Forward Looking Long Run Incremental Costs for the calculation of interconnection fees

Authors:

Roland Belfin

Martin Lukanowicz

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Forword

It is important to emphasise that this document is merely the basis for discussion and that the conclusions drawn will be amended as required. Furthermore, Telekom-Control GmbH reserves the right to draw new conclusions or take a different view if, due to subsequent information or at present unknown circumstances, changes should become necessary. In addition, we would like to point out that the Telekom-Control Commission does not feel bound by the contents of this paper.

1   Purpose of this Paper

Interconnection is of particular significance for the liberalisation of telecommunications. Interconnection with the networks of incumbents is a crucial prerequisite for most new entrants to gain access to the customers of incumbents within domestic markets. The pricing mechanisms used to determine interconnection fees have a strong effect on the intensity of competition and the profitability of telecommunications companies. Therefore it is particularly important that decisions made with regard to interconnection fees are based on economic principles and objective facts.

This paper provides an overview of different ways of determining interconnection fees and discusses their practical applicability. There then follows a more detailed description of the method of Forward Looking Long Run Average Incremental Costs (FL-LRAIC).

2   Introduction

When telecommunications markets are liberalised, at the beginning there is always one firm which has significant market power. This has at its disposal an access and core network with total coverage. New entrants to the market need access to the network of this company in order to provide their services at all. Since the firm which has significant market power has greater bargaining power, and incentives for the provision of efficient interconnection are lacking (in extreme cases interconnection may even be refused), regulatory intervention is necessary to guarantee that the conditions for access to the network will not be influenced by this unequal bargaining power.

In principle there are two different forms of access for the new entrant:

- Unbundling and
- Interconnection.

2.1   Unbundling

With unbundled access an operator leases parts of the network of another operator (for example, the local loop). The new operator then has the exclusive use of the unbundled part of the network. For example, if an operator leases a local loop (local loop unbundling), then they make all the connections via this line to the subscriber. The rental for the loop is therefore dependent on the length of time the capacity is available and not on actual utilisation, which is the case with interconnection. Rentals are generally set at a monthly flat rate for each specific network element.

2.2   Interconnection

Interconnection is the logical and physical connection between two networks. It enables the customers of one network operator to communicate with the customers of another network operator and also enables them to use the products and services of the other network operator. Interconnection, depending on the location of the points of interconnection, can be implemented at different layers of the network hierarchy.

In contrast to unbundling a party requesting interconnection does not have exclusive rights of use of the network or parts of the network of the interconnection provider. The interconnection provider's network is only used if subscribers choose to use it, (for example, if a customer of a new operator phones a customer of the firm with significant market power). Therefore the network or individual network components are only made use of by the network operator or interconnection partner according to need.

Interconnection fees are dependent on utilisation and are generally quoted per minute.

In the rest of this paper reference is only made to interconnection of telecommunications networks, not unbundling.

Interconnection facilitates competition between telecommunications operators. Conditions for interconnection determine efficiency of utilisation, construction of new infrastructure and entry of new operators to the market, and consequently the intensity of competition.

With regard to the determination of interconnection fees the following have to be taken into account:

Efficiency of investment: This implies that opportunity costs are taken into consideration, i.e. investment costs and usual rates of return on capital employed.

Efficiency of resource use: The price for an additional unit must not be lower than the marginal costs (i.e. costs for an additional unit).

Efficiency of market entry: The entry of efficient firms should be encouraged and the entry of inefficient firms should be prevented.

Practicability: It must be possible to apply the system to determine conditions for interconnection in practice. Data has to be available, transparent and reproducible.
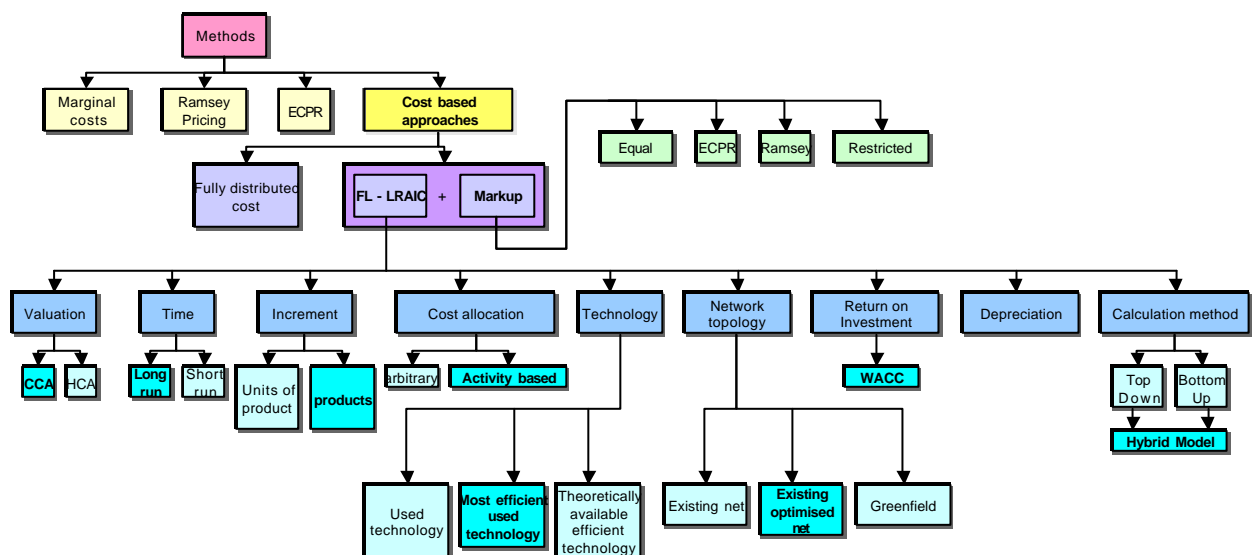

Diagram 1: Methods for determining interconnection fees

The above diagram shows possible methods for determining interconnection fees. These methods will be examined in greater detail in the following sections.

