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EFFICIENT OPERATOR:

METHODOLOGIES, MODELLING AND APPLICATION FOR TARIFF REGULATION

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1. INTRODUCTION

Taken at its simplest, regulation may be defined as setting up rules or standards by which a given market or any of its agents must abide in order to correct a failure or undesirable situation in the interests of a social benefit.

Regulation is not the ideal way to encourage market competition. It is always preferable to encourage market competition. However, there are "market failures" when the market is not perfectly efficient in allocating resources, leading to suboptimal distribution among the population. Therefore, the aim of any market regulation should be to replicate what happens in a market under conditions of perfect competition.

Regulation also has its failings, so market intervention is not always recommended, since it entails costs and application errors. Failings or inefficiencies may have several causes, mainly associated with the following:

– Regulated prices may not reflect the costs of the service and may transfer rents to the wrong groups

– The importance and highly cost of non-economic objectives–   The cost of the services which reduce incentives to enhance efficiency

– Administrative overheads and indirect costs of regulation

– The possibility of market agents engaging in regulatory capture

– The regulator has been unavailable to pursue its own agenda separate from economic objectives.

To display conditions of perfect competition, two conditions of efficiency – productivity and assignativity – must be fulfilled together. In other words, operators must minimize their production costs, while goods and/or services must be produced and provided in a quantity and with a quality that people value and the units must be consumed by those who value them most.

In practice it is very difficult to find examples where both conditions are fulfilled. Usually markets operate under conditions of imperfect competition or market failure, such as monopoly, duopoly, market power or "information problems".

Market regulation is accomplished by government agencies in order to grant a reliance on competition. It trends to enhance the allocation of resources. Under the strict point of view , regulation should be implemented only when the expected market benefits outweigh the costs of intervention. Regulation may serve to correct productive inefficiencies by setting prices or production quotas, or to correct assignative inefficiencies through subsidies.

Tariff regulation may be exercised through various methods or methodologies, including price-cap, rate of return (cost of capital), fully distributed costs, efficient operator and benchmarking.

The main characteristics of each of these methods are as follows:

Regulation by rate of return is the conventional type of regulation applied in the United States. It lays emphasis on the real costs of companies and investments made in the past. In this method, tariffs are set by periods, such that the operator is able to finance the operating and maintenance costs, asset depreciation and the return on capital invested. Under the rate of return method, tariff reviews are endogenous. In addition, there are tariff review mechanisms that the regulator, companies or users can call upon in the event that a key variable - whether on the expenditure or investment side - differs from the original projections.

The inconvenient associated to regulation by rate of return are those related with the lack of incentives for companies to reduce its costs. If the operator becomes less efficient, the tariffs rise to compensate for that situation. The regulatory contract therefore has little effect in terms of the incentives it deploys to ensure cost containment, instead generating more in the way of incentives for over-investment.

The greatest advantage of regulation by rate of return is associated with the fact that absorption of cost reductions does not dependent on the operator (inputs), these are passed on directly to the consumer.

Price-cap regulation is the type of regulation traditionally applied in the United Kingdom. It corresponds to a modified form of regulation by rate of return in which the objective is to increase the power of the regulatory contract. The two main modifications are as follows:

–   Setting of regulated access charges or tariffs for a specific period (usually four or five years) with not right to enquire a tariff review.

–   Projection of efficient expenditure and investment without necessarily taking the operator's past real expenditure as a basis.

Price-cap regulation generates similar conditions to those in a competitive market, in which the operator is unable to influence the market price and hence generates incentives for increasing benefits solely by reducing costs. The problem with this methodology is that in order to ensure adequate investments the Government allows the operator to increase tariffs/ access charges over its average costs. This practice disincentive companies for reducing real costs and has an effect on the tariffs to the public. The issue on price-cap regulation is the adjustment due to efficiency gains (the X-factor), the technical efficiency which is in many cases affected by political considerations.

Another widely-used means of regulation is benchmarking, which essentially consists in comparing the costs of a given operator with its "peers" or companies with similar characteristics. This method may be applied directly to the final prices of the services to be regulated. The main problem topics have to do with the fact that:

–   Most of the companies operate in different markets and under different conditions and therefore are not directly comparable;

–   The empirical results may be distorted owing to the quality of the information and by the methodology itself.

