QUESTION 12/1

Tariff policies, tariff models and methods of determining the cost of national telecommunication services

ITU-D STUDY GROUP 1 2nd STUDY PERIOD (1998-2002)

Final Report

Telecommunication Development Bureau (BDT)

International Telecommunication Union

THE STUDY GROUPS OF ITU-D

The ITU-D Study Groups were set up in accordance with Resolutions 2 of the World Telecommunication Development Conference (WTDC) held in Buenos Aires, Argentina, in 1994. For the period 1998-2002, Study Group 1 is entrusted with the study of eleven Questions in the field of telecommunication development strategies and policies. Study Group 2 is entrusted with the study of seven Questions in the field of development and management of telecommunication services and networks. For this period, in order to respond as quickly as possible to the concerns of developing countries, instead of being approved during the WTDC, the output of each Question is published as and when it is ready.

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FINAL REPORT

1 Introduction

The level and structure of telecommunication tariffs have an important role to play, at least in creating internally generated funds which in most cases are ploughed back into telecommunication entities' development programmes and also used in meeting their recurrent expenditure requirements. Tariffs can also promote efficient use of the network and services, enhance universal service provision and generate multiplier effects in the rest of the economy, since telecommunications are a commercial service which facilitates economic and social development. The role of tariffs could be enhanced by various countries putting into place appropriate telecommunication tariffs.

Current trends in technology and commerce, and changes in the telecommunication environment are having major repercussions on telecommunication tariffs, with the gradual opening up to competition of the telecommunication sector being set to oblige incumbent operators to develop tariff policies which take greater account of the actual costs of providing telecommunication services at both national and international levels.

Cost-orientated tariff-setting has become a prerequisite for durably enhancing the role of telecommunication tariffs for the sustainable development of telecommunications.

Many developing countries lack adequate experience and skills in formulating cost-orientated tariffs to enable them to benefit fully from telecommunication tariff policies, strategies and practices.

Developing countries therefore need assistance in formulating cost-orientated tariff levels and structures for terrestrial-, space- and submarine-based telecommunication services including accounting and settlement rates, and transit and interconnection charges.

They will need methods and tools for determining and calculating costs, in the context of the stage-by-stage implementation of analytical accounting systems similar to those developed by operators in the industrialized countries.

The use of these tools will be supplemented by an analysis of tariff models in order to assess the conditions in which gradual implementation of a tariff restructuring and rebalancing policy might be both desirable and feasible.

2 Definitions

At the request of the Rapporteur's Group, Working Party 2/3 of ITU-T Study Group 3 spelt out the following concepts:

- **Cost methodology**: This concept is not normally used.
- **Methods of calculating costs**: This refers to the actual computational steps needed for obtaining cost figures, such as converting investment outlays into annualized cost figures with the help of depreciation rates and interest rates, or determining the shares of the cost of a centre of operations to be charged to different services, on the basis of information about that operation's cost drivers. The way in which the methods are applied, e.g. the type of depreciation system used, whether assets are valued at historic or current prices, etc., then determines the approach followed.
- **Cost models**: The concrete implementation (on a spreadsheet, for example) of a particular "method for calculating costs". Given the raw cost data (prices of capital goods, values of depreciation rates and interest rates, values of cost-driver coefficients assigning shares of the total cost of an operation to different uses), the model produces the cost figure for a particular service, for example, at the push of a button. The "cost model" is thus the tool of the cost analyst who is using a particular "method of calculating costs".

- **Transparency**: The publication of all administrative measures of general application affecting access to or operation of the telecommunication market, including: tariffs and other terms and conditions of service; specifications of technical interfaces with such networks and services; information on bodies responsible for the preparation and adoption of standards affecting such access and use; conditions applying to attachment of terminal or other equipment; notifications, registrations or licensing requirements, if any, except where disclosure would harm legitimate commercial interests of particular enterprises.

- **Non-discrimination**: The application of no less favourable administrative treatment to any service or service supplier than those accorded to other services or service suppliers for the provision of like services.

3 Current situation

In the vast majority of countries, gradual market liberalization is under way. The combination of competition and technological development is endangering incumbent operators' ability to sustain their resources, since in some cases between 50 and 70 per cent of an operator's turnover is represented by income derived from international traffic and income from international accounting settlements.

Most countries are now aware of this phenomenon and are planning to compensate for the shortfall in resources on international communications by lowering their international tariffs and re-evaluating their domestic tariffs, or taking measures to stimulate national traffic.

During the meeting of the Working Party on Question 12/1 which was held in Geneva on 1 and 2 March 1999, the participants stressed the need for information on tariff models and methods of determining the cost of national telecommunication services. To that end, it was decided to send a questionnaire on tariffs, within the framework of Question 12/1, to all the administrations of ITU Member States and to Development Sector Members, in response to which a total of 88 replies were received.

3.1 Analysis of the current situation: results of the questionnaire

The following brief conclusions can be drawn from a study of the replies.

It emerged that the administrations of countries having both a high teledensity and high income levels (in terms of GDP) are also those which most commonly use specific methods to calculate national communication costs, as is the case in the most developed countries. The higher the teledensity, the greater the use of cost calculation methods.

In general, the calculation of national communication costs is much less systematic in developing countries than in developed countries. A significant number of the replies received do not appear to distinguish between costs and tariffs. Where administrations state that they calculate costs, the proportion of them basing the process on a cost model rises in line with the country's level of development. However, administrations of countries with a teledensity between 5 and 10 are found to be strongly in favour of using cost models.

3.1.1 Existence of methods for calculating national communication costs

3.1.2 Use of a cost model

Of those administrations which responded to the questionnaire, only 51 per cent used a cost model and, as in the case of the previous question, it was those countries with a high teledensity that were also found to have the highest rate of use of a cost model. In the breakdown according to GDP, it is at the "high income" level

that use is most commonly made of a cost model. However, a positive trend can be seen at the "middle low income" level. In the breakdown by region, it emerges that Europe is at the forefront, followed by Asia-Oceania, and that use of a cost model is more common in the Americas Region than in the Africa Region.

More and more countries are using cost accounting data to calculate their costs; here again, however, this trend would appear to be concomitant with the level of development of the country. The fully distributed costs (FDC) concept is widely used (with or without activity-based costing (ABC)), irrespective of the level of development. The number of administrations stating that they use the long run incremental costing (LRIC) concept increases according to the level of development. It can also be seen that some developed countries use the current cost accounting (CCA) concept. Western Europe and Asia, however, have a considerable lead on the other regions. For the most part, the allocation of common costs is still based on conventional methods, irrespective of the level of development.

3.1.3 Existence of a plan for tariff rebalancing

A very positive trend towards the adoption of tariff rebalancing can be seen for all the countries, particularly those in Asia-Oceania, although the administrations of countries having a teledensity between 10 and 20 still remain somewhat behind with respect to this type of plan. The most widespread method used for tariff rebalancing seems to be the gradual reduction of the access deficit. In developed countries that have not yet completely rebalanced their tariffs, the level at which the monthly fee is set is the primary means of controlling the process. The role of the regulator in the homologation of tariffs (45 per cent) is predominant. This predominance grows with the level of development of the country. It should be noted the emergence of approval on simple notification in markets open to competition. On the other hand, the homologation of tariffs by the Supervisory Ministry (16 per cent) and by Governmental Act (15 per cent) remains largely practised.

3.1.4 Taking into account of inflation and currency devaluation

A significant 58 per cent of the total number of administrations state that they take inflation and currency devaluation into account in their calculation of costs. A positive trend emerges where inflation and devaluation are taken into account according to the GDP of the country of origin. However, the countries of Central Europe lag slightly behind.

3.1.5 Use of universal service financing arrangements

It emerges that one quarter of administrations apply universal service financing arrangements. Of these, only the ones with a high teledensity had higher percentages. It is, however, noteworthy that the countries of the Africa Region are currently endeavouring to improve their situation.

In general, the percentage remains very low worldwide, although the use of such arrangements increases with the level of income. No marked trends really emerge from the replies received. Although a few administrations state that they have a universal service financing policy based on cross subsidies, the establishment of a universal service fund is still rare. Only Western Europe appears to be moving towards financing by interconnection charges, either in conjunction with a fund or otherwise.

3.1.6 Use of time bands for charging

Most administrations (88 per cent) apply time bands for charging.

3.1.7 Existence of tariff zones

In 89 per cent of cases, administrations use clearly defined tariff zones. In some cases, however, there are no tariff zones owing to the size of the country (small Caribbean islands). Administrations have generally adopted a two-zone tariff division. Developing countries often have more than three *zones.*

3.1.8 Application of interconnection charges

It is the administrations with a high level of income that most commonly apply interconnection charges (Europe Region). The other administrations show a certain stability, with the tendency being for the application of charges to increase in line with teledensity. In the breakdown by region, it is noteworthy that Africa and America have the lowest percentages, the majority of their countries being currently engaged in the process of establishing interconnection policies and costing methods. It also emerges that in some countries interconnection charges are particularly applied to cellular services and the Internet.