3   Methods for determining interconnection fees

The comparison of the various methods is based on the following assumptions:

The firm with signficant market power offers interconnection both as an intermediate product to other network operators and as an end product (e.g. local calls) to its own subscribers.

Interconnection as a product is a bottleneck service, without which new operators cannot offer their services at all or cannot offer complete coverage (at least no products or services which involve the customers of other operators).

If in the long term, costs for a network of their own are lower than the costs for interconnection then, in the long-term, there is a chance of bypassing the network of the firm with significant market power.

Parties requesting interconnection offer, among other things, end products which are substitutes for the end products of the firm with significant market power.

Both the firm with significant market power and the parties requesting interconnection are seeking maximization of profit.

3.1   Short-term Marginal Costs

In a market which operates under conditions of perfect competition, assuming that full capacity utilisation and the possibility to arbitrarily increase capacity exist, market prices approach marginal costs.

If the existing capacity of a network has not been fully utilised, then short-term marginal costs approach zero. Therefore the price for a unit in this range also has to approach zero, given that an increase of one unit does not cause step fixed costs. If, however, the capacity limit of the network is reached, the costs for an additional unit are increased due to higher opportunity costs (loss of expected turnover from demand which cannot be met). For investment in an increase in capacity to take place prices must be above short-term marginal costs. The short-term marginal costs reflect only the utilisation of an existing network, therefore only variable costs which are dependent on utilisation are included.

Since in the telecommunications industry capacity cannot be increased arbitrarily by one unit, this approach to price determination is impracticable. It can only function as a benchmark for the short-term floor for unutilised capacity.

3.2   Ramsey Pricing

Ramsey Pricing is used to find an optimal price from a macroeconomic point of view. This is achieved by taking into consideration standard rates of return and price elasticities of demand. In this way both consumer and producer benefits, and therefore overall benefits are meant to be maximized.

With this method prices are set close to marginal costs in accordance with price elasticities of demand. With price elastic products or groups of customers the mark-up on marginal costs is slight. With price inelastic products the mark-up on marginal costs is higher. In this way the fixed costs of a firm are distributed among products or groups of customers in inverse proportion to price elasticities of demand.

Extreme inelasticity of products can result in extremely high prices. Customers find these high prices unjust and therefore undesirable. The same is true for particular groups of customers where price elasticity is dependent on the respective customer segment. However, we have to ask ourselves how far these price differentiations for different customers or groups of customers are acceptable, desirable and reasonable.

Ramsey Pricing requires an exact knowledge of price and cross price elasticity of demand. This data is currently unavailable for Austria and to gather it would involve costly and extensive empirical studies. This would be particularly difficult with regard to the telecommunications market since it is extremely dynamic, with constant shifts in demand. This approach is therefore more suitable as a benchmark to ascertain if the proportions between different set prices are adequate.

3.3   Efficient Component Pricing Rule (ECPR)

According to the Efficient Component Pricing Rule (ECPR) the party requesting interconnection pays the opportunity costs of interconnection to the incumbent. These opportunity costs cover the costs which the firm with significant market power has incurred by providing interconnection. However, they also include the costs the incumbent has entailed through a loss of contribution margin caused by a reduction in its martket share in the subscriber market. In effect, the ECPR is based on the subscriber tariffs of the incumbent.

In this way the revenues of the firm with significant market power remain unchanged, regardless of whether the network is used for interconnection purposes or for its own internal subscriber calls. This method ensures that the firm with significant market power has no incentive to obstruct entry of new operators to the market through discriminatory behaviour. This is because it receives the same contribution to cover indirect costs, independent of whether network access is provided or not.

The level of prices calculated in this way depend on highly influential subscriber tariffs, and the lower costs for interconnection in comparison with services offered to subscribers. The higher subscriber tariffs are, the higher interconnection tariffs are, since the higher losses in revenue caused by a drop in subscriber call minutes are compensated for by means of these higher tariffs.

A fundamental assumption of this approach is that the subscriber tariffs of the firm with significant market power are the basis for the costs of an efficient operator. However, this is seldom the case in reality. Furthermore, this method assumes that new operators do not incur fixed costs. Due to the restrictive nature of the assumptions in this model, it does not seem suitable for determining interconnection costs as they have to be based on transparent and objective facts.

3.4   Cost Based Approaches

As shown in the approaches discussed above there are discrepancies between theoretically efficient approaches and approaches which can be implemented in practice with the information available. Thus through the choice of certain methods of valuation, cost centres, and taking opportunity costs into account, an attempt can be made to arrive as closely as possible at economically efficient methods.

