholesale service termination.

Since TIM does not provide its own MS Excel file based model, it is not possible, as done for BS, TM and NX, to do a recalculation of the LRIC of the termination services provided by TIM. We will provide in the next chapter an approximate approach which uses information from the other three models and our own understanding of mobile networks in general and the particulars of the TIM network.

61 TIM, cuadro 1.12, p. 15.
62 TIM, cuadro 1.11, p. 14.

Figure 3-6: BTS distribution in the TIM network*



wik CONSULT

* The digits in the figure indicate the number of BTS in the corresponding province.

4 WIK-Consult's alternative calculations

4.1 Introduction

As outlined in Chapter 2, we will use as much as possible the model software and the data provided by the companies to develop our alternative methodology for calculating the costs of termination in the individual networks, to be used as a basis for determining the MTCs. This will to a large extent be possible for BellSouth (BS), Telefónica Móviles (TM) and NexTel (NX). To carry out this approach analogously for TIM is not feasible because of the complete absence of a software-based bottom-up cost model comparable to those of the three other operators. We will develop an approach based in part on our knowledge of the installed equipment and facilities in the TIM network and in part on results from the model for the BellSouth network which is still the closest to that of TIM in terms of subscribers, structure and coverage. This way we will arrive at an approximate estimate for the relevant cost .

Applying the cost standard developed in Chapter 2, the cost of termination services consists of the LRIC due to the provision of the service plus a mark-up for common cost, where the LRIC consists of CAPEX and OPEX. The determination of CAPEX will occupy most of the discussion in this chapter. As pointed out in Chapter 2, the detailed determination of OPEX on the basis of a genuine bottom-up cost model has generally turned out to be extremely difficult so that one normally works with percentage markups on the amounts of investment in the different network elements. BS and TM have followed this approach using a mark-up of 15 % on the replacement value of the equipment. Nextel has used lower mark-ups than 15 %. We believe that the 15 % markup used by BS and TM can be accepted as a reasonable upper limit.

As already pointed out, there should be a mark-up for common cost on the per-minute LRIC of termination. A figure which we know from other environment to be sufficient for this mark-up is 10 %. In addition to mark-ups for common cost that are higher than we just suggested, BS, TM and TIM also include in their costs a number of items that are not related to the provision of termination but rather to retail activities, in particular customer acquisition, handset subsidies and the cost of IT related to retail operations. None of these cost items should be included in our calculations for which we strictly follow the arguments developed in Chapter 2.

It should be noted that the cost models for BellSouth and Telefónica Móviles do not account for data services. In the case of TIM it is not known to what extent they have been accounted for in the calculations, and our alternative calculations will also necessarily leave them out. According to our observations, data services play so far a very minor role in classical mobile network operations. In our opinion their impact on the level of costs of voice services can be considered as negligible.

Regarding the amounts for license and spectrum fees that the operators report to have paid and following our discussion with OSIPTEL during the meeting of 17 to 19 May 2005, these amounts do not appear to be the ones that should actually be taken into consideration. In fact, OSIPTEL should consider a methodology that adjusts license fees to realistic market values. To a lesser degree this also applies to the cost items on account of IT. Once the correct figures are known, OSIPTEL could easily make the corresponding adjustments in the calculations to arrive at corresponding cost estimates.

Taken all the above into account, unit prices of the use of the different network elements follow that are consistent with international experience.

4.2 Recommendations for Calculations for BellSouth, Telefónica Mobiles, and Nextel

In each of the MS Excel files incorporating the cost models of the three operators that provided them, there is a set of calculations that start from the CAPEX of the network elements. By adding appropriate amounts for OPEX and then applying to the resulting sums the relevant routing factors, the models obtain the shares of CAPEX and OPEX that need to be assigned to incoming calls. We intervene in each of the relevant models' MS Excel files at this location to determine the cost of incoming calls as follows:

- Use replacement values for the year 2004 of the network facilities and equipment items, where the number and locations of the latter are according to MNOs' network structures. In the case of BellSouth (BS) and Telefónic Móviles (TM) these values are shown directly in the relevant worksheets of the Excel files. In the case of Nextel (NX), these values are derived from multiplying the number of installed network elements with their prices which in their turn can be obtained from the relevant worksheets of one of the two Nextel model Excel files.