If we now look at the situation of those countries that have rebalanced their tariffs, we see that they have at the same time succeeded in stimulating their market.

3.2 General evolution of tariff structures

3.2.1 In countries with liberalized telecommunication markets, prices are based on costs

A provider of telecommunication services requiring special network access will purchase intermediate inputs from another company. It is clear that new network operators and other service providers will be reliant on such inputs from the incumbent operator to a significant extent. This is particularly true in the local loop, as building an alternate network here, delivering calls on the last mile, would take considerable time and would not always make economic sense.

The possibility of purchasing intermediate inputs at cost-orientated prices is designed to ensure that new providers are not unreasonably hampered in their competitive opportunities through a lack of network infrastructure of their own. Where such input is not offered within a competitive framework, regulatory rulings must create a situation mimicking the workings of a competitive market. Hence costs and prices should comply with competitive criteria. This ensures that new infrastructure will only be built where services can then be provided at lower cost than on the basis of the existing network. An economically inefficient bypass of the facilities of the incumbent will be avoided. At the same time, rigorous cost orientation will guarantee that new competitors' service offers are not subsidized by the incumbent provider. Such subsidizing would then also lessen the incentive for new operators to invest in their own infrastructure in cases where this promised efficiency gains, in dynamic terms at least. Cost-orientated price regulation within the meaning of this costing approach provides incentives for a regulated network operator to produce efficiently.

The great relevance of interconnection charges to players' costs and revenues and to the evolving dynamics of competition requires the regulator to find a benchmark with reference to which these charges can be determined, i.e. the cost statements appraised, and which, on account of its simple, clear structure, makes rulings transparent and verifiable in order thus to achieve broad acceptance for them, at least with regard to how they have come about.

Costs of efficient service provision can first be established, as a general rule, with reference to business accounting. The advantage of this approach is that data are, in principle, available and complete. Problematic, however, is the historical base of cost-accounting data that we observe in many areas and that may run counter to the cost efficiency sought, as it is not certain whether the particular company has produced efficiently in the past. Where appropriate, the cost-accounting data should be adjusted for inefficiencies. Costs must also be allocated on the principle of causation, where reasonable. Such allocation presupposes the use of activity-based costing, a method that appears suitable primarily in divisions requiring large numbers of staff. Only the so-called non-volume-sensitive common costs that can no longer be allocated should and must be apportioned to the individual products by means of other methods.

From the regulatory point of view, a valuation procedure based solely on cost-accounting data is problematic, not least because the decisions can only be publicly substantiated to a very limited extent, given the high sensitivity of the data submitted.

Interconnection costs are primarily determined by the capital costs of the fixed assets and related operating costs. Analytical models by means of which network operation is replicated and the costs of individual services or network elements are identified can be used as well as conventional cost accounting to establish these costs, and generally to support telecommunication companies' financial and product strategic policy. Such models are also a useful tool for the regulatory authority in preparing and substantiating its rulings.

3.2.2 Tariff rebalancing is therefore a necessity

Tariff rebalancing is a necessity for all governments and operators. There are three main reasons for this:

- In a monopoly, telephone service tariff structures (installation costs, subscription charges, local, long-distance and international call prices) are generally designed to meet policy and financial considerations. A typical feature is major cross-subsidization between services, with little account being taken of real costs.

- Technological advances and the development of new international calling procedures (such as callback and refile).

- The gradual liberalization of telecommunication markets and private sector acquisition of incumbent operator capital.

Countries which have implemented a tariff rebalancing policy have systematically orientated tariffs for various basic services towards costs by abolishing any tariff averaging at national level.

In order to enable the maximum number of people to telephone, some countries have included the offer of specific services in the definition of universal service, within the context of tariff rebalancing.

In the case of the European Union, for example, universal service includes basic telephony, public phone booths, operator assistance, information services, access to the emergency services and services for the disabled. Operators responsible for universal service are obliged to provide this set minimum service, at a reasonable price and irrespective of the location of the user.

As regards the arrangements for funding this universal service, a number of options are offered to governments and to the European regulatory authorities, namely:

- no particular financing if the deficit incurred by the operator is very small or offset by profits;

- funding by the State;

- the application of an additional access charge on top of interconnection tariffs;

- the use of a universal service fund or clearing house at national level.

3.2.3 The case of France

In general, tariff structures have evolved along similar lines in the different countries of the European Union. The case of France, in respect of which a certain amount of significant data are available, has been chosen as an example.

Telecommunication tariffs in France have been falling constantly since 1987, with the trend sharpening since 1995.

3.2.3.1 Fixed telephony

Between 1996 and 1998, retail tariffs dropped by 11 per cent while business tariffs fell by 26 per cent in constant francs over the same period.

This change comprises two contrasting developments. The subscription has been progressively re-evaluated to reach a balance price – a target specified by the law of July 1996 and set by a group of independent experts – of FRF 65 exclusive of tax.

Successive reductions in call charges have more than made up for the increase in subscription. France Telecom cut its long-distance and international call charges by over 20 per cent in 1997, and by 15 per cent in 1999. In April 2000, the company reduced its tariffs for long-distance and international communications by around 20 per cent.

In addition, a wider range of services has been available to consumers since 1 January 1998, at particularly attractive rates, offered also by new operators. Competition has increased in particular in long-distance and international telephony.

3.2.3.2 Mobile telephony

Mobile tariffs have also evolved in a manner extremely favourable to consumers since 1996. This phenomenon gathered pace in 1998: in the first half of the year alone, average prices paid by residential subscribers fell by between 5 to 13 per cent according to the category of user. The intense competition between the three operators (France Telecom Mobiles, SFR and Bouygues Telecom) has also led to the emergence of a very broad portfolio of services on offer, tailored to needs expressed by the clientele. Prepaid cards and flat-rate offers have proliferated, in line with the very sharp growth in the market.

3.2.3.3 Universal service

As regards universal service, it is defined in France by the Act regulating telecommunications of July 1996 as a quality telephone service at an affordable price. It includes the routing of telephone calls to and from subscribers, the provision of an information service and a directory as well as telephone booths nationwide. France Telecom is the public operator responsible for providing universal service. Universal service tariffs are subject to approval by the minister responsible for telecommunications.

To offset the net costs of universal service, France has set up a specific fund fed by contributions from operators in proportion to their market share. The costs of universal service comprise three components:

- a component linked to the imbalance of the France Telecom tariff structure between subscription and calls, fully absorbed in 1999;
- a social component;
- a geographic component, linked to national and regional development objectives.

For 1999, the net cost of universal service was put at FRF 2.9 billion by ART, the telecommunication regulatory authority.

4 Methods of calculating costs

In all cases, there are several requirements that methods of cost compilation should fulfil:

- transparency;
- objectivity;
- practicability;
- the principle of cost causality, which calls for a clear cause-and-effect relationship to be established between service delivery and network elements on the one hand and underlying cost determinants on the other;
- the need for cost recovery, which derives from the fact that every firm needs to recover all of its costs, in particular also its common costs, in order to be viable in the long run.

4.1 Cost concepts

Differences regarding costing depend to a large degree on differences of opinion as to what is to be achieved by the exercise and what concepts are best suited for the purpose. There are those wanting information on costs that allow successful and efficient pricing in a competitive market, and those that want cost information for the formation of prices that assure recovery of all relevant costs. Given those differences regarding purpose, one should not expect to overcome the differences arising out of the differing preferences by a mere reference to some magic wand called "methodology".

4.1.1 Fully distributed and incremental costs

Economic discussions and also regulatory decisions in the last years in the area of cost-orientated pricing in telecommunications have shown that two cost concepts are in the centre of interest: incremental costs and fully distributed costs. These concepts serve different purposes and are, therefore, used in different contexts.

4.1.1.1 Incremental costs (IC)

The cost of an increment or the incremental cost is the change in cost caused by any change in output, holding constant the remaining output of the firm. It comprises all the costs directly or indirectly attributable to the increment, including those arising as a result of indivisibilities in producing the increment. Non-attributable common costs – costs where no causal relationship to the product is observable – are not taken into account. However, this does not mean that these costs should not be covered; it should just be borne in mind that they are not part of the incremental costs and should be identified separately. According to the concept presented here, coverage of these common costs is assured by a mark-up on the IC.

The incremental costs of a production unit – the "average incremental costs" – are obtained by simply dividing the cost of the increment by the number of units. The concept of "average incremental cost" is to be distinguished from the "marginal cost" concept frequently used in general economic theory. The incremental cost concept is the more relevant one as it is usually a question of determining the cost of a whole service relative to the situation in which this service is not supplied.