Another method is known as "efficient operator" - the subject of this report. The efficient operator methodology consists in using a business model which sets tariffs for services on the basis of the costs that would be incurred by a operator equipped with the most efficient technologies available on the commercial market at the time of the tariff-setting exercise and with optimum organization of operations, i.e. a situation altogether removed from the real situation of regulated companies. Economists such as Newbery[1] are recognized as the source of this type of regulation in Chile.

Regulated tariffs are derived from estimates of the investments required in order to meet demand for the projected service for a planning time-frame of four to five years and of all the relevant operating costs that would be incurred in order to provide the services in the most possible efficient manner.

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[1] Newbery, David (1999), "Privatisation, Restructuring and Regulation of Network Utilities", MIT Press, pp 163-164

This document sets forth and analyses the methodologies for fixing tariffs used in the modelling of an efficient operator, focusing on the advantages and disadvantages and looking at the results of a number of recent applications in Chile, Venezuela and Colombia.

## 2.   EFFICIENT OPERATOR MODELLING FOR TARIFF REGULATION

The methodologies used in the design and modelling of efficient operator networks enable us to simulate the costs to be met by a network operating and providing services in a given market and under the conditions and characteristics prevailing in the country in question.

The evolution in world trends as regards modelling for regulatory processes, especially in the telecoms field, has been slow. In the past, States used to own the telecommunications companies and held monopoly power over the market. To liberalize and making it competitive, them decided to transfer its ownership to the private sector which involved problems associated to regulation.

In the early years of regulation, the practice was to have negotiations between the incumbent (ex-state) operator and regulatory body, as well as between the incumbent and the new market entrants. Being far more political/legal than technical in nature, the negotiation system produced one of two possible results for the States applying it, one of them being an increase in the power of the market incumbent.

In other cases, the failure of this type of approach was acknowledged and the focus switched to technical modelling systems for calculating access or interconnection charges, thereby providing an avenue other than a legal one for resolving technical issues. The approach used in different countries for determining the value of interconnection charges has thus evolved as shown in Figure 1, with an ever greater number of countries opting for new and proven regulatory schemes, such as those based on long-run incremental costs (LRIC).

Figure 1: Modelling trends worldwide
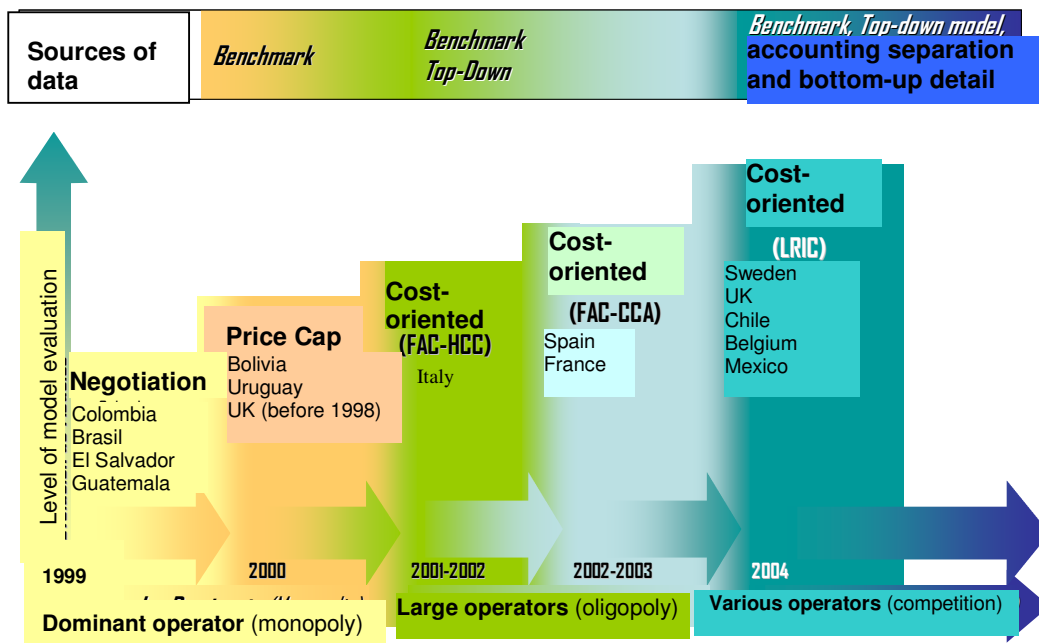
The problem of determining the cost of accessing the telecommunication networks of competitors is theoretically complex and controversial. The theoretical complexity stems from the fact that the sciences of network economics, regulation and design which underpin developments in this area are demanding and involve mathematical topics that can be highly advanced. The controversial aspect can be seen in the empirical international evidence of resistance to change and a refusal of telecommunication operators to disclose information in the face of such regulatory processes, thereby generating information asymmetries vis-à-vis the regulator.