- Apply the same structure of economic lifetimes as used by the operators, except in the cases of BTSs and MSCs for BS and TM where we increased lifetimes due to the effect of civil works included in the BTSs' and MSCs' replacement values. Civil works have a higher life expectancy than the 5 years, respectively, 10 years for the BTSs and MSCs proper. We use a value of 20 years for the civil works which increases the average lifetime for BTSs including civil work to 10 years in the case of BS and to 9 years in the case of TM, and for MSCs to 11 years for BS and to 10.6 years for TM.

- Apply a WACC of 19.68 % for all operators as provided to us by OSIPTEL.

- Determine CAPEX on the basis of the capital recovery formula (see Chapter 2) using the values of input variables as discussed above, i.e. replacement values of network elements, economic lifetimes and the WACC.

- Determine the OPEX on equipment and facilities by applying a mark-up of 15 % on the replacement values of the network elements. In the cases of BS and TM, OPEX shown as actual expenditures for annual license and spectrum fees, and in the case of TM for leased lines, are left at their initial values. (On the implications regarding license and spectrum fees, see last paragraph of Section 4.1.)
- Add up CAPEX and OPEX for each network element.
- Use the operators' models to calculate from the sums of CAPEX and OPEX the LRIC per minute of terminating calls in the individual networks.
- Add a 10 % for common cost and overhead.

Table 4-1: Intermediate values for the calculations of the cost of termination in the networks of BellSouth, Telefónica Moviles and Nextel

Parameter	Operator		
	BellSouth	Telefonica Móviles	Nextel
Number of subscribers in 2004 (in thousands)	751.5	2,000.6	170.1
Total minutes of traffic 2004 (in million)	638	1,238	963
Of these: voice minutes (in million)	638	1,238	241
Incoming voice minutes 2004 (in million)	241	475	82
Total minutes per subscriber per year	849	619	5,664
Incoming minutes per subscriber per year	321	237	480
Total value of facilities in replacement values, including investment for license and frequency band (in million of US$)	155.1	241.8	241.2
Total CAPEX	30.6	48.2	44.1
Total OPEX, including annual fees for licenses and spectrum	25.4	50.4	21.3

4.3 Calculations for TIM

In Section 3.4 we discussed that TIM did not provide a bottom-up cost model, expressed in corresponding MS Excel files, as was the case for the three other MNOs. This does not allow us to proceed as we did for these operators in Section 4.2. We therefore have to apply an indirect methodology, using information of the TIM network that we do have as well as whatever useful information we can extract for the purpose from the other models. As happens to be the case, the TIM network can best be compared with that of BS. As appears from Table 4-2, both operators have a similar number of customers and traffic values that are not too far apart. There are of course also differences as the following analysis will show.

Table 4-2: Comparison of network parameter values for BS and TIM for 2004

	BS	TIM
Number of users end of June 2004 (in thousand)	751.5	747.8
Total voice traffic in 2004 (million minutes per year)	638.0	917.5*
Incoming traffic in 2004 (in million minutes per year)	240.9	305.1*
Total traffic per subscriber in 2004 (minutes per year)	849	1,310
Incoming traffic per subscriber in 2004 (minutes per year)	320	401
Nº of switching locations	4	2
Nº of switching units	5	2
Nº de BTSs	284	581
Frequency band	900	1900
Technology	CDMA	TDMA

* Information obtained from OSIPTEL in the course of the preparation of this report.

The differences between the two networks lie in technology, frequency assignment and geographical coverage, which all mainly imply a higher number of BTSs for TIM. From this follows that one cannot use the result from BS directly. Accordingly, for an estimate of the LRIC of terminating a call in the TIM network, a separate, indirect calculation needs to be carried out. We base this calculation on an extrapolation of the investment figures for BS to those for TIM, using coefficients which are derived according to our evaluation of the effects of the differences in the characteristic parameters of the BS and TIM networks.

The calculation is based on the investment amounts for the three LRIC cost positions of transmission, switching and BTSs (for details see Chapter 1). We assume that the values per item of equipment shown for the BTSs are the same for TIM . Therefore, the coefficient to obtain the amount of investment for TIM's BTSs is obtained by dividing the number of BTSs of TIM by the corresponding number for BS. With respect to transmission, we assume that the amounts of investment are mainly determined by covering the BTS in the different departments and routing the traffic to the corresponding MSCs. We use as coefficient the ratio obtained by dividing the number of departments covered by TIM by the corresponding figure for BS. As regards switching we have been provided the information that there are altogether two switching machines. As coefficient we take the number of switching machines from TIM divided by the ones from BS. This is a conservative approach because it does not consider the substantial reduction of MSC locations from four in the case of BS to only two in the case of TIM.