The IC concept has recently undergone a change in that it now differentiates between "total service" and "total element" IC. The first measures the increment in cost occurring when offering a complete service in addition to other services in the portfolio of the firm. In contrast, the latter refers to the increment in cost that is caused by identifiable elements that are needed in the production of a service, like switching, transmission between switching centres, or some advanced function implemented in the switch. In telecommunications the total element approach is of higher relevance as it leads to the proper assessment of all the network elements necessary for the provision of the service in question, here the international telephone service, where account is taken of the fact that some of the relevant network elements are also used for other traffic.

In a competitive environment, incremental cost is the measure that a company uses in deciding whether or not to offer a particular service in the marketplace, i.e. it serves as a lower bound for pricing decisions. By covering at least this cost, it is guaranteed that the firm does not incur a loss from offering the service in question. In markets where competition is either non-existent or weak, the IC concept can serve as an as-if competitive standard for the purpose of price regulation. As a suitable method for the derivation of IC, the activity-based costing (ABC) approach is described below.

4.1.1.2 Fully distributed costs (FDC)

This cost concept provides for an exhaustive allocation of all costs of the firm to the services provided. The resulting FDC data generally include the costs directly and indirectly attributable to a service, plus a share of those costs with no causal relationship to the service, i.e. non-attributable common costs. The methods for allocation of the indirect costs and overheads are supposed to be causally related, but in practice arbitrary allocations prevail. The most common methods adopted in practice are:

- The "relative output method" (ROM) where costs are allocated to services in proportion to their share of total output. This method is only possible when all outputs can be expressed in terms of a common physical unit.

- The "gross revenue method" (GRM) where costs are allocated to services in proportion to their share of firm revenue.

- The "net revenue method" (NRM) where costs are allocated to each service in proportion to its contribution to net revenue.

- The "attributable cost method" (ACM) where costs are allocated to each service in proportion to the directly attributable costs of the service.

The use of the FDC method in pricing and regulatory decisions has been widely criticized. The main arguments can be summarized as follows:

- The arbitrariness of cost allocations underlying the FDC data makes them unsuitable for pricing decisions.

- When GRM or NRM are applied as allocation methods, the use of costs of service to set prices involves a circular argument as these methods are based on revenue.

- It can be shown that a profitable multi-product firm may become unprofitable when it withdraws a product from the market whose fully distributed costs are higher than the revenue generated by this product.

Given these weaknesses, the continuing use of the FDC standard can be explained by the circumstance that in the industries in question the pressures of competition are not yet sufficiently great to force it to be phased out. As long as low competition allows one to rely on FDC-based prices, it guarantees coverage of the total costs of the firm.

4.1.1.3 Conclusion

The two costing concepts presented serve different purposes from a managerial and also from a regulatory point of view. It depends on the market structure whether one is forced to use the one or may be allowed to rely on the other. In the past, when on most telecommunication markets there was no competition, use of the FDC concept was predominant.

During the past 10 to 20 years, in which telecommunication markets have increasingly been opened up to competition, the incremental cost concept clearly gained in relevance. Telecommunication operators have been forced to apply the concept in pricing decisions, because of emerging competitive pressure or due to regulatory provisions in cases where market forces are still insufficiently developed.

4.1.2 Historical and current cost accounting

The costing systems of telecommunication operators, like those of companies in other industries, have generally been based on historical prices of the inputs used in the production process. This is usually done in connection with an FDC approach. There are mainly two arguments for the use of historical cost data:

- The data are easily available as they are documented in the books and records of the operator.

- If the operator is in a market situation that allows it to base the prices of its products and services on historical cost data, it is able to ensure the recovery of its past expenditures.

In recent years the inadequacy of historical cost accounting (HCA) with regard to pricing decisions has increasingly been recognized by managers as well as regulators.

From management's point of view, HCA is becoming inappropriate as a basis for pricing decisions since telecommunication markets are increasingly subjected to competition. In the course of this process, incumbent network operators' dominant market positions are threatened and with that the ability to charge prices to cover all their revenue requirements. Suppose a new entrant provides the same services using modern equipment with much lower costs than the historical costs of the incumbent. The incumbent is then forced also to set prices on the basis of these current costs in order to maintain its competitive position.

From a regulatory point of view, HCA has become problematic for reasons that are closely related to the reasons that motivate management. In the case of services for which customers need the protection of the regulator, prices should also satisfy the competitive standard of efficiency. However, prices based on historical data do not satisfy this criterion. Only prices based on current cost data provide for efficient resource use as consumers are encouraged to take account of actual resource costs in their purchasing decisions.

As competition develops, there will be an increasing need for current cost accounting (CCA) instead of HCA. One can conclude that the advantages of CCA outweigh possible costs arising from the creation of the relevant databases.

4.1.3 Costs actually incurred and costs of efficient service provision

A further distinction with regard to cost concepts can be made with regard to the underlying efficiency standard. On the one hand, there are those costs which are actually incurred by the telecommunication operator. Especially in respect of incumbent operators we observe expenditures that are due to their past status of state-owned enterprises, expenditures resulting from specific regulatory provisions (e.g. a universal service obligation), or expenditures resulting from the investment history of the operator, as investment decisions were made at a date in the past where the most recent modern technology was not available. To some extent these expenditures will necessarily be inefficient and it is debatable whether these inefficient parts can be regarded as "costs" at all.

On the other hand, there are the costs of efficient service provision independent of actual imbedded costs. These costs imply an adaptation of costs to those on which competitors newly entering the market and using the newest technology would be able to base their prices. This cost concept corresponds to the standard of long-run incremental costs (LRIC) that we have met already. Competitive firms will effectively apply this standard by revaluing their stock of capital goods according to current prices, simultaneously also taking into account changes in their productive capacity.

In a world where telecommunication networks start from scratch, the relevant cost concept is that of "costs of efficient service provision". This especially holds under a regulatory point of view as these costs reflect the competitive standard. In a sub-optimal world, however, we are confronted with many constraints regarding this requirement. These constraints result from the fact that the networks of incumbent operators, which were developed in the past in a long gestation process, cannot be rebuilt from one day to the next, that it is difficult to forecast future demand exactly so that varying amounts of reserve capacities need to be taken into account, and that even new network operators do not always choose the newest technology in order to avoid the risks associated with the installation of possibly untested technology.

Therefore one usually deals with those constraints making some allowance for the investment path chosen in the past:

- One generally uses the convention that the standard of costs of efficient provision is adhered to although the locations of the network nodes are given by the existing network structure of the incumbent ("scorched node approach").

- Actual reserve capacity is taken into account to some extent.

- Cost calculation is based on the least-cost technology that is currently in actual use ("most recent employed technology") instead of the newest but not yet proven technology ("most recent available technology").

4.1.4 Activity-based costing (ABC) approach

In the telecommunication sector, large parts of the costs are not directly attributable to the services supplied (e.g. costs of integrated networks). Therefore, the need arises to attribute costs by indirect methods, avoiding the more or less arbitrary cost allocation methods. This requires a detailed analysis on the basis of which every cost component can be assigned to the products and services that generate it.

Activity-based costing (ABC) is the approach which largely meets this requirement. It differs from the traditional FDC approach in that it focuses primarily on the underlying activities required to produce products and services, rather than on the products and services themselves. So the ABC data are generally better capable of meeting information needs for the strategic decisions of an organization's management as well as those serving regulatory purposes.

According to the ABC method, costs are attributed to products and services on the basis of an analysis of the causes of those costs which are called cost drivers. Costs are traced and allocated on the basis of the activities performed for the products and services produced. So the ABC approach establishes a clear cause-and-effect relationship between activities performed, their associated costs, and the output resulting from those activities.

A step-by-step review of the functioning of an ABC system consists of the following essential measures:

- Identification of the products and services offered by the organization.

- An activity analysis to define the set of activities required to produce, market and deliver the product or service.

- Identification of the cost drivers which determine the level of costs incurred for the level of activities performed.

- Attribution of direct and indirect costs to the activities performed on the basis of consumption of these cost drivers.

- Linkage of activities and their attributed costs to products and services produced.

ABC systems provide not only the relevant information for pricing decisions, they are also an effective tool for the control of production processes and thereby for cost control. It is mainly for this reason that they are increasingly applied in the economy, i.e. to meet the demands of a vigorously competitive process.

Two concluding observations:

- The ABC approach fulfils the requirement that costs should be assigned to services on the basis of causality. This corresponds to the incremental cost concept, since costs would be allocated to the different services according to causality as much as possible. Carried to the farthest extent possible, only corporate overheads (for example, costs of general R and D, general lobbying activities, chairpersons' and presidents' offices) would not be allocated using this criterion. In this case, when all other costs are assigned to the various services on the basis of the ABC approach, we can say that the true incremental costs of the services are identified and, accordingly, that the difference between incremental and fully distributed costs is minimized.

- It follows from the above discussion that, in order to be able to face up to their future competitive environment, operators will need to install analytical costing systems of the ABC type for their own, and not only for regulatory, purposes.