3.4.1   Fully Distributed Cost Based on Embedded or Historic Cost

Using the fully distributed cost approach, the total costs of a product or service are taken into account. These include a share of the joint and overhead costs, arrived at by applying certain allocation bases. Thus, in contrast to the marginal cost approach, fixed costs independent of output are also taken into consideration. The overhead cost allocation bases are usually set (cf. e.g. OECD, Universal Service Obligations in a Competitive Telecommunications Environment, p.111f)

- according to the relative network utilisation, or in proportion to the level of output, of each service or product (relative output method);

- proportionate to the directly attributable cost (attributable cost method);

- in proportion to the relative share of revenue of services of products (gross revenue method);

- in proportion to relative net revenue (net revenue method); and

- in proportion to the expected (forward looking) relative share of revenue of services or products in a planning horizon.

A lack of fair apportionment and transparency can lead to an unjustified allocation of joint and overhead costs to products and services which are more affected by competition than others. In principle the costs and prices of a product can be varied over a wide range by the structuring of the allocation base. Further,

using the fully distributed cost approach not only the cost of individual products but also the firm's overheads which should not be apportioned are charged.

This approach is based on historic costs and therefore inefficiencies enter price calculations. The cost of these existing inefficiencies are borne by the new market entrants in the form of higher interconnection fees. Furthermore, it leads to a cost-related mapping of the existing network in which possible inefficiencies, for example the network topology, additionally enter the costs. If prices are calculated on the basis of these costs, not only do incentives still exist for inefficient network extensions but inefficient companies can also enter the market.

Although by using this method, opportunity costs on capital employed, joint costs and overhead costs are taken into account, calculating economically efficient prices is hardly possible, since this approach lacks transparency with regard to activity-based allocations and replacement values.

The majority of incumbents at present use cost accounting systems which are based on fully distributed historic costs. As discussed in section 4 of this paper, basing the determination of interconnection fees on historic cost tends to lead to the over-statement of interconnection costs and is therefore not suitable as an approach to promoting competition.

3.4.2   Forward Looking Long Run Average Incremental Costs (FL-LRAIC)

By using the forward looking long run average incremental costs approach one is attempting to determine the costs of an efficient network operator necessary for the provision of a certain service. With FL-LRAIC one calculates the costs of offering a particular service or product incurred by an efficient firm.

Given a competitive market, the value of an investment is not dependent on the original historic cost but on the potential future revenues which can be accrued on this investment. In a competitive environment operators often cannot set the price for every product in order to cover complete historic cost, since they have to respond to market prices, which can often lie well below the historic cost. They cannot therefore work according to historic cost since reversing investments is, for the main part, either not possible or only possible at a great loss. An operator will, however, include the costs necessary for maintaining future real-asset values in the market price. This means that an operator is motivated to make future supply efficiently correspond with expected demand. Costs incurred in maintaining production capacity are therefore relevant. In the future, in order to achieve the strongest competitive position possible, an operator will have to use the most economically efficient technology and network topology. The replacement cost of this efficient and essential equipment is the basis for the calculation of forward looking long run average incremental costs.

Using this approach is a way of simulating a competitive situation and therefore anticipating prices which will only become established in a particular market at a later date.

In contrast to the fully distributed cost approach, when using incremental costs only the direct and indirect replacement costs of certain products and services are taken into consideration. Only unavoidable costs related to offering particular products and services are calculated. Another essential element of the FL-LRAIC approach is that these costs are appropriately allocated to the costed unit of output and that the joint and overhead costs are minimised as much as possible. Arbitrary cost allocations are therefore largely avoided.

4 Principles Regarding the Forward Looking Long Run Average Incremental Cost (FL-LRAIC) Approach

The question of how to arrive at appropriate and efficient cost oriented interconnection fees is being asked in all liberalised markets worldwide. There is a clear trend towards the FL-LRAIC approach, whereby the setting of interconnection fees is based on forward looking long run average cost. To quote from the Interconnection Directive (Recital 10): "whereas the level of charges should promote productivity and encourage efficient and sustainable market entry, and should not be below a limit calculated by the use of long-run incremental cost and cost allocation and attribution methods based on actual cost causation, nor above a limit set by the stand-alone cost of providing the interconnection in question ".

The long run incremental cost method provides an analytical framework for estimating the cost that would be found in a market operating under conditions of perfect competition.

4.1 General Comments

A telecommunications network has to be designed in such a way that it can maintain the required level of service during periods of maximum traffic load. If, during peak periods, traffic from other interconnected networks has to be handled, extra capacity is necessary to ensure the desired quality of service. During peak periods the additional volume of traffic requires a corresponding increase in network capacity if the same quality of service is to be maintained in the terminating network. Investment in capacity constitutes the bulk of additional costs incurred in a network when delivering interconnected traffic.

An analysis of the capacity costs for maintaining this quality of service (based on data concerning demand or, subsequently, the actual interconnect traffic handled) enables the apportionment of costs among interconnecting parties.

In an ideal situation where a branch of industry consisted of well-established market players with relatively stable market shares, capacity based charging would be the most efficient pricing rule to determine interconnection fees. Such a case would require detailed knowledge of future market developments (growth, the market share of all participants). However, these ideal conditions do not apply in newly liberalised telecommunications markets. In fact, the usual basis for interconnection fees is traffic based pricing so that the total traffic-related forward looking interconnection costs of an efficient operator are recovered.

When using this approach in order to determine the costs of an efficient operator as closely as possible, certain assumptions need to be agreed on. These will be examined in further detail in the following paragraphs.

4.2 Valuation

In a dynamic and competitive market it is the future return on investment, not the historic cost (historical cost accounting, HCA), which determines the value of an investment.