Leased lines are in the BS model mainly used to connect MSC locations. As this number is quite small in the case of TIM and both locations are situated in the same department (Lima) we do not consider extra leased line cost for TIM. Table 4-3 shows the result of the Transformation of BS figures into TIM estimates. It leads to total amount of investment for TIM that is 80 % higher than BS.

Table 4-3: Estimated investment into the TIM network at replacement values (excluding license fee and IT)

LRIC dirver	BS: Investment in US$	BS: Distribution by type of driver (in % of total)	Coefficient of TIM/BS	TIM: Investment in US$	TIM: Distribution by type of driver (in % of total)
Transmission	23,427,022	21.0	1.71	40,060,208	20.6
Switching	15,944,400	14.3	0.4	6,377,760	3.3
BTS	72,264,296	64.7	2.05	148,141,807	76.1
Total	111,635,718	100.0	1.80	194,579,775	100.0

In addition to the amount for physical investment shown in there needs to be taken into consideration the amount paid for the license, respectively, for assigned spectrum. According to specific information obtained from OSIPTEL, the up-front license fee paid by TIM was 184 US$. This amount is substantially higher than the one paid for by BS. On the other hand, according to information received from OSIPTEL in the course of preparing this report, TIM paid in 2004 annual license and other fees that with an approximate amount of 1.4 million US $ for incoming minutes alone corresponds to that paid by BS which, according to the information in its model, paid in total 4.7 million US$. To maintain comparability regarding the effects of different network structure, two possible calculations can be done, the first using the reported amounts for TIM, the second based on the amounts paid by BS, i.e. 35.1 million US$ up-front and 1.8 million US$ proportionately for incoming minutes. For the IT investment, one could also add an amount, i.e. that is not used for retailing, in the amount of 7.2 million US$, following a similar investment used by the BS model, or it could be estimated using other data the amount of IT used by TIM.

Leading up to the LRIC figure per minute averaged over all minutes in the TIM network, the calculations are straight forward. For deriving the per-minute cost figure for incoming calls, we are lacking the routing factor information that we have for the other operators. Here one alternative is to use a proxy from the BS model, i.e. the relation of the LRIC per minute for incoming calls to the LRIC per minute averaged over all calls in that network. This relations turns out to be 85 % which should be applied to the average per-minute LRIC obtained for TIM to get an estimate of the LRIC for the incoming minutes on the TIM network. It should be added to this the amount reported for annual fees for incoming traffic, expressed in per minute. To this sum it should be added 10 % for common cost to obtain the (all inclusive) cost per minute of a call that is being terminated on the TIM network.

Regarding license and spectrum fees figures reported by TIM, it should be noted that they are substantially higher than for the other operators, so it should be considered which should be the right amount for them. As we already suggested in Section 3.4, TIM has a generally higher cost than BellSouth due to the circumstances that it has been provided with the less advantageous 1900 frequency band and that the network has a wider geographical coverage. This has, however, at least in part been compensated due to the fact that TIM has been able to attract customers relatively quickly and generate a correspondingly high volume of traffic.

5 Résumé of the Cost Study

Our discussion of issues and findings regarding the costs of termination services in the networks of MNOs in this report can be summarized as follows:

- Chapter 2 presents our methodology of how we go about verifying the submitted cost estimates as well as the principles that we apply in our own calculations for determining the cost of providing termination services. The companies' model calculations were examined against these principles.

- Chapter 3 shows the results of our examination of the data, information and model software submitted by the MNOs. We find that BellSouth, Telefónica Moviles, and Nextel use bottom-up approaches where the CAPEX and OPEX, driven by the shown amounts of investment in equipment and facilities, are distributed to the different services on the basis of routing factors. The three operators state that their current network structures, after a number of improvements, would correctly represent an optimized model network that a newly entering operator would implement today. We accept these evaluations as plausible for BellSouth and Telefónica Moviles. We find that their models from a methodological point of view are relatively well adapted to the requirements of determining the LRIC of providing termination services. As regards the Nextel model, it also implements the LRIC standard but as we have noted it shows a number of features in the network structure that in our view do not reflect efficiency, and we have therefore applied corresponding corrections.