4.2 The four existing regional cost models

The question of cost models has already been partially addressed, from the international standpoint, in the work of ITU-T Study Group 3, which deals, among other things, with international tariffs. For some years now, regional groups have been developing cost models geared to their situations.

4.2.1 TEUREM (Europe and the Mediterranean Basin)

According to the TEUREM approach, a recognized operating agency (ROA) determines the costs of international telecommunication service by distinguishing three basic elements: transmission as part of the international network, international exchanges, and the national extension which denotes the part of the national network of each terminal country involved in completing the connection.

In order to obtain the relevant investment costs of the reference year, the costs per item of equipment installed are updated by coefficients which take account of:

- The relationship between equipment installed and equipment in service, i.e. spare capacity, is considered.

- The annual rate of price changes, i.e. a move away from historical cost accounting, is intended.

- The composition of the standard network in order to represent technological differences between countries.

- The ratio "actual length/crowflight distance" of transmission facilities.

Annual costs for the transmission and switching parts of the network comprise financial charges representing amortization (depreciation plus return on invested capital) of the equipment, building costs (annual rental for the space occupied by an equipment), maintenance costs calculated per given equipment and operating costs (costs of staff responsible for operating a service). The other direct costs, e.g. attributable administrative costs identified in an ABC approach, are not considered. Traffic unit costs are calculated by dividing the total annual charges of the equipment by the average number of traffic units per year.

According to the TEUREM methodology two alternative methods for calculating average costs are recommended:

- In cases where individual equipments and the structure of the network are similar in the different countries, it is customary to compare the detailed numerical data provided by the ROAs and to calculate the costs for each element, step by step, according to the classical analytical method. This method is generally used for determining the average cost of the international part of a service.

- In cases where equipment and network structure differ considerably from one country to another, which holds especially for the national extension component, an estimate of the average cost of the national extension is obtained by applying a "simplified method". According to this method, the costs calculated for the respective countries are compared directly per traffic unit (minute) to one of the following elements or services: local or trunk exchange, a terminal transmission equipment, 100 km (crowflight) of national circuit, billing of subscribers, international accounting, management of international services.

The second method seems to be motivated by the concern of obtaining an accounting rate that expresses the cost for the whole connection between calling party in the originating country and receiving party in the country of destination. It aims at determining and analysing the cost differences of similar elements or services, between the two countries.

The TEUREM approach does not consider indirect or common costs such as administrative costs, R and D costs or taxes. Accordingly, it appears to be suited to the application of an LRIC plus common cost mark-up approach. Such an approach would, furthermore, leave some room for efficiency considerations to become part of the analysis.

4.2.2 TAS (Asia)

The TAS group cost model is a fully distributed cost (FDC) approach. In respect of international transmission and switching, the relevant network elements for the provision of international telephone service are identified: international exchange, earth station, cable station, etc. In respect of the national extension, the relevant cost is also discussed in terms of an element-oriented approach, i.e. broken down into costs of switching, transmission and local loop facilities. In the actual cost calculation, however, it appears as one lump sum or one per-minute charge. The cost of the local loop may be included in the national extension cost, if this is part of a bilateral or multilateral agreement.

The model derives the world average cost of the provision of international telephone service on a "bearer capacity basis", i.e. the total cost of the network element used for international transmission or switching is attributed to the telephone service according to the ratio of bearer capacity assigned to telephone service to bearer capacity assigned to all services. In cases where the information provided by the ROA is detailed enough, the cost can be calculated on a stream basis which means that country-specific costs are again derived on a bearer capacity basis, or on a stream number of circuits basis where the calculation is based on the number of circuits on the specific stream related to the number of circuits to the world.

The total facility, investment and operating costs of the network elements are given in one sum, i.e. it is not possible to identify the operating and maintenance cost component or to know whether other direct costs have been taken into account. Furthermore, no reference is made to the underlying depreciation rates, economic lifetime of installations or possible spare capacities.

The facility, i.e. investment and operating cost for international traffic installations, plus the rental and lease costs, plus the national extension cost, make up the total direct costs. General administrative costs and appropriate taxes are identified as indirect costs to be allocated to the international telephone service using an activity-based approach based on the size of the workforce or, in the absence of other more accurate

measurements, on the proportion of telephone direct cost in relation to total direct cost. It should be noted that, although ABC is referred to, the proportions of workforce size or the ratio of relevant to total direct costs do not appear to be representative of causal links that would be identified if a true ABC approach were used. Finally, other related costs are taken into account when they qualify for inclusion by bilateral agreement, e.g. direct and indirect R and D costs.

Adding direct, indirect and other related costs gives the total costs apportioned to international telephone service elements. Dividing these costs by the ROA's world incoming, outgoing and transiting traffic minutes generated for the same year, and adding per-minute costs, i.e. costs which are already expressed as a per-minute figure, produces the ROA's world average per-minute cost to terminate incoming international telephone traffic. On the basis of country-specific data or by bilateral agreement, according to which the world average cost can be adjusted for stream-specific characteristics, the country-specific cost figures are derived.

4.2.3 TAL (Latin America)

The costing approach of the TAL Group is identified as adapted fully distributed costing (AFDC). It is element-oriented and follows in this respect Recommendation D.140 in that it includes as elements international transmission, international switching and the national extension.

The national extension is divided into two components: access network (provision of access lines in the local network) and transport network (provision of switching and transmission facilities to enable call transport). The national extension does not seem to be sufficiently differentiated since national switching and transmission are not regarded separately. This would hold even more if, as is explicitly allowed for, the two components – access and transport – were to be bundled into one element.

The annual costs of each element consist of capital-related costs (depreciation, rate of return, effective income and property taxes) on a replacement cost basis and operating expense-related costs (maintenance, network administration, traffic, marketing and billing expenses). The latter are characterized as indirect expenses to be allocated using a suitable mechanism, e.g. activity-based costs, carrying charge factors or any other suitable method.

Furthermore, according to the TAL approach certain facility-based costs are also identified as indirect or common to network elements, as, for example, air-conditioning in a switch building or route structures used by different services. These costs should also be included under the direct category, as they can be attributed directly to the service elements according to a causal relationship, e.g. by usage factors.

Non-attributable overheads (indirect or common costs) are recorded as allocated administrative costs, allocated research and development costs and allocated tax costs. The first includes expenses related to executive management, planning, financial and human resource management, legal input and investment support charges such as expenses for land, building, furniture, office equipment and motor vehicles.

The proposed formula to determine the termination charge for one minute of (incoming) international telephone service contains two components not directly related to the actual cost of service provision:

- A term subtracted from the unit cost and representing the efficiency gains or a cost-lowering proxy based on forecast productivity over the period of estimation.

- A term added to the unit cost and representing the cost per minute of the universal service obligation (USO). It is supposed to include, *inter alia*, an access deficit contribution and expenditures associated with network expansion in uneconomic areas for countries with low teledensity levels. The USO component is derived from the projected cost of attaining the nationally prescribed level of teledensity in the following period divided by the expected incremental minutes, so it is not part of the current cost of the network elements.

The first of the above components recognizes that costs reflect inefficiencies that need correcting. It is in line with Recommendation D.140 according to which accounting rates should take cost trends into account. It is not quite clear, however, how the rate of reduction would actually have to be determined and when, using this rate, the cost level of efficient operation could expect to be reached.

As far as the second component is concerned, there is no discussion of how the amount of the USO is arrived at. It is simply referred to as one lump-sum figure so that it is not possible to identify which elements will be part of the planned network expansion. The figure is apparently the full cost of obtaining the addition in teledensity; i.e. it is the total investment cost involved in network expansion in uneconomic areas. Subscription and national call revenues (additional revenues from incoming and outgoing calls in the newly served areas) are not netted off to obtain the imputed loss to the local operator of the network expansion, with the result that some costs seem to be recovered twice.

4.2.4 TAF (Africa)

In determining the cost per minute of international calls, the following components are taken into account and are separately identified in the cost model:

- International transmission.
- International exchange (switching and transmission equipment).
- National extension.

In accordance with Recommendation D.140, an international call may also have a national transmission cost component. In addition, in every case, as provided for in Recommendation D.140, the land section separating an earth station or a landing station from the international switching centre forms part of the international transmission. As a rule, international links are set up by means of the following transmission media: radio-relay links, cables (coaxial land, optical fibre or submarine), and satellites. No distinction is made between these different media for determining the cost of international transmission. In allocating costs to the various services, account will be taken of frontier traffic wherever there is significant justification for doing so.

The TAF model offers members the possibility of determining in a fairly simple way the cost per minute of international automatic telephone call, distinguishing between the shares of the three components: international transmission, national switching and national extension.

The TAF model also offers an answer to the questions raised about a possible preponderance of international traffic to the national capital in view of the very high degree of centralization in African economies.

In view of the fact that cost accounting and other methods of allocating costs are still not well established in the region's administrations, the Group opted for a fully distributed cost model while awaiting the chance to develop other concepts during the next study period.