From the moment an investment is made (i.e. the time when the investment cannot be reversed without considerable cost), the value of an asset to a firm depends on what the firm can do with the asset. It can either sell the asset at the highest possible price or use it to produce goods or services in order to generate future cash flows.

The goods or services produced with the help of this asset usually face competition from competitors' close substitute products. If any of the competitors is more efficient to the extent that it is able to offer better value for money, less efficient market players will have to react accordingly, and will no longer be able to

base their prices on historic cost. In other words, in order to survive, firms are compelled to look forward to calculate prices, rather than backward to their original investments. This also means that the cost of outdated infrastructure cannot be charged to the customer since this would create a competitive disadvantage in comparison with efficient firms.

Only a firm with considerable market power can demand from customers (or, in the case of interconnection, competitors) a price calculated according to the required rate of return on past investments. Interconnection fees based on historic cost serve to protect incumbents from competitive market forces.

Given a competitive situation, a network operator who offered a certain network performance (investment to the value of X a year previously) would be in direct competition with another operator (investment to the value of Y a month previously). The cost of Y would be significantly lower than the cost of X as the telecommunications market is noted for falling prices of essential equipment (for example, transmission and switching technologies).

If the operator offered the service at a price based on the higher investment cost X, many customers would switch over to the new operator who was offering the same service at a lower price (based on Y). Therefore in a competitive situation, the older operator is compelled to offer its service, which actually cost X, at a price based on replacement cost Y, otherwise many customers would change operators. This of course presupposes that price is the exclusive decision-making criterion for choice of operator.

Therefore in a competitive market, historic cost is not suitable as a basis for determining interconnection fees. For this reason, valuation needs to be based on current replacement cost (current cost accounting, CCA), and take into account the costs of an efficient modern network.

The application of replacement cost methodology in the field of telecommunications is, due to the speed of technological change in this branch, often difficult. This has consequences both for the determination of fair replacement cost for technologically outdated assets as well as for the stipulation that replacement assets should have the same degree of functionality and performance as the outdated assets.

Among the technological decisions that have to be made by operators are, for example, the choice between copper and fibre optic cable or PDH and SDH transmission technologies.

With regard to functionality and efficiency, modern technologies are usually superior to older technologies. Since valuation based on Modern Equivalent Assets presupposes assets with equivalent performance and functionality, adjustments with respect to the current procurement price as well as to operating costs are necessary. For example, modern assets might require less maintenance.

One way of calculating asset replacement cost comprises applying special price indices to the current gross book value. Alternatively, MEA ("Modern Equivalent Asset") valuation methods can be used. They take modern equivalent asset values as well as cost reductions into account.

It can be useful to use indices for certain fixed asset groups.

4.3   Time horizon and increments

A very long time horizon is observed in which investment capital and network capacity can change arbitrarily. This means that capacity already in place can also be regarded as variable, since in the long run all the network infrastructure can be replaced. In fact, it has to be replaced eventually, due to its limited life.

In contrast to marginal costs, which measure the cost per additional unit produced, incremental costs measure the cost which is caused by larger changes in production, i.e. changes in production for more than one unit.

In the short run any increase is limited by the current production capacity of the firm. In the long run, on the other hand, the firm can and will invest in order to increase capacity. "Long run" in this context denotes

therefore the time horizon within which the firm can adjust (upwards or downwards) all of its inputs, including the size and range of all its production plant, in order to meet an increase or decrease in the volume of production. Therefore the total investment cost incurred at any point of interconnection would be avoidable and thus covered by long run incremental costs. All these costs taken together, including the cost for the incumbent's increase in traffic, form the total incremental cost for interconnection. These costs would be distributed in a fair and transparent way between all parties wishing to interconnect with the incumbent, with the result that the cost of interconnection for each party would be, based on the demand for traffic, the long run average incremental cost (LRAIC).

If an increment is taken to be the whole of an additional service, independent of the number of units that constitute the increment, incremental cost consists of all direct and indirect cost attributable to that service. These are costs additionally entailed because of the service or that could be saved in the absence of that service (avoidable cost).

For example, an international exchange is needed to provide the service "international call"; if this service did not exist, the cost of the international exchange would be saved. Therefore the cost of the international exchange is incremental cost for the service "international call". For all calls that do not require an international exchange, for example a single tandem termination call, the cost of an international exchange is not to be taken into consideration. The additional provision or increment is therefore to be interpreted as the whole possible output of a service, i.e. provision of a service or a network element.

With respect to interconnection this means that interconnection as such is an increment. Therefore cost which is caused exclusively by interconnection must be fully attributed to this product.

The cost of a switched network is incurred on the one hand from the operator's own utilisation of the network (for example for local calls) and on the other hand from interconnection utilisation. Since the time period observed is very long and forward looking, and thus capacity is variable, the cost of switching and transmission capacity can be divided up according to demand for interconnection as a proportion of the overall quantity of demand for traffic in the network (call minutes).

We have chosen this definition of an increment because using smaller increments would lead to an unfair distribution of cost between network operators.