Development of competition and success of liberalization depend on access to markets and other conditions. Therefore, regulation is a key area of public policy, which grants the adequate consideration to the corresponding terms and conditions since, in unregulated markets, telecommunication operators can use their market power to engage in unequal negotiations on the rate to be charged, which can result in economic inefficiencies. Additional factors such as a low level of economic growth, could also have an impact on adequate growth in this sector, as could specific policies imposing minimum levels of state participation in the ownership of telecommunication operators.

Given the high levels of investment (both network and administrative structure) involved in setting up and running a telecommunication operator, both the competing (new entrant) and dominant companies face a financial obstacle at the outset and thus have a keen interest in negotiating aggressively in those market segments which call for the establishment of advantageous operating conditions, one such area of negotiation clearly being the level of the termination charge in an unregulated environment.

Many countries, both developed and developing, have used regulatory schemes to determine charge levels for access to their mobile networks. Cases such as Chile, Mexico, Peru and, more recently, Colombia and Venezuela in Latin America, and Spain, the United Kingdom and Sweden in Europe, are examples of the application of theoretical methodologies and models for determining network interconnection charges or access.

–　　In Chile, telecommunication network access charges are determined using an efficient operator model in a regulated process involving the operators and regulatory body (the *Subsecretaría de Telecomunicaciones de Chile* (SUBTEL)).

–　　In July 2005, Peru's regulatory body (the *Organismo Supervisor de Inversión Privada en Telecomunicaciones* (OSIPTEL)) established a procedure for setting maximum mobile operator access charges, involving use of an LRIC-based model.

–　　Mexico has a system for negotiation among operators whereby the initial step is to seek mutual agreement on their access charges. In the event that no such agreement is reached, the regulatory body, COFETEL, uses an LRIC-based model to establish them.

–　　In Europe, Spain uses a methodology based on the historical costs of companies, while both the United Kingdom and Sweden use LRIC-based models.

–　　In Colombia, CRT has in recent years developed and implemented efficient operator models for the fixed and mobile segments which have enabled it to establish a framework for the regulation of maximum tariffs.

–　　In Venezuela, CONATEL has likewise developed and implemented efficient operator models, geared towards incremental development costs, which have enabled it to send price signals to the market to facilitate interconnection negotiations and agreements among the various operators.

2.1   Regulation of markets in imperfect competition Error! Bookmark not defined.

According to microeconomic theory, in a context of natural monopolies it is better to allow a single operator to supply the market and, to ensure that the monopoly operator does not impose an abusive price on the consumer; the State should establish or "regulate" the price to be charged by the operator for its service.

The next question is: what is the price to be set by the regulator? If the regulator's objective is to maximize total well-being, this being understood as the sum of the consumer's surplus and that of the producer, the tariff should be set at a level such that the marginal benefit of producing one additional unit is equal to that of the additional cost incurred in producing that unit. This is equivalent in effect to setting an equal price to the marginal cost of producing the good, and is known as efficient tariff-setting or "first best".

However, given that the situation most commonly found in natural monopolies is that the marginal cost lies below the average cost for the relevant level of production, the operator will not be able to finance itself by means of the "first best" tariff and will therefore prefer not to operate rather than to operate at an economic loss. If the aim to cover at least its total production costs, it will be necessary either to make a direct transfer to it or raise the tariff until it reaches the average production cost. This latter solution, known as the self-financing or "second best" tariff, is applied in cases where it is decided not to effect transfers from the State to the operator[2].