The TAF model charges directly to the telephone service as a whole all the charges which can be attributed to it with certainty (national switching, international switching, national transmission, international transmission and access network); however, if the different categories of telephone services are considered (local, national and international), the charges related to the network are common charges which are allocated in proportion to the traffic they each carry.

Common and indirect charges other than those relating to the network are attributed to the categories of telephone services in proportion to traffic, in the absence of any other more precise method of accounting used by the administration.

Due account is taken of the fact that certain indirect charges, such as those incurred for the invoicing of outgoing traffic, are charged exclusively to outgoing traffic (local, national and international outgoing), whereas other charges, such as those incurred in the recovery of payments due are charged as a whole to international incoming traffic.

To take account of variations in economies of scale in relation to the geographical location of investments and to eliminate the bias that would be introduced by a direct distribution of costs in relation to traffic, a geographical correction coefficient is introduced. This makes it possible to charge the right cost to each category of traffic.

The model takes into account the cost of the capital invested, which should not duplicate the financial costs. When the structure of the net fixed assets is known, those assets can be distributed among the different categories of telephone services on the basis of the cost distribution table and their cost to each service determined by application of the rate adopted to the resulting sum. Otherwise the distribution will be made directly in accordance with the relative volume of traffic of the service in question.

The TAF model can be applied with ease if the administration has at least a general accounting system that is in line with international practice. This should enable it to distinguish between the following cost elements applicable to the different network components (international transmission, international switching, national transmission, national switching and network access), including in each case, energy and building: depreciation costs; reserves to cover exchange rate losses for the renewal of equipment, if authorized by national legislation[1]; operating and maintenance costs; loan charges; taxes and levies on assets. As far as service management charges are concerned, the accounting system should make it possible to identify all *specific charges*. Nevertheless, when not all the cost information is directly identifiable by the general accounting system, the model will use the most recent budget to estimate the necessary distribution factors.

A knowledge of distribution by volume among the different categories of telephone traffic is essential for this model. The volume of international outgoing traffic is generally known, as is, to a lesser extent, that of incoming international traffic. The high degree of digitization in international transit exchanges means, however, that on the basis of local observations or in collaboration with the chief international correspondents, it is possible to find out the volume and destination of incoming international traffic.

Local and trunk traffic is not generally measured in minutes. Where that is possible, observations can be made (e.g. a "normal" full week) with a view to estimating annual volumes and their distribution. Where it is not possible to observe the traffic in minutes, it can be estimated on the basis of the invoicing data and statistics on the average duration of calls. It is also possible, in the absence of any other solution, to estimate the different kinds of traffic by volume on the basis of the national traffic matrix (in Erlangs).

5 Cost models

Having reviewed the main costing methods, it is now necessary to reflect on the best way of evaluating the cost of a given part of the network with its different components in practice.

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[1] When a currency is devalued, some national laws may authorize revaluation of assets in order to correct the initial depreciation, which would prevent replenishment of imported plant and equipment. The accounting technique usually used in such cases is a provision for replenishment on top of the depreciation, providing for the replacement of equipment by setting aside an appropriation equivalent to its future market price.

Ideally, all the following elements need to be included:

- existing sites;
- types of equipment (transmission, distribution, etc.);
- licences;
- charges.

For each item of equipment, it would be desirable to know:

- date of construction;
- cost of construction and installation;
- rental cost;
- operating cost (rental, human resources, operation, etc.).

Finally, it would be necessary to know how these elements are utilized and develop equipment utilization matrices by hours of operation and services.

Most of the time, this is totally impossible, since many of the elements needed for such a system are simply not available. One thus has to resort to determining the cost of a particular part of the network by estimation and approximation. Cost models reduce the complex process of producing telecommunication services to a manageable number of essential cost-determining relationships between the factors of production and the service offer.

Germany submitted an excellent document (Document 1/016) on an analytical cost model for the local network. This analysis corresponds to that country's characteristic network structure and usage. It is interesting to note that, in this modelling process, the perspective of an external observer is adopted in order to develop the basic relationships between input and output parameters that are relevant to local network costs. This approach allows model calculations to be made without necessarily having recourse to company-specific information, which may be useful for the regulator.

Thomson-CSF likewise submitted an excellent document on spectrum pricing (Document 1/129). This contribution is particularly relevant inasmuch as some countries have decided to put up for auction, or establish charges for, certain frequency bands in the radio spectrum, where the amounts in question could have an impact on service costs and hence on the tariffs proposed to customers.

Nevertheless, the developing countries will be able to draw a number of concepts from this document. For instance, in the light of Germany's experience, it appears to make particularly good sense to draw up a cost model in areas where a number of individual cases need to be analysed or where parameters such as return on investment, period of depreciation or extent of spare capacity must be investigated with a view to assessing their impact on the results.

5.1 Long-run incremental costs

Telecommunication tariffs are to be based on the cost of service provision, derived from the long-run incremental costs of providing service plus an appropriate mark-up for non-volume-sensitive common costs.

The benchmark for the long-run incremental costs is the measure a company applies in deciding whether or not to offer a particular service in the marketplace. It will make sense to do so when the costs incurred in the long run by the decision to provide the service are at least covered by the revenues achieved.

The costs of an increment are the costs a company incurs in providing a service in addition to a portfolio of other services. They include all the costs directly or indirectly allocable to the service, i.e. they also include those arising as a result of indivisibilities in producing the increment. Non-volume-sensitive common costs should appear in the form of appropriate mark-ups on the incremental costs in order to ascertain the total costs of the service portfolio.

The concept of the long term implies that companies are not subject to any restrictions imposed upon them, say, by irreversible past decisions on investments and hence capacity. Assuming workable competition, a company's pricing flexibility in a situation in which there was unrestricted access to the market would be constrained by the prices charged by a potential competitor that, by definition, was subject to no restrictions in its choice of production process and decisions on capacity.

Principles and conventions must be laid down as a basis for establishing the long-run incremental costs of providing services. These conventions address the network structure underpinning costing. This encompasses the type, number and location of concentrators and exchanges as well as the kind of transmission and access technologies. It also concerns questions of the valuation and depreciation of fixed assets, demand levels, use of spare capacity, and the relevant operating costs.

The telecommunication network is broken down into elements defined by the functionality provided, such as switching and transmission. Incremental costs are regarded as the costs of providing the entire network element quantity for which demand exists. Hence the costs of a network element are established as the difference between the costs of a network including the relevant element and those of a network not providing this element. Indivisibilities in providing the network element are therefore taken into account as a general rule, which is not the case with a marginal costs approach. The long-run average costs of provision of the increment are therefore established with reference to one unit of output of such an element.

Where use of the network elements by various services can be attributed to a common denominator, the incremental network element costs must be allocated to these services in the same way[2]. In this sense the long-run incremental costs of the network elements are the costs "common" to different services, but are not non-volume-sensitive common costs whose very distinguishing feature is that allocation by origin is not, in principle, possible.

Yet the existence of common costs at the network element level too cannot be ruled out. These include costs arising through the joint provision of several network elements. They could be the costs of a conduit system jointly used by feeder cables and junction cables.

In such cases, consideration should be given to whether a common measure of use cannot be found by means of which the costs can be allocated. This measure could be, for instance, the number of pipes used with reference to which the civil engineering costs are allocated to the network elements. Only when a common measure of use cannot be found or proves unmanageable should other allocation mechanisms be considered[3].

Only those costs that are not directly or indirectly – without unreasonable effort – allocable are apportioned to the network elements by means of mark-up rates or other methods.

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[2] For example, local and long-distance calls use a local exchange in fundamentally the same way: the incoming and outgoing interfaces to the access network and one channel are occupied. The number of busy-hour call minutes is therefore identified as a cost driver. By adopting the element-based approach it is possible not to consider the fixed costs caused by indivisibilities (e.g. costs of the central processing units) as being the common costs of several services, but as allocable network element costs that are allocated to the different services according to use at peak periods.

[3] A possible procedure for common costs allocation is the Shapley method, which can be used to obtain a distribution of the common costs thus incurred. The Shapley value is determined by adopting an approach in which the sequence of projects to be carried out is considered uncertain and hence probable. Regarded as projects in this connection are, say, setting up routes for various utility networks. Depending on the sequence in which projects are implemented, different allocable costs are incurred for the individual projects: if only two projects are executed, all the direct and common costs in their entirety are assigned to the project that was implemented first, whereas only the incremental costs are allocated to the subsequent project. All such allocable costs are established for each project, in every possible sequence. The Shapley value is the expected value for the costs allocable to a project in this way. It is a conceivable costs allocation mechanism in particular for all cases in which traditional common cost keys lack the basis of, say, roughly comparable output volumes.