The connections between the various approaches to costing are shown in the following graph:
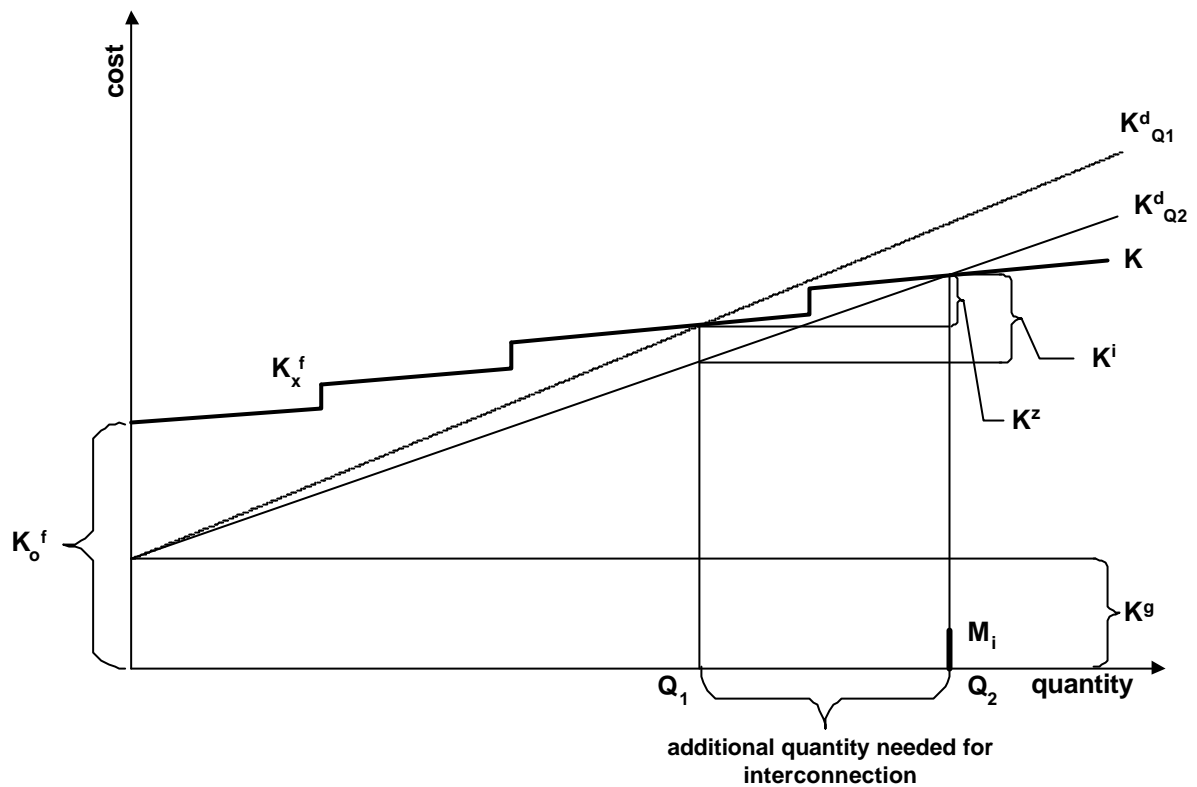
K	Total cost of an efficient network
K_0^f	Fixed cost of an efficient network
K_x^f	Step fixed cost of an efficient network
K^g	Overhead cost of an efficient network
K_{Q1}^d	The slope gives the directly and indirectly attributable cost of quantity Q_1
K_{Q2}^d	The slope gives the average directly and indirectly attributable cost of quantity Q_2
K^i	Average incremental cost of interconnection
K^z	Additional cost of interconnection (based on marginal cost)
M_i	Mark-up
Q_1	Quantity without interconnection
Q_2	Quantity including interconnection

Diagram 2: graph depicting the average incremental cost of interconnection

Looking at a short-term simplified model could lead to the following scenario:

A firm with significant market power has, for example in the last 15 years, invested in a network which has a specific capacity:

Network capacity (N in min) of the existing network
Cost (K) of the existing network
Own cost per call minute = K/N

This year there is an alternative operator which wishes to interconnect with the existing network. Assuming that there is no need for the firm with significant power to extend the network in order to handle the alternative operator's traffic, the firm with significant market power incurs no short run additional cost. Only using short run incremental cost as a basis for determining the price would result in the following:

Network capacity (N in min) of the existing network remains the same
Cost (K) of the existing network remains the same
Short run incremental cost approaches zero
Own cost for the firm with significant market power per call minute = K/N
Cost for the alternative operator on the basis of short run incremental cost ~ zero

Using a short-term model, this would mean that the firm with significant market power would bear the total cost of the network, and, in an extreme case (for example, if no network extension were necessary), the alternative operator could use the network almost cost-free (given that the short-term marginal cost approaches zero). This would discriminate against the firm with significant market power.

In contrast, a long-term forward looking model would produce the following result:

Network capacity required (N_{total} in min) to cover the planned total demand (based on own and interconnection utilisation)
Network capacity required ($N_{Interconnection}$ in min) to cover the planned interconnection demand
Replacement cost (K_{total}) for an efficient network with capacity N_{total}

Long run incremental cost for interconnection is the cost of an efficient network caused by demand for interconnection ($N_{Interconnection}$) – that is, assuming variable capacity - the capacity cost which is caused through the capacity demanded for interconnection as a proportion of total demand.

Using a transparent apportionment of the cost of the switched network (for example, according to call minutes) one arrives at an average cost per unit which is the same for all parties requesting interconnection.

The forward looking long run time horizon ensures that parties requesting interconnection bear the cost required for an efficient provision of interconnection capacity. Without interconnection the incumbent's network would be planned and renewed only for its own estimated future traffic volumes, which means that there would be no cost for the provision and maintenance of interconnection capacity. In this sense addtional cost for the incumbent is caused by interconnection and the additional traffic it generates.