- Also, the Nextel model bases its calculation of the cost of termination services on a vision of the development of Nextel's network and services over a period of 50 years, i.e. from 1998 to 2047. While this approach represents a sophisticated way of modeling economic depreciation, it involves assumptions regarding future developments which must be considered as extremely uncertain. The approach is also being used to cast backwards expenditures for new technology that will only be incurred in the future, to be recovered from services being delivered today, which we find highly questionable. Furthermore, results are being determined for the year 2002 and not, as for the other operators, for the year 2004. Given these drawbacks, and also for purposes of consistency and comparability, we have adapted the Nextel model in a way that the transformation of invested amounts into annual cost figures is performed analogously to that in the BS and TM models.

- Though we accept the methodology as represented by the BS and TM models, we cannot accept a number of parameterizations that were used for the calculations. In our own calculations, we therefore corrected parameter values where we found them not to adhere to the relevant costing principles. These corrections concern in particular economic lifetimes of BTSs and MSCs when these did not consider the longer lifetimes of civil works; and the transformation of replacement values of equipment and facilities into annualized cost figures when the corresponding calculations did not comply with the appropriate capital recovery profile, as discussed in Chapter 2.

- In contrast to the models of BellSouth, Telefónica Moviles and Nextel, the proposal by TIM derives from a pure top down approach based on values of their current accounting system. We found that in general the data cannot be traced back to the underlying network structure. Given that the TIM network resembles that of BS, we derived from information regarding the latter an approximation of the TIM network, taking into account differences in network characteristics.

- As regards the value of the WACC, the values proposed by the operators varied between 14.4 % in the case of Nextel and 19.5 % in the case of BellSouth. OSIPTEL has derived a value of 19.68 % for the WACC which we have used throughout in our own calculations.

- Taking a standard approach to the determination of a cost-based charge, we accept only the LRIC of the termination service plus a mark-up of 10 % for common cost. Therefore we dropped from consideration all those elements that cannot be considered as cost drivers of the service. To these belong the retail related items of handset subsidies and the cost of customer acquisition.

- Based on the model assumptions as discussed above, OSIPTEL could determine per-minute costs for terminating incoming calls on the MNOs' networks, i.e. LRIC plus a mark-up for common cost:

- Differences in terms of technology, coverage, number of customers and volumes of traffic could influence the level of charges, and these factors potentially could have the effect of offsetting each other. If this is the case, this may be an indirect sign of the effect of competition despite all the differences.

- One final observation: The BellSouth and Telefónica Móviles models are set up to calculate the cost of termination for calls coming in from other mobile networks. Our examination shows that the matrix of routing factors for calls arriving from the fixed network are exactly parallel. From this follows that the costs of terminating calls coming from the fixed networks are the same as those calculated for calls from another mobile network. The very minor differences that showed in calculations to verify this presumption must be due to rounding errors. In the case of the Nextel model, no such observation is called for as there the cost of termination is calculated on the basis of the volumes of all incoming calls.

6 Policy Issues

In this final chapter we take up issues that are of a more general policy nature. They cover considerations as to whether there should be a unique MTC for all operators or individual ones depending on differences in measured costs, how adjustment to any new level(s) should be managed, what the impact on costs of different cost drivers are, and what the impact of a decrease in the MTCs would have on retail prices. They will in the following be discussed taking them up one by one:

- *How should the transition for current levels of termination charges to the new ones, or in case, to the unique new one be accomplished?*

  There are currently a number of countries in the world where charges for the termination of calls in mobile networks are in the process of being reduced from initially high levels to substantially lower ones. In most of these countries the actual adjustment is being spread over several years. This is done to give operators sufficient time to adjust their structure of tariffs in a way to compensate for the reduction in revenues due to lower charges for termination services. It is obvious that the adjustment has to be primarily in retail tariffs and it follows that it has to be done with care and judiciously as otherwise there may be a loss of confidence on the part of customers who might accept only after a certain time that some services become more expensive.