5.2 Costing steps

Modelling begins with a definition of the nature and extent of all the services and facilities offered on the basis of the network infrastructure. In the local network these will be provision of subscriber lines, switching and transmission and, where appropriate, leased lines. The quantity to be provided is derived from the number of lines in the local network and from the resultant demand for telephone calls, each of which uses one switch at least. In many cases, transmission devices are also used in the local network.

For modelling purposes, a total of four parameters have to be identified: demand for subscriber lines; peak-hour traffic demand, including calls to and from interconnected networks; number of call attempts at peak times; and, possibly, number of lines leased in different sections of the network.

The next step identifies the investment volume required to build a local network infrastructure capable of satisfying demand. Account must be taken of both technical constraints and the efficient service provision requirement.

The investment volume identified is valued at the current prices of the capital goods. This reflects the calculations of a new entrant. For a company already operating in or about to operate in a competitive environment that has already taken investment decisions, the replacement cost is the parameter which it must use to value the productive capital employed in costing and cost-based pricing, if it is to compete successfully. Using current prices to establish a standard of valuation for the costs of efficient service provision will guarantee an economically efficient use of resources, especially because potential decisions on network-based market entry will not be distorted by different costing criteria from those providing and those requiring network access.

The investment values are converted into annualized costs. Account is taken of depreciation and expected return on productive capital employed and current operating costs. It will not be possible to avoid value judgements especially in fixing the depreciation periods and methods and appropriate returns on investment.

Annual costs are given for network elements such as subscriber lines, exchanges and transmission lines. Costs of conveyance, that is costs arising from the use of network elements dimensioned for expected traffic demand, are generated by keeping capacity available for peak loads. Hence initially, these costs can only be established as the annual costs of providing capacity, measured as the traffic volume handled, with a certain loss probability, in the busy hour on which the dimensioning is based (busy-hour erlangs).

The costs of interconnection result from the total costs of the network components used. Where appropriate, factors stating the statistical frequency with which a network element is used to provide a defined service should be applied. Costing is then performed in relation to one local network. Where average values are to be established at national level, the network element costs of the separate local networks must be averaged and weighted appropriately on the basis of subscriber statistics or traffic volumes.

5.3 Cost of capital

In order to determine the annual costs of providing the network elements, the cost of productive capital employed must first be established. The cost of capital is established in three stages. First, the productive capital is valued. The benchmark is the replacement cost of those capital goods that would have to be acquired in a forward-looking approach to provide the functionality of the network elements in question. The second stage specifies the depreciation periods and methods for various groups of assets. And finally, the expected return on capital employed must be established.

5.3.1 Valuation of capital goods

Essentially, two different approaches are put forward in response to the question of what basic value to apply in working out the cost of capital: first, the purchase cost or cost of production of the capital goods at the time of purchase (historical cost) and secondly, the replacement cost or market value as the price payable at the time of valuation (current cost) in order to replace the existing assets with ones of the same nature and quality, serving an equivalent function, in their new state, i.e. without consideration of the loss in value that has occurred.

As data on investment expenditure have generally been documented in the past in fixed-asset accounting, the historical cost approach is regarded as the easier of the two to carry out. This is also a fundamental reason why most established telecommunication companies still opt for this method.

However, valuing assets at historical cost is in clear contradiction to the approach regarded as appropriate in a competitive environment. Only costs that are established under forward-looking assumptions can provide a suitable basis for efficient pricing.

Application of the current cost principle is often seen as problematic when there is a decline in the price of the assets over time. This is observed with telecommunication systems in particular, which can rapidly become obsolete. The objection is made that companies must bear 100 per cent of the historical costs in money terms and that prices based on lower current values would not cover these costs. Yet this argument is only valid insofar as it is concerned with price changes that have not been anticipated. The decrease in value caused by anticipated price changes can be written into the annual depreciation by adding the loss in value caused by the price decline to the amount of depreciation calculated on the basis of the replacement cost. This yields, in each period, an amount of depreciation composed of the loss in value as a result of the time factor and the loss in value as a result of the price decline.

Only the efficient technologies among those currently deployed in production will be used to underpin costing. Normally, the current prices for these technologies should be available. Difficulties will occur in cases where the technology underlying the model's assumptions no longer has any place in future investments or is only considered for limited-scope reinvestment. It may be necessary here to establish current prices on the basis of replacement prices or to index the start-up installation prices[4].

5.3.2 Depreciation

In line with the provisions of fiscal and commercial law, companies mostly use the straight-line or the declining-balance method of depreciation in their fixed-asset accounting. Practicability then often dictates that the corresponding figures be used, unchanged, in costing; accordingly, there is no depreciation specifically for cost-accounting purposes, i.e. differing from book depreciation.

Besides the arguments of transparency and practicability cited above, another point in favour of applying straight-line depreciation to this model is that it closely approximates economic depreciation in practice. This is true when, as shown in the previous section, the current-cost principle is applied and changes in asset value resulting from price development are taken into account. Assuming that the procurement markets for telecommunication systems have largely competitive structures, we can then assume that the impact of the above factors on the net present value of an asset has been taken into at least approximate account in the

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4 This does not run counter to the efficiency requirement. For instance, PDH-based equipment was initially used for digital transmission technology. Meanwhile, network rollout and presumably reinvestment, too, when this affects a sufficiently large segment of the network, is effected with the more modern SDH technology. All the same, it is proposed that costing continue to be based on PDH technology for the offer of narrow-band services in the local area in the absence of proof of its inefficiency.

prices. Additionally, straight-line depreciation can be regarded as the average annual depreciation charge over the entire depreciation period. A generic model represents the "average" of a large number of local networks, so it is appropriate for the model to use the average depreciation charge for all local networks, irrespective of the particular depreciation method used.

If, following this approach, the assets are then valued according to the current-cost principle, the average will roughly match the depreciation charge produced by the straight-line method. This charge is presumed to have been adjusted by a figure reflecting the rate of price changes for the asset in question. Adjustment is downwards when the rate of price changes is positive and upwards when it is negative. Accommodating the rate of price changes in the depreciation charge accords with the use of a "real" rate of interest which is required when assets are valued at replacement costs. With a rising asset price the real rate of interest is lower than the nominal rate of interest, and with a falling price it is higher.

Accordingly we may conclude that straight-line depreciation based on replacement costs is adequate. This assessment is borne out by the findings of a comparative study by Oftel, in which use of the straight-line method was not found to produce any systematic bias.

5.3.3 Expected return on investment

Companies usually estimate the cost of interest on the capital tied up in the assets as a fictitious amount. This means that it is not the figures from financial accounting, i.e. the interest actually paid, that are used; rather, it is assumed that the entire corporate assets are financed by the entire equity and debt capital employed. This idea stems from an opportunity cost concept: although the company has no interest expense on equity employed, it should not be forgotten that it should generate at least an annual rate of return on an alternative investment outlet, so that the equity holders do not go elsewhere. The cost of capital is then derived from the weighted sum of the expected rate of return on equities (before corporate income tax) and the average interest rate on debt.

For some years now, preference has been given to the CAPM[5] to determine the expected rate of return, i.e. the interest rate on equity. Accordingly, the interest rate on equity results from the sum of risk-free interest rate and a risk mark-up. An alternative solution would be to determine the rate of return on equity on the basis of network operator information, i.e. international comparisons. The rate of return on a risk-free security of average maturity, e.g. federal loans with a life of four to six years, can serve as a basis for determining the average interest rate on debt.

The expected return on investment and the depreciation rate are converted into an annuity using the capital recovery factor. The expected return is estimated on the average capital tied up during the economic lifetime of the asset.

5.4 Asset-related operating costs

To be added to the direct capital costs of the stock of assets are the costs arising from the day-to-day operation of the telecommunication network (operations, administration, maintenance, ...). Use of factors set in relation to the investment amount can deliver reasonable approximations. They are derived by calculating the relationships between the company's fixed assets and its asset-related expenditure. Operating cost factors established in this way do not reflect any causal relationships, however; they are always historical and may contain operating inefficiencies.

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5 CAPM: Capital asset pricing model.

5.4.1 Activity-based costing

Deriving these costs on the basis of technical or economic causality, accords with the fundamental approach of analytical cost modelling. Proceeding thus allows the costs of efficient network operation to be established and to be allocated on the principle of causation via an analysis of the cost drivers.

The different processes taking place within a company will not always be available to the same degree for a detailed cost-driver analysis. In each case a trade-off must be considered between the costs of more precise cost allocation and the insights gained.

5.4.2 Historical costing

The pragmatic and easily available alternative lies in recourse to operators' past expenditure, as far as this is broken down into asset categories. This expenditure must then be set in relation to the fixed assets and incorporated in the model calculation as operating cost factors. In principle, the fixed assets can be valued at initial or replacement cost. As the model calculation is based on replacement costs, valuing the assets at current costs of modern equivalent assets (MEAs) makes good sense, provided the data available so permit.