4.2   Allocation of Cost

All directly and indirectly attributable costs are allocated to the service or product which caused them. To calculate the directly and indirectly attributable costs, it is necessary to establish the dependencies between costs and cost drivers. For example, the required call handling capacity of a switch is directly dependent on the demand for call minutes. Maintenance costs for switches are directly dependent on the number of switches. There is therefore an indirect dependency between maintenance costs and the demand for call minutes. If all costs and cost drivers are known, using a multi-layer approach to cost allocation, all indirect and direct costs can be apportioned to specific products. The analysis of all relevant direct and indirect relationships between costs and cost drivers (activity-based costing) is the basis for a full allocation of cost.

Joint costs, i.e. costs for components which are used in more than one product or service, cannot be specifically allocated to one service or product. These costs should, as far as possible, be both dependent on use and activity-based in order to allocate them to specific products. This assumes the application of activity-based costing. Joint costs are allocated to the lowest possible aggregated level of a component. Only if there is insufficient information on cost causation are these costs transferred to the next level.

For example, maintenance costs for switching technology should not be equally apportioned to all switches, instead, to arrive at a fair allocation, a distinction should be made between different types of switches, in so far as the level of maintenance for these switches differs.

Using activity-based costing, indirect costs are allocated according to an analysis of cost drivers. These activity-based costs constitute the directly and indirectly attributable costs, and therefore the incremental costs of a product or group of products.

Certain costs in a firm (e.g. bookkeeping) cannot be directly or indirectly attributed to a specific service since they arise independently from the service (unattributable costs). The sum total of these costs form the overheads of the firm.

All overhead and joint costs should be checked to see whether they would be avoidable if a service were not offered. For this purpose the so-called "stand alone criterion" is applied. By "stand alone costs" we mean the costs which would be unavoidable if only one specific product or product group were supplied. In the case of interconnection, all costs which an operator would incur if it only offered interconnection come under stand alone costs. Starting from the joint and overhead costs of an operator, which in reality offers more products (e.g. retail services like local and distance calls, or wholesale services like interconnection), every cost item has to be checked with regard to its necessity for interconnection. For example, marketing costs (e.g. sponsorship of a sports event) which serve to increase consumer awareness cannot be taken into account when calculating the FL-LRAIC for interconnection fees because these costs are not incurred by supplying interconnection.

An example of overhead costs which should be taken into consideration are the costs for accounting, in that even a firm which only offered interconnection would incur unavoidable costs for accounting. Therefore a proportion of the cost which is captured by the stand alone cost is added to the interconnection fee in the form of a mark-up.

Joint and overhead costs calculated in this way are taken into account in the form of a mark-up in interconnection fees. (See section 4.7).

4.3   Technologies

In a telecommunications network there are normally several technologies in simultaneous use which were acquired at different times and which are therefore more or less efficient. Modernisation and renewal of individual components takes place on a regular basis. If one only takes cost as the decision-making

criterion, this will generally only happen if the average variable operating cost (e.g. maintenance cost) is above the average cost for the replacement (cost of capital and operating cost).

If one starts from the existing technologies in the network of the firm with significant market power, there are few incentives to invest in efficiency improvements since, as the price level is adequate despite higher costs, there is still a profit margin. Furthermore, new operators have the chance to by-pass the network of the firm with significant market power with their own, possibly inefficient, networks, which has a negative effect on overall efficiency. It cannot therefore be guaranteed that competitors will invest in the latest and optimal technologies if interconnection fees are not based on an efficient network.

In a dynamic market network operators are compelled to continually renew their network in order to remain competitive. Competition therefore forces operators to invest in the most efficient technologies. All prices are influenced by the technologies at present employed by competitors if exactly the same performance can be achieved at a better price.

To remain competitive in the future, future network structure for subsequent years has to be planned. Technologies already available on the market or anticipated future technologies form the basis for this planning process. In order to calculate the cost of such a network one needs market prices which are not available for technologies which are not yet employed. Even the allocation of direct cost, or rather attributable allocation of cost, can hardly be carried out without available empirical data. A sound knowledge of the capacity and cost structure of new technologies is only available after they have been put on the market.

Given the choice of using

- the current technologies of the firm with significant market power,
- the most efficient technologies on the market or
- technologies which are theoretically available on the market

to calculate the cost of the network, the first option is not practicable due to inefficiencies and the last due to difficulties of of practical implementation.

For these reasons one should use the most efficient currently available technologies for the determination of interconnection fees since this gives incentives for investment in efficiency improvements and is forward looking. The availability of specifications for the currently most efficient technologies should also be a given.

4.4 Network Topology

The network topology (hierarchical levels, number and location of switches, and transmission technologies) is a significant factor affecting cost. In determining interconnection fees it must be decided whether the existing network architecture of the firm with significant market power, a "greenfield approach", or a combination of both should be used.

If only the existing network structure is taken into consideration, a perhaps less than optimal network topology can enter the interconnection fee calculation. Because of these higher interconnection fees there is no incentive for efficient extensions of the network and the possibility exists that additional investment in inefficient alternative infrastructure will take place. The advantage of this approach is the availability of data and consequently a high level of accuracy in the calculations.

The greenfield approach is an attempt to build a model of an optimal network with the same features (e.g. traffic handling capability, the same number and distribution of subscriber access lines , the same quality criteria) as the network of the firm with significant market power. This model, on principle, does not take existing network topology into consideration. This means that all cost factors, such as for example the

location and number of switches, or the number of hierarchical levels, are equally eligible (scorched earth approach).