2.1.1   Regulation in practice

Application of the above-mentioned tariff models to regulated companies in infrastructure sectors involves a number of complex issues. First, there is what is known as "Indivisibility of Investment", which means that an expansion in system capacity is not automatically adjusted to the level of existing demand, but rather by means of discrete changes. Second, regulated companies are multiproduct in nature, i.e. their assets are used to provide a range of services for which, although it is possible to establish an unambiguous marginal cost measurement, there is no a single methodology for calculating their average cost, with the result that if the aim is to apply self-financing tariffs at the operator level it will be necessary to determine the manner in which each "first best" tariff is to be adjusted until self-financing is achieved.

The first marginal cost measure is referred to as "short term" since the expansion in capacity is not taken into account, while the second is referred to as "long term" since the capacity varies according to the demand. To avoid any discontinuities or jumps between short- and long-term marginal cost measures, use is made of an approximate variable representing the marginal cost over a given evaluation period and corresponding to a kind of average additional cost for different levels of increase in demand. This approximate marginal cost measure is known as "incremental development cost".

The incremental development cost can be applied to each of the services provided by the operator, different geographic areas, peak or off-peak hours, or network access or communication service within the telecommunication network. It is important for each service to clearly identify which are

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[2] There are two types of reasoning in support of the decision not to make direct transfers from the State to companies. The first argument is that the total cost of providing the service should be borne by those who benefit from it, i.e. the direct consumers. The second argument is that the public funds from which the transfer would be made are costly to generate and also have a high opportunity cost.

the essential investments to cover the demand. The tariffs derived on the basis of the incremental development cost are referred to as efficient tariffs since their purpose is to deliver a price signal with regard to the additional resources used in the production of each service.

Revenue generated solely by applying efficient tariffs does not guarantee the operator's self-financing, which is verified by comparing the revenue generated by the efficient tariffs during the tariff period in question with the cost of replacing or rebuilding the operator from scratch for a level of demand representative of the period in question. This replacement cost is known as total cost or long-run incremental cost.

2.1.2 Role of the regulator and information requirements for regulatory purposes

Describing the role of the regulator tends to be a complex task. In most Latin American and Caribbean countries, the regulator is called upon to play a variety of roles, often with opposing interests, inasmuch as it must seek, on the one hand, to foster development of the sector by encouraging investment in telecommunication networks, while on the other hand it must perform a subsidiary role by encouraging investment in less-developed, geographically isolated or other population segments, and by ensuring that companies within the sector abide by the regulations or legislation in force in the interests of the well-being both of their users and of the public at large, to which end the most common indicators are their tariffs and the quality of the services they provide.

On establishing corrective measures - such as price levels or quality-of-service standards - to correct a shortcoming or undesirable situation in the market, or in respect of a specific company, in the interests of improving the overall social well-being, the regulator must be in harmony and consistent with the sectoral objectives and economic development policy being pursued by the State in question.

Tariff regulation must be carried out within a context that fully and properly reflects the country's legal, normative and social framework. In this respect, an efficient operator model for regulatory purposes can be developed from two different standpoints:

– **Efficient operator model developed by companies** subject to tariff regulation. This arrangement enables the regulator to analyse the presentation of companies subject to tariff regulation, improving and correcting loss-making aspects, for example, by means of cost comparisons or correction of demand estimates. The natural situation is for this arrangement to be applied to tariffs applied by way of a ceiling or to mandatory tariffs.

– **Efficient operator model developed by the regulator** on the basis of information provided by the companies subject to regulation. Under this arrangement the regulator can follow more closely the development of networks and demand estimates, with an eye to the specific policy aspects it wishes to put in place. In this case, the tariffs can serve as a reference to facilitate negotiations between interconnected companies.

No matter what presentation approach is selected, it is essential to establish technical and economic bases that make for objectivity in the submission of information by companies and enable preparation of the parameter and variable estimation methodologies needed for developing the efficient operator model.