  In Sweden the so-called glide path extends over 3 years, in the UK over 4 years and in Austria over more than 5 years. There are no criteria precise enough on which to recommend the length of the necessary adjustment period. It appears, however, that if there are operators that have entered the market only recently and are facing disadvantages relative to other operators, the adjustment period should not be overly short which seems to mitigate against the example of Sweden of a glide path over 3 years. On the other hand, a period of 5 years ore even longer as in Austria would appear overly cautious so that our recommendations would be to opt for an adjustment period of 4 years. We assume that the beginning of the 4-year adjustment period could be placed at the end-2005, the first adjustment be made around beggining-2006 and three more adjustments be made in 2007, 2008 and 2009.

- *Cost drivers in mobile networks*

  When considering the effect of network development on costs, like in the situation discussed under the preceding bullet point, the question arises to what extent costs react to an increase in coverage and to what extent to increases in traffic. The focus is here less on the increase in total cost than on the effect on the cost per unit of service which is here the per-minute cost of terminating a call on the network. For this purpose it is instructive to consider first separately the effect of an increase in coverage and then in traffic and after that an increase in both dimensions. For this we write down the following equation for total cost:

C = nBTS*pBTS + IT*pT + nMSCpMSC,

where nBTS = number of BTSs,
IT = length of transmission network,
nMSC = number of BSCs, and
pBTS, pT, and pMSC = prices of corresponding equipment items.

With respect to above equation we note that total cost depends on the physical size of the network, i.e. number of BTSs, total length of transmission links and number of MSCs and the prices of the equipment items. We also remember from the earlier discussion that the cost of BSCs makes up around 65 % of the total, that of transmission about 20 % and that of switching about 15 %. Now let us consider an increase in coverage through the addition of a BTS in a new location. Since we want to analyze the effect of coverage separately from the effect of traffic, we assume that the traffic carried by the additional BSC corresponds to that of the previously already existing BTSs. This means that the effect on the average cost per unit of traffic does not change through the fact alone of adding the BTS. What are the effects in the other two components of the network? Given that an additional BTS has to be connected, the total length of transmission links increases which may be more or less proportional than the relative increase in the number of BTSs depending on whether the additional area being covered lies far out or lies within the parameter of existing BTSs. In the first case one would expect an increase in the average per-minute cost of transmission and thereby of traffic in general while in the latter case there would rather be a decrease. As regard MSCs, the assumption appears to be justified that in the case of MNOs in Peru the capacities of switches are sufficient to handle the extra traffic being generated through the additional BTS so that there would be a decrease of the average cost per minute of switching and therefore also a decrease in the average per-minute cost of traffic. Overall one might observe an increase in the per-minute cost of traffic due to an increase in coverage which is brought about by the cost increase in transmission, depending on where the additional BTS is placed. This increase will then, however, be mitigated by a decrease in the cost of switching. In any case the increase in the per-minute cost would also be relatively small because of the fact that transmission makes up, as noted above, only about 20 % of the total cost. We consider next an increase in traffic where this may happen due to an addition of new customers or due to greater use by existing customers in regions where coverage is already provided. If available capacity is sufficient to absorb the additional traffic there will be no addition to total cost but a one-to-one reduction in the per-minute cost of traffic, i.e. a 10 % increase in traffic would bring about a 10 % decrease in per-minute cost. Of course, with traffic increases there will also be the need to increase capacity. This capacity increase will, however, be never oneto- one because there are substantial economies of scale in the provision of a network service like telecommunications so that on average the per-minute cost of providing traffic will decrease.

In the last step we now consider a simultaneous increase in coverage (expressed as an increase in the number of BTSs) and an increase in traffic (where it does not matter whether this traffic comes about through more subscribers or through existing subscribers each generating more traffic). We should expect the cost decreasing effect of the increase in traffic to dominate over any cost increasing effect of the increase in coverage. This is easily seen if we consider that in the case of more coverage only through the effect on transmission may there may be a costincrease while in the case of traffic there is sure to be a decreasing effect over all three network components, BTSs, transmission links, and switching. The following conclusions can be drawn from the above. As a network expands both in coverage and traffic per BTS, the expansion in coverage must be relatively much larger than the expansion in traffic to cause an increase in the per-average minute of traffic. For the foreseeable future the converse is, however, more likely to occur. Also, a network with a large coverage but at the same time a relatively high load of traffic per BTS may have lower cost than another network of more restricted coverage but a relatively low load of traffic per BTS. Only when coverage increases and at the same time total traffic volume does not increases at the same rate so that the average traffic load per BTS decreases should one expect, everything else remaining equal, that per-minute cost of traffic starts increasing. It is, however, unlikely that everything else will remain equal. One thing that is probably going to occur is the decrease in equipment prices which will in general mean that future cost of provision will decrease.