The greenfield approach captures the costs which an efficient operator would have if it had the chance to build a completely new network. Due to the unrealistic assumption that all locations (for switches and duct and cables) are equally eligible, such a model does not answer the question of which costs will arise in the future for the maintenance of real-asset values in an efficient network, since costs are calculated for an optimal network which cannot in reality be built.

If a combination of the above approaches is chosen, it is possible to arrive at costs which very closely reflect those of an efficient network operator. This hybrid approach involves taking the existing network of the firm with significant market power as the starting point (scorched node approach) and attempting to eliminate inefficiencies in the network architecture (e.g. via a reduction in the number of switches and a check on the importance of existing hierarchical levels. This approach is based on the existing network and possible efficiency improvements and is therefore implementable.

The basis for sizing the network is the required capacity for supplying demand. An important question in relation to this is to what extent excess capacity should be allowed to enter the calculation of interconnection fees.

In principle the building up of excess capacity in an efficient network should be avoided. However, since demand and therefore the full utilisation of the network cannot be strictly predicted, a certain amount of excess capacity is required to guarantee a high quality of service. Therefore this technically important excess capacity is to be taken into consideration.

Excessive capacity in an existing network, which could, for example, have been caused by misplanning, cannot be part of an efficient network and therefore cannot be included in calculations based on FL-LRAIC. This is also true for capacity or network elements which are not actively connected to the core network (e.g. dark fibre, network elements which are switched off).

4.5   Return on Investment

An efficient investment decision must take the opportunity cost of the equity capital employed into consideration. In determining the rate of return on the capital employed it is assumed that in a competitive situation, in the long-term, it is not possible to achieve higher rates of return than the opportunity cost of the capital employed.

The weighted average cost of capital (WACC) approach is suitable for taking risk and the market rate of return on capital employed into account. The calculation of a suitable rate of return is done by means of the capital asset pricing model (CAPM).

This method takes

- Capital structure,
- risk,
- interest rates on borrowed capital and
- return on investment

into account. Since no empirical data with respect to investment risk for listed Austrian telecommunications companies exists, it is necessary to compare international benchmarks with Austrian empirical data in order to calculate objective and transparent rates of return.

Capital cost for operators should include opportunity cost for investment in network components and related assets, Traditionally these are:

- the weighted average cost of borrowed capital for the operator with significant market power,

- return on investment measured by the dividends which have to be offered to shareholders for them to provide capital for investment in the network considering the risk involved and

- the ratio of equity and borrowed capital.

Consequently, the WACC is calculated as follows:

$$WACC = r_e \cdot E/(D+E) + r_d \cdot D/(D+E)$$

where r_e is the cost of equity capital, r_d is the cost of borrowed capital, E is the total equity capital needed for operational purposes and D is the total borrowed capital needed for operational purposes.

Determining the cost of borrowed capital is not normally a problem since the weighted average cost of borrowed capital r_d of a firm is known. This is different when estimating the cost of equity capital r_e because it is affected by risk. The CAPM (capital asset pricing model) can be used to estimate r_e :

$$r_e = r_f + \beta(r_m - r_f)$$

where r_e is the cost of equity capital ,

r_f is the risk-free rate of interest ,

$r_m - r_f$ is the risk premium for investment in a non-risk-free firm and

β is a factor comparing individual risk of investment with the overall stock market risk.

Since the risk for certain products or groups of products can be different to the average risk of the remaining products, different values for beta can result in different equity capital cost, given that the overall financial structure remains the same. This means that the return on investment does not have to be the same for all products. In this case it would be possible to obtain a different WACC for different business activities.

The amount of necessary operating capital depends on whether valuation is carried out according to historic or replacement cost. Since efficient operators in a competitive environment have to base their decisions on replacement cost, the necessary operating capital is also dependent on replacement cost. It is therefore the best basis for the approximation of economically efficient opportunity cost.

4.6 Depreciation

Due to the capital-intensive nature of telecommunications networks, depreciation plays a significant role. The most important factors influencing decrease in value are wear and tear through usage and the shortening of theoretical asset life through the development of newer, more efficient technologies.

In order to provide incentives for expansion investment, efficient depreciation must allow for a firm to recoup the cost of investment during the economic life of an asset. What makes telecommunications unusual is that in this a dynamic market replacement cost for some categories of assets sinks very fast due to rapid technological development.

The way that the decrease in value due to rapidly changing technologies affects costs is dependent on how it is written off. If the decrease in value is directly reflected in depreciations, the amount depreciated is the sum of wear and tear and a drop in price - given an efficient level of investment in assets.

To calculate the actual loss in value and therefore the depreciation of total fixed assets, it would be necessary to have, at any given time, the data on current and future replacement cost, the actual asset life, utilisation from past and future periods and the revenues and costs of assets at the end of their life span. Since in reality this data is not available in sufficient amounts, calculating depreciation is simplified.

For example, for certain network components we can assume linear depreciation and replace cost that decreases yearly by a constant factor. Furthermore, sales revenues or dismantling costs at the end of the asset life should only be taken into account if this markedly affects the depreciation.

4.7 Mark-up

Interconnection fees solely based on FL-LRAIC would not be sufficient to cover a firm's joint and overhead costs. Since even an efficient firm must include joint and overhead costs in tariffs in order to survive in the long run, mark-ups have to be added to the FL-LRAIC. Mark-ups are usually given as a percentage of FL-LRAIC.