The information requirements for basic regulatory purposes are:

– **Lines-in-service and subscriber statistics**: To estimate the demand for regulated services, the regulator must periodically update a series of statistics in order to have an adequate picture of the different market segments. The State's administrative characteristics and geographic features must be included as significant fields, as must the types of network, technology and consumer profiles in terms of average consumption.

- **Traffic statistics**: Estimation of the demand for regulated services will also require the establishment of users' historical consumption levels in terms of their relevant relations with other networks. Traffic will generally need to be identified by, among other things, service (e.g. voice or data), network (e.g. fixed or mobile), routing (e.g. outgoing, incoming or intra-network) and geographic unbundling by destination.

- **Information on relevant input market costs**: To verify or determine the cost levels faced by the efficient operator, the regulator will need to have adequate knowledge of the input markets required for the pursuit of business activities in the local market. These inputs are related to, among others, the labour markets, telecommunication equipment provider markets, markets for the goods and services required for the operator's operations, and the financial market.

2.2 Implementation and development of an efficient operator model

The implementation of an efficient operator model for tariff regulation purposes calls for the application of different methodologies. For the purposes of tariff regulation, this chapter looks at various theoretical and practical aspects in order to provide a comprehensive picture of the methodologies required for implementation and development of the various main modules or components needed for the construction of an efficient operator model relating to telecommunication service provision.

As already mentioned, the efficient operator determines the tariffs for regulated services on the basis of the costs that would be those of a hypothetical operator providing those services under the same market conditions (economic, geographic and regulatory) with commercially-available efficient technologies and optimum operations.

To estimate the efficient costs, it is necessary to construct and analyse a database that includes information on the recurrent both operative and administrative costs; their current assets, broken down by stage and facility; the operator's service levels; the coverage area or areas; the number of users; and traffic levels for the different types of communication carried over the network.

The above considerations presuppose a high level of information asymmetry. First, regulated companies also operate in competitive or semicompetitive markets, which mean that, although the total costs can be audited, the allocation of costs among regulated and unregulated operations presents a grey area. Second, the operator has a highly specialized human capital with practical operational knowledge, whereas the regulator does not, the upshot of this being that the operator is the entity better placed to determine the design of the efficient operator, while the regulator is only able to produce an approximation thereof on the basis of information obtained from the operator or from its practical knowledge on the engineering side.

Some regulators have resolved this latter issue by requesting the regulated companies themselves to submit the efficient operator model, through the establishment of presentation conditions or specific reference frameworks, confining themselves solely to reviewing or reformulating the data used in support of the tariffs proposed for regulation. Another effective way of improving these information asymmetries is to require the regulated companies to submit, on a regular basis, the information needed for adequate development of the efficient operator models.

We shall now go on to look at the various methodologies used in the implementation and development of the main modules or components needed for modelling an efficient operator providing telecommunication services.

2.2.1   Cost of capital rate

The cost of capital rate is a relevant parameter in setting tariffs for services, corresponding to the cost of capital invested or rate of return on assets imposed on the operator by the market, and is used as a discount rate applicable to cash flows generated by the efficient operator.

The most widespread method used in financial economics for determining the cost of capital rate is the capital asset pricing model (CAPM), which states that the rate is calculated from the following formula:

$$K_0 = R_F + \beta * MRP$$

where:

K_0 : cost of capital

R_F : risk-free rate of return

β : operator's systematic risk

MRP   : market risk premium

The risk-free rate of return corresponds to the interest rate prevailing within the country at the time of regulation, associated with a fixed-income instrument supported by the State. A bond issued by the State in indexed local currency constitutes the best approximation to a risk-free asset from the standpoint of a local investor. In practice, the best option for determining the risk-free rate corresponds to the expected return from sovereign bonds issued by the Central Bank for an equal period or similar to the regulatory period in question, or, failing this, to the lending rate specified in similar instruments issued by prestigious financial institutions or banks that are representative of the national context.

The risk premium corresponds to the gain between the market return and the risk-free rate $(R_M - R_F)$. Estimates of the risk premium should be based on local market data, or, where this does not meet the basic technical requirements for generating a reliable estimate from the formal statistical point of view, on validated international estimates of a similar nature which meet those requirements. The relevant literature has focused mainly on the United States, which has the most highly-developed capital market, representing a significant proportion of the international capital market and having sufficiently broad data series. At the time of writing this report, Ibbotson Associates represents the main source of data on returns from the North American capital market.