- *What would be the impact on retail prices?*

The reduction in the MTC is mainly brought about through the elimination from the cost calculation of handset subsidization and customer acquisition costs. In the cases of BellSouth and Telefónica Móviles, this could be done as part of the recalculations on the basis of their own model software, and in the case of TIM it could be done by not including relevant items in the indirect calculation carried out. Nextel started from a much lower level of cost and did not have customer acquisition costs included; the reduction in cost was here primarily due to reparameterization of the network model. In any case, Nextel has an excess of outgoing over incoming traffic so that through a decreasing level of the MTC here would be no shortfall of revenue, rather on the contrary an increase.

Given that BellSouth, Telefónica Móviles and TIM will have to rely on reduced levels of income from MTC, they will either have to increase revenues from other sources or to reduce costs. Their main source for cost reductions would be the cessation of providing overly generous bonuses to new customers in the form of free telephone sets or the same kind of bonuses to retain existing customers. The primary effect will be a reduction of churn due to the competition among the MNOs to lure customers away from each other through the granting of these bonuses. Given that there is still a pent-up demand for access to mobile services, it can be expected that the growth of subscription as a whole would not seriously be jeopardized.

If the reductions in cost just described are not sufficient to compensate the shortfall of revenues due to the decrease of revenues from termination services, MNOs would need to increase their tariffs for on-net and off-net outgoing calls accordingly. This is an immediate consequence of the cessation of a subsidization practice. Customers would then have to pay for services at a level that is sufficient that all relevant costs of the services they demand are covered, which should in any competitive market be the normal standard.

Annex: Comparison Between CDMA and TDMA air interfaces

Here we provide a comparison between CDMA and TDMA technologies applied in the air interface of mobile networks. For the sake of simplicity and comprehensiveness we provide here an overview over the systems where we avoid detailed explanations. As we go along we make references to the literature to support the main ideas

From the point of view of capacity, a TDMA is a hard blocking system (see RAB). This assessment means that the base station (from now on BTS) has a limited and specific number of traffic channels which depends on the amount of hardware installed. In GSM systems, which apply TDMA in the air interface, each voice user uses a traffic channel defined by a specific time slot and a specific frequency. The maximum number of active users in the system is strictly defined by the number of traffic channels available.

Radio propagation planning is an independent issue from capacity planning in TDMA systems, and it is the main limiting criteria in cell planning.

CDMA is a soft blocking system. This means that the capacity is not strictly limited by the amount of hardware installed in the BTS but by the interference produced by the users in the system (in the cell of interest and in the surrounding cells). Therefore there is no strictly defined number of channels in the system, and each user does not use the same amount of capacity. In these systems capacity and radio propagation planning are largely interrelated, and there is no one main limiting criterion but there are several ones (see HOL).

For a rough comparison between these two air interfaces, it is instructive to consider basic TDMA and CDMA BTSs, with the minimum equipment, in the same frequency band, and in terms of two different demand scenarios.

For the first scenario we assume an area with a very low traffic demand. In this case the cell radius will be limited by radio propagation. If we consider the same transmission power the two BTSs will reach approximately the same distance, and therefore both of them will have the same performance.

For the second scenario let there be an area with a relatively high traffic demand. In this case due to the fact that the basic configuration of a CDMA cell provides higher capacity than the basic configuration of a TDMA cell, the first technology may obtain better performance (see VIT).

There is an intensive controversy going on about which technology is better. There are many qualified opinions in favor of or against each technology (see 3GA for GSM, GEM or QUA2 for CDMA). As a résumé we conclude that for voice traffic use in mobile networks there is no clear advantage of one of the two systems against the other. This vision changes if we look at the medium to long term development of a third generation mobile network with service integration. In this case the use of CDMA has clear advantages against the use of TDMA because the CDMA system adapts better for bursttraffic resulting from data application and mobile Internet access. It must be stressed, however, that this is only valid if we regard the medium to long term development due to the fact that the GSM system based on TDMA covers part of the way toward third generation services due to the introduction of GPRS and some enhancements like EDGE.

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