Past operating costs, however, are caused by the historical stock of assets, which always covers a variety of degrees of obsolescence. Extrapolating these costs for future periods is therefore permissible only in the absence of better alternatives. On the one hand, technological advances in switching, say, tend to be accompanied by the replacement of operating costs in the form of payroll costs by investments in assets. Hence the operating costs required in the future in this and other areas will be lower than those of the past. On the other hand, however, we may expect, on balance, an increase in nominal operating costs in those areas in which the replacement of labour by capital proceeds more slowly. This applies, for instance, to buried cable infrastructure.

Yet prices for switching and transmission fall over time, whereas prices for cable installation tend to rise. These opposing trends would suggest that the relationship between fixed assets at historical costs and asset-related expenditure can be regarded as an acceptable approximation of forward-looking operating cost factors. One of the reasons for applying such factors to the replacement costs of MEAs is that replacement costs and forward-looking operating costs develop in proportion to one another.

5.5 General network architecture

5.5.1 Access network[6]

A basic cost driver is the demand for lines in their geographical spread. The average costs of a subscriber line in the local network are fundamentally affected by subscriber density. High subscriber density enables economies of density particularly in infrastructural terms; conduit systems and trenches can be well utilized and loop lengths to the first concentration point are relatively short. Precise costing presupposes knowledge of geographical line distribution at a heavily disaggregated level. Local networks with the same average subscriber density may show substantial differences in costs on account of different settlement patterns, for instance greater or lesser line concentration in centres of population.

Other factors affecting subscriber line costs are the prices of materials and civil engineering, i.e. the prices for various kinds of installation.

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6 The access network serves to provide transmission functionality between the terminal equipment and the termination point of the outside plant before the first concentration point, set-up either at a local exchange or at a remote concentrator unit.

The access network is decomposed horizontally into the distribution network and the feeder cable network. The feeder cable network terminates on the line side with the main distribution frame. The feeder-distribution interface separates the feeder cable and distribution networks. The distribution network can be broken down further into the distribution cable network in the strict sense and the drop segment. The interfaces here are taps in the distribution cable.

5.5.1.1 Distribution network[7]

Drops run from the subscriber distribution interface to the distribution cable, normally laid to follow the path of the street. Several drops are concentrated in a tap (sleeve) taking them on to the distribution cable. The distribution cables terminate at the feeder-distribution interface where they are connected to the feeder cable wires.

Critical factors for the level of costs in the distribution network are the type of installation (buried cable, underground cable, aerial cable), the average length of drop, the number of lines that can be accommodated in one drop and the kind of surface to be reconstructed in the case of underground installation. All the parameters cited can be determined at the local network level and additionally differentiated according to subscriber density in the distribution area into a current total of three categories representing rural, suburban and urban areas. Finally, spare capacity in the form of unused wire pairs must be taken into account. Also important is the degree to which there is shared use of drops, trenches and underground systems between distribution and other cables such as coaxial cables for cable TV. The potential for shared infrastructure use can currently be accommodated by price variations, for instance for civil engineering services.

5.5.1.2 Feeder cable network

The feeder-distribution interface and the main distribution frame are connected by feeder cable. Each main distribution frame with its associated feeder cable and distribution cable represents an access area. The basic cost factors correspond, with the exception of the drops, to those of the distribution area. Added to this is the fact that the entire length of the feeder cable network, unlike that of the distribution network, is determined by the location of the main distribution frames. Hence it is necessary to decide whether the locations (and the number of locations) should be determined, endogenous to the model, as the result of cost minimization rules or whether existing locations should instead provide the reference for the cost calculations. Both approaches can be followed.

5.5.2 Local exchange and remote concentrators

Feeder cables terminate in distribution frames from which the wire pairs are routed to the main distribution frame located at an exchange or a remote concentrator. The main distribution frame forms a cross-connection point connecting to the line cards, by means of junction cables, the wire pairs attached to the terminal equipment. The costs of the main distribution frame and the line cards can be fully allocated to the individual subscribers.

Call set-up takes place in the exchange. The signalling information is evaluated by one or more microprocessors, including control software. Here, the cost driver is not the expected holding time but the expected number of call attempts including those in which call set-up to the called party is not completed.

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[7] The distribution network refers to the connection between the general network termination point on or at the subscriber's premises in the form of the subscriber distribution interface and the nearest cross-connection point at the ground level feeder-distribution interface. The in-house cabling providing the connection between the subscriber distribution interface and the socket should be looked at separately.

The total costs of the switch are therefore determined by the number of subscribers connected and by the traffic these subscribers generate. Also relevant are the costs of housing, air-conditioning, power supply and installation structures that cannot be apportioned either directly or, in most cases, indirectly to the cost drivers cited. Equipment serving transmission purposes is also co-located with the local exchange or the remote concentrator unit. Hence these costs are not part of the long-run incremental costs of the given network elements. All the same, they should be taken into due account in the usage charges.

5.5.3 Transport between remote concentrator and local exchange

It is assumed that concentrator units dislocated from the exchange are connected to a local exchange in a star-shaped topology. Aside from the terminal equipment, i.e. multiplexers and optical line terminals, the structure of the transmission line in terms of outside plant has a bearing on the costs. What was said about the various sections of the access network also applies here with regard to the costs of civil engineering and possible apportionment between the network elements.

5.5.4 Switched transport between local exchange and long-distance exchange

It is assumed that incoming and outgoing long-distance traffic is routed within the local network together with local traffic, in shared transmission systems. The interface with the long-distance network is either an exchange with long-distance switching functions co-located with a local exchange, or a similarly co-located transmission facility representing the termination of a transmission link to a long-distance exchange. Assuming a co-located long-distance exchange, these costs will correspond to the costs of the transmission segment between the long-distance and the local exchange.

6 Pricing of scarce resources

For the time being, only the frequency spectrum is considered; other scarce resources, such as numbering, may be examined at a later date.

The radio-frequency spectrum, being a free and – for a long time – abundant resource to which little attention was ever paid, has only recently acquired the importance that is now accorded to it. Until relatively recently, the usable part of the radio-frequency spectrum was essentially exploited for sound and television broadcasting and for military applications, as well as by just a handful of professional users providing long-distance civil links. Today, however, the environment has changed dramatically. While it is true that the accessible resource has evolved towards higher frequencies, the technology that has allowed the use of ever-higher frequencies has not succeeded in completely overcoming the physical constraints which make these higher frequencies difficult to generate with a high power level and result in their being unable to pass around obstacles and in their being noticeably attenuated by precipitation, indeed even by the very presence of atmosphere. Thus the frequency resource remains intrinsically limited.

For a decade now, advances in electronics, and especially microprocessors, have been opening up a whole panoply of new services and equipment both to the general public (satellite broadcasting of television and sound programmes, GSM mobile telephony, etc.) and to professionals (individual or collective security, etc.). A key factor, moreover, in the rapid progress which characterizes the services provided to users, particularly the general public, has clearly been the introduction of competition within the context of a global trend towards the opening up of markets and borders, a natural consequence of such competition being an increased demand for frequencies.

The advances being made have produced a growth in frequency requirements that has far outstripped the growth in resources, necessitating a shift towards a rational, optimized and very constrained use of radio frequencies. Given that the spectrum is a scarce resource, setting a price on it is one way of encouraging operators to use it more efficiently, based on the assumption that economic efficiency will naturally bring about technical efficiency.

ITU has studied this problem. Two documents are available: Report ITU-R SM.2012 on economic aspects of spectrum management, and the ITU-D handbook which looks at economic, administrative and regulatory aspects of national spectrum management. These documents point to the existence of a number of principles for spectrum pricing, including the following four:

- pricing aimed at recovering the costs of spectrum management;
- pricing in proportion to operator turnover;
- incentive-based pricing designed to take account of the economic value of the spectrum;
- auctions, which are a market-based mechanism.

The term "pricing" should be understood here as referring to all the amounts payable for obtaining the frequencies used, except for certain charges such as processing fees.

6.1 Pricing based on the management costs of the regulatory authority

Pricing may be based on the cost of managing the spectrum, including the costs associated with any refarming of frequency bands to permit the introduction of new services.

6.2 Pricing in proportion to operator turnover

Pricing can be based on the revenues of spectrum users. The decision-making body takes into account the revenue of a user or defines a coefficient. The approach is similar to a "cost plus" mode of regulation, where an effort is made to determine the company's profit or to establish a coefficient that is equal to the difference between the company's rate of return and the market interest rate. The spectrum regulatory authority can also set the amount of the fee in relation to variables which determine the profit of the frequency user. According to the service in question, these variables can be the number of consumers of the telecommunication service, the number of calls by radio link or the number of mobiles in the network.

The difficulty of this method lies in its implementation, insofar as it calls for a costly and complex audit of operators' activities. It also has the same drawback as "cost plus" regulation, in that it provides no incentives for cost reduction.