The systematic risk – beta – represents the covariance between the return on the asset and the return on a well-diversified portfolio (market). The beta of a financial asset represents a measurement of risk, and indicates the sensitivity of the return on that asset with respect to variations in the market return.

− $\beta > 1$: represents an asset which amplifies market movements

− $\beta < 1$: but positive, corresponds to an asset which follows the direction of the market, but to a lesser extent.

The systematic risk depends on the individual characteristics of the asset to the extent that they are correlated with the body of assets that make up the market portfolio. The beta is a risk that cannot be diversified since it corresponds to the risk that cannot be eliminated by diversifying the portfolio.

The systematic risk of a given operator is calculated by means of the following equation:

$$\beta_i = \frac{Cov(r_i, r_m)}{\sigma_m^2}$$

where:

$Cov\ (r_i, r_m)$: covariance between the return from the asset i and the market return, discounting the return on a risk-free instrument

σ_m^2 : variance in the market rate of return.

The systematic risk value – beta – is determined using the relevant data available in the national market. In the absence of local country data that can be deemed relevant for the purpose, the systematic risk may be calculated on the basis of data extracted from an international sample of telecommunication companies providing similar services under similar market conditions.

2.2.2 Estimating the demand for telecommunication services

Analysis of the demand for telecommunication services is crucial in determining the required investment for an efficient operator. Analysis of traffic demand and numbers of subscribers, and subsequent projections thereof, constitute key parameters for describing the industry with a view to proposing corrective measures in order to enhance operations or, alternatively, adjust regulatory policy so as to achieve stated social objectives.

Demand analysis is complex, essentially on account of five factors:

a) **Analysis of service prices.** This is the most complex element within the analysis, since the large number of tariff plans and types of subscriber make it almost impossible to determine the "price" for the telecommunication service requested. Generally speaking, even determining the "average price" (weighted average by type of plan) is made extremely difficult by the fact that the regulator does not always have all of the information relating from the operator.

b) **Number of subscribers to the telecommunication system.** The behaviours and socio-economic variables that describe them can vary according to the different groups of subscribers, and the behaviour of the series can be completely different, requiring the joint modelling of series which may in themselves be complex.

c) **Types of traffic.** Traffic flows, by their very nature, behave in very different ways according to the type of subscribers, to whether they are incoming or outgoing, are between companies, are going to or coming from other interconnected networks, etc. Modelling of these flows will to a large extent depend on the information that is available to the regulator, and that information is very often highly bundled, making it necessary to make a number of assumptions in order to unbundle it.

d) **Substitution or complementarity.** A further difficulty in determining the demand for services has to do with the potential effects of substitution or complementarity with other telecommunication services. It becomes relevant when it comes to estimating both subscribers and flows, moving forward the model-maker to consider simultaneous models.

e) **Geographical breakdown of demand.** The locating of demand can be a key factor in what we will come to understand by efficient operator. Thus, an unbundling exercise on the basis of the available information and in line with the requirements of the efficient operator model and regulatory mechanism ultimately agreed upon will be a key task to be taken on board within the context of this analysis.

2.2.3 Network design and investment in telecommunication infrastructure

On the basis of the estimate of subscriber and traffic demand, it is necessary to establish the network design for the efficient operator, in order, once the required quantities of each network component or element have been determined, to establish the level of infrastructure investment and costs.

The result must be a network that provides service to users with the required level of quality at the lowest possible cost, and within the prevailing technical and economic constraints such as, for example, spectrum availability or location of exchanges, and budgetary constraints in terms of available investment resources. The communications network must include the entire infrastructure strictly necessary to provide the telecommunication services for which tariffs are to be regulated.

It is necessary to establish the network design for the efficient operator, in order, once the required quantities of each component have been determined, to establish the required level of infrastructure investment and costs in respect of access network, transmission, switching, management of operations and maintenance, and operating systems for ensuring optimum service provision with the defined quality and time-frames.