Wherever possible, in accordance with the principle of cost causation, joint and overhead costs should be appropriately attributed to products or services. When a transparent allocation base is lacking, remaining joint and overhead costs form the basis for the calculation of mark-ups.

Special difficulties are posed by the fact that a firm with significant market power has, in addition to products which are subject to price regulation (e.g. interconnection), other spheres of activity which are not regulated (e.g. end user equipment rentals). When allocating joint and overhead costs care must be taken that no unjustified transfer of cost from unregulated spheres to regulated ones takes place.

The basis for the level of joint and overhead costs are the unavoidable costs of an efficient operator in the period under review. Therefore these costs are also valued according to replacement cost.

There are several methods for allocating mark-ups to individual products or services:

Uniform mark-up: The mark-up is the same for all products and services. The information requirements for this approach are small, which makes it the easiest one to implement in practice.

Mark-up according to the efficient component pricing rule (ECPR): This mark-up is based on the opportunity costs of a firm with significant market power. These costs are based on subscriber tariffs for the product or service in question.

Mark-up based on Ramsey Pricing: The mark-up is in inverse proportion to the price elasticity of demand for the product or service. Since a dynamic telecommunications market makes it difficult to measure price elasticities, this approach is difficult to implement.

Limited Mark-up: Only the absolute floors and ceilings for allocating joint and overhead costs are set. Within these limits the firm with significant market power can set its own mark-up for each product or service.

4.8 Methods for the Determination of FL-LRAIC

Depending on the chosen assumptions regarding network topology (see 4.4) there are several ways of determining FL-LRAIC. In general cost models are used which reduce the complex production processes of telecommunications products and services to a manageable number of relations between factors of production and services offered.

4.8.1 Top Down Approach

In this modelling approach the existing network is the starting point from which an attempt is made to find the most accurate mapping of cost centres, costed units of output, and activity-based allocations. This is based on available accounting and cost accounting information. The top down approach eliminates all costs not relevant for interconnection (costs not directly attributable to interconnection, obsolete infrastructure, excess capacity and inefficiencies. A good top down approach should enable a firm with

significant market power to calculate and document the costs incurred in efficiently responding to demand for call handling capacity. This should also include possible future (forward looking) supply and demand.

Since this approach is based on actual costs and all the costs are activity-based, given appropriate transparency and objectivity, it provides a good benchmark for the level of FL-LRAIC. If, however, existing inefficiencies are not eliminated from the model, FL-LRAIC will be over-estimated. Perhaps there are more assets than required, or the network architecture is less than optimal. The introduction of an economic-engineering bottom up model will provide more information about these inefficiencies.

A fully detailed top down approach which takes many cost centres and dependencies into consideration results in a very complex and opaque model. On the other hand, simplifications and reductions in complexity have the built-in danger that the principle of causation may be violated.

4.8.2   Bottom Up Approach

Bottom up cost models are an attempt to determine analytically which network components are necessary to efficiently satisfy a given demand. For this approach it is necessary to build a complex technical model of an optimal network that includes number, type and location of network nodes, as well as switching and transmission technologies for the access and core networks. After modelling, cost is allocated to individual network elements. Since all cost necessary for the provision of the service is taken into account, FL-LRAIC can be approximated.

This model has to be based on considerable simplifications since it would not be possible in practice to build a model for a network covering the whole of Austria down to each individual household. An important success factor for this modelling is the availability of data. A pre-condition is that the appropriate data on call behaviour and demand are available from the firm with significant market power. This data forms the framework for designing the network. Realistic replacement cost has to be be incorporated into the model during the modelling process. This replacement cost should be provided by market players.

Due to its lack of complexity this approach is more transparent and easier to make objective than a top down approach. It is partially based on an existing network (e.g. the location of switching centres). The more realistic and finer the modelling is, and the more reliable and exact the inputs and assumptions regarding the network structure, replacement cost and operating cost, the more meaningful such a model will be.

4.8.3   Hybrid model based on Top Down and Bottom Up Approaches

By contrasting the results of the top down and bottom up models approximate values for the FL-LRAIC of an efficient network can be determined. The bottom up model is refined by means of the results of the top down model and various assumptions about the inputs are double-checked. It is also possible to check the plausibility of some of the results of the top down model using the bottom up model.

This combined approach gives the best approximation of FL-LRAIC. It is, however, the most difficult to implement since it presupposes existing top down and bottom up modelling.

5   Glossary

Directly attributable costs: costs where there is a direct connection between a cost driver and the level of cost (e.g. the direct connection between call minutes and the call handling capacity of a switch). Directly attributable costs are those costs which can be directly and unambiguously related to a service or product.

Indirectly attributable costs: costs attributed which are attributed over one or more intermediate cost-volume relationships to a product. For example, maintenance costs are dependent on the number of switches. The number of switches is in turn directly dependent on the number of call minutes. Therefore the

maintenance costs are indirectly dependent on the number of call minutes. Indirectly attributable costs are those costs which, based on their relationship to directly attributable costs, can be related to a service or product on a non-arbitrary basis (e.g. by applying capacity utilisation rates to every usage of joint resources).

Overhead costs: costs which cannot be allocated to products because there is no activity-based connection.

Joint costs: costs which arise from the joint utilisation of two or more products and cannot therefore be allocated to one product.

Marginal costs, MC: costs measured according to an increment or decrement in quantity of one unit of production.