In addition, it can be applied only to users having revenues that are directly related to spectrum usage, i.e. operators providing audiovisual and mobile communication services. A further drawback lies in the fact that this type of fee does not encourage efficient spectrum use since the user's income is not directly linked to the value of the spectrum.

6.3 Incentive-based pricing

The last type of pricing, which can be termed incentive-based, seeks to include incentive-based criteria of an economic, social or technical nature, such as:

- bandwidth;
- frequency;
- the surface area covered;
- location;
- the population covered;
- the population density (inhab./km^2);
- the GNP/inhab. in the coverage area;
- the degree of spectrum sharing;
- the period of use;
- the type of application: broadcasting, transmission or coverage;

- services with public constraints and those without such constraints;
- a spectrum utilization intensity coefficient;
- a coefficient based on the type of technology;
- an incentive-based coefficient for observance of specifications.

There would clearly seem to be no possibility of combining all these variables in a single formula, if only because the services are not the same, the infrastructures differ from one another and the technologies are varied. Some recommend establishing a linkage between the bandwidth and frequency and the population density or GNP per inhabitant to obtain an appropriate pricing basis, insofar as these variables have positive effects on both spectrum utilization and the social aspect, and can be economically justified.

Spectrum pricing should result in more efficient spectrum utilization and thereby make the resource less scarce. However, it is difficult to find a middle way between a high and a low price level. A price level which is too high is a barrier to entry for new entrants, and may lead to a low level of investment and penalize customers. Too low a price level may lead to excessive operator demand for frequencies, which would pose a problem of selecting candidates and lead to congestion of frequency bands and hence non-optimum use of bands. Spectrum pricing, i.e. the setting of the level of fees, represents a policy and regulatory choice.

6.4 Auctions

Auctions are a market-based mechanism. They afford a means of ascertaining the value of the spectrum. A stable legal framework is essential to the proper functioning of the market, it being necessary to define in as much detail as possible the nature and duration of the right that is auctioned and the corresponding responsibilities.

As a rule, auctions only come into play where the demand for spectrum exceeds availability. Some countries, however, use auctioning as a means of obtaining financial resources. According to the level of economic development of the country, the degree of modernization of its communication infrastructure, the level of its investments and any restrictions that might be imposed on foreign shareholdings or trade with other countries for the provision of services relating to spectrum use, the administration might be well advised to keep a portion of the spectrum out of the auction process.

Recently, some countries have introduced auctioning systems to grant licences for certain applications in certain frequency bands: United States for PCS, Great Britain and Germany for IMT-2000/UMTS, Burkina Faso, Morocco, Mauritania, etc. for GSM, for example.

7 Regulation and policies

7.1 Introduction of analytical cost accounting

In order to make tariffs cost-orientated, operators have first of all to introduce an analytical cost accounting system. The purpose of cost accounting is, firstly, to ascertain the costs of the various functions performed by the company, determine the bases for evaluating certain items in the company's balance sheet and explaining the company's results by calculating the costs of products in order to compare them with the corresponding sale price. Second, it serves to establish forecasts of regular expenditure and income (budgeting), track actual expenditure and income and explain any differences which emerge (cost and budget control). Cost accounting provides considerable data that can help in decision-making.

To that end, operators have to introduce cost accounting systems in order to analyse their costs. The cost of any telephone service includes:

- the direct costs incurred by the operators in setting up, operating and maintaining the voice telephony service and in marketing and billing the service;
- common costs, i.e. costs which cannot be directly assigned to either the voice telephony service or other activities, shall be allocated as follows:

– whenever possible, common cost categories shall be allocated on the basis of direct analysis of the origin of the costs themselves;

– when direct analysis is not possible, common cost categories shall be allocated on the basis of an indirect linkage to another cost category or group of cost categories for which direct assignment or allocation is possible; the indirect linkage shall be based on comparable cost structures;

– when neither direct nor indirect measures of cost allocation can be found, the cost category shall be allocated on the basis of a general allocator computed by using the ratio of all expenses directly or indirectly assigned or allocated to, on the one hand, the voice telephony service and, on the other hand, other services. Other cost accounting systems may be applied if they have been approved by the national regulatory authority for application by the telecommunication organization.

Where operators have an obligation for their tariffs to follow the principle of cost orientation, national regulatory authorities shall ensure that the cost accounting systems applied by such operators are suitable and that compliance with such systems is verified by a competent body which is independent of those operators. National regulatory authorities shall ensure that a statement concerning compliance is published annually. They shall ensure that a description of the cost accounting systems, showing the main categories under which costs are compiled and the rules used for the allocation of costs to voice telephony services, is made available to them on request. For their part, Member States shall ensure that the financial accounts of all telephone service operators are drawn up, submitted to audit and published in accordance with the provisions of national legislation applying to commercial undertakings.

In the European Union, separate accounts must be kept in respect of interconnection activities for operators with significant market power.

7.2 Cost orientation of tariffs

Tariffs for use of the fixed public telephone network and fixed public telephone services shall follow the basic principles of cost orientation. Tariff principles must be consistent. These principles imply, in particular, that:

- Tariffs must be based on objective criteria and be cost-orientated, on the understanding that the fixing of the actual tariff level will continue to be the province of national legislation.

- Tariffs must be transparent and must be properly published, in order to leave users a choice between the individual service elements, and, where technology so permits, tariffs must be unbundled. In particular, additional features introduced to provide certain specific extra services must, as a general rule, be charged independently of the inclusive features and transportation as such.

- Tariffs must be non-discriminatory and guarantee equality of treatment.

Tariffs for access to and use of the fixed public telephone network shall be independent of the type of application which the users implement, except to the extent that they require different services or facilities. Tariffs for facilities additional to the provision of connection to the fixed public telephone network and fixed public telephone services shall be sufficiently unbundled so that the user is not required to pay for facilities which are not necessary for the service requested.

Tariff changes shall be implemented only after an appropriate public notice period, set by the national regulatory authority, has been observed.

Different tariffs may exist, in particular to take account of high traffic load during peak hours and low traffic load at quiet times, provided that the differences are commercially justified. However, national regulatory authorities shall ensure that, where an operator has an obligation for its tariffs to follow the principle of cost

orientation, discount schemes for users, including consumers, are fully transparent and are published and applied in accordance with the principle of non-discrimination. National regulatory authorities may require such discount schemes to be modified or withdrawn.

Last but not least, any charge for access to network resources or services must comply with the principles set out above, and with competition rules, and also take into account the principle of fair sharing in the overall cost of the resources used and the need for a reasonable level of return on investment.

7.3 Rebalancing

Tariff rebalancing effectively means abandoning tariffs which are not cost orientated. Time-limited safeguards may be necessary to avoid a situation where losses of income due to the lowering of tariffs for certain services and/or in certain areas are not offset by price increases for other services and/or other areas (peripheral, rural, etc.).

Tariff rebalancing is a fundamental aspect of a competitive market. Price caps, geographical averaging or other similar schemes may be introduced to avoid undue prejudice to users on account of the necessary rebalancing and to ensure that rebalancing does not undermine the affordability of telephone services.

8 Recommendations and guidelines

Several points should be included in the recommendations submitted to the next World Telecommunication Development Conference.

8.1 Operators must introduce analytical cost accounting

Costing methods used must satisfy a number of criteria:

- transparency;
- objectivity;
- practicability;
- the principle of cost causality, which calls for a clear cause-and-effect relationship to be established between service delivery and network elements on the one hand and underlying cost determinants on the other;
- the need for cost recovery, which derives from the fact that every firm needs to recover all of its costs, in particular also its common costs, in order to be viable in the long run.

8.2 Tariff rebalancing effectively rules out non-cost-orientated tariffs

Time-limited safeguards may be necessary to avoid a situation where losses of income due to the lowering of tariffs for certain services and/or in certain areas are not offset by price increases for other services and/or other areas (peripheral, rural, etc.).

Tariff rebalancing is a fundamental aspect of a competitive market. Price caps, geographical averaging or other similar schemes may be introduced to avoid undue prejudice to users on account of the necessary rebalancing and to ensure that rebalancing does not undermine the affordability of telephone services.

8.3 Cost orientation of tariffs

Tariff principles must be consistent. These principles imply, in particular, that:

- Tariffs must be based on objective criteria and be cost-orientated, on the understanding that the fixing of the actual tariff level will continue to be the province of national legislation.
- Tariffs must be transparent and must be properly published, in order to leave users a choice between the individual service elements, and, where technology so permits, tariffs must be unbundled.
- Tariffs must be non-discriminatory and guarantee equality of treatment.

Tariffs for access to and use of the fixed public telephone network shall be independent of the type of application.

Different tariffs may exist, in particular to take account of high traffic load during peak hours and low traffic load at quiet times, provided that the differences are commercially justified.

Last but not least, any charge for access to network resources or services must comply with the principles set out above, and with competition rules, and also take into account the principle of fair sharing in the overall cost of the resources used and the need for a reasonable level of return on investment.

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