Having regard to the various facets of the establishment of a telecommunication network, it must be possible to establish a methodology – based on engineering – for determining the costs of each of the network elements involved in the efficient operator. Although this stage will depend a lot on the overall regulatory approach and the quantity and quality of available information, there are generic steps to be followed in the modelling process.

2.2.4 Administrative investment

Once the infrastructure investment for the mobile network has been determined, it is necessary to determine the level of administrative investment associated with provision of the services. Such investment relates mainly to fitting out buildings to house the efficient operator's commercial and administrative activities and all investment necessary for operation of the services provided, as well as personnel costs. These estimates will also include the working capital required for start-up and running of the operator.

To determine the investment in technical buildings, i.e. those that will house the network equipment, it is necessary to quantify the network elements identified in the previous stage, including their dimensions, the technical and architectural requirements for the buildings, and, of course, the cost of such buildings for each specific network element. In the case of buildings to be used for offices, information on the local real estate market and specific features of the buildings in question will need to be obtained in order to determine the most appropriate costs, with the dimensioning effort depending mainly on the numbers and type of staff to be allocated to the operator's different units. Once the various accommodation requirements have been settled it will be necessary to quantify requirements as to the fitting out of the buildings, taking into account security measures such as special locking facilities and alarms.

The investment to be made in microcomputing and access network facilities, internal and external communications and office furniture and equipment will need to be dimensioned according to the efficient operator's human resources and quantified on the basis of market data pertaining to the particular requirements.

Investment in operating, administrative and commercial management systems or platforms will need to be quantified as part of the administrative investment.

2.2.5   Human resources – wage bill

Another relevant aspect for modelling of the efficient operator is design and dimensioning of optimum staffing levels and functions within the human resources structure required to provide the telecommunications services. On this purpose, , the current organigram of the regulated company will be analysed and, on the basis of related efficiency parameters, functions will be identified in relation to the company's level of service, while preserving quality and timely service provision.

Once work posts or duties have been specified within the structure, along with their functions and units within the organigram and the corresponding staffing levels for each, the remuneration level of each of the efficient operator's employees will be set. This calls for information on the local labour market, in order to gear salaries in the efficient operator to the corresponding functions. Local market surveys are usually available with information on average national salaries, which will be relevant for analysing suitable rates to be incorporated in the model. From the costs of salaries and the staffing levels in the efficient operator, an estimate of the operator's operating costs for personnel will be derived.

To the foregoing must also be added other mandatory staff payments or benefits, such as health insurance, service awards or bonuses, which will depend to a large extent on the labour legislation of the country in question.

2.2.6   Operating costs

The costs of goods and services employed in the provision of regulated services have to be estimated on the basis of the various business activities that the telecommunication operator in question undertakes. The most important items to be estimated are the following: office rental, network maintenance, leasing of vehicles, leasing of transmission media, termination charges, personnel costs, office supplies, publicity, marketing, commercial costs, etc.

To model each of these various costs, it is important to have information on the regulated operator so as to validate the associated costs and propose parameters and standards for dimensioning that will sustain them.

2.2.7   Depreciation – residual value

To estimate depreciation on investment, it will be necessary to determine for each investment item the time that a depreciable asset is expected to be useable and the depreciation method to be used (straight-line or accelerated) to achieve this

The residual values of investments made by the efficient operator have to be determined on the basis of the useful lifetimes and cumulative straight-line depreciation of the asset.

For both estimates, it will be useful to have an information base on the methods applied by telecommunication companies that are subject to regulation and on the parameters used to determine the useful lifetimes of the assets involved, having regard to the local legislation in force and prevailing market conditions.

2.2.8 Attribution of costs between services provided

Once the levels of investment and operating costs entailed in providing the telecommunication services have been identified and planned according to demand, the different cost items will have to be allocated to the services provided, on the basis of the proportion in which the different network elements and assets in general are used in the efficient operator model, specially with respect to allocation for determining access or interconnection charges and those addressed to the public at large.

In order to allocate costs among the various services provided, it is necessary to establish a cost allocation matrix that enables the allocation of costs to the different services provided by the efficient operator. To this end, consideration has been given to a number of approaches which reflect the principle of allocating those costs that can be duly ascribed to the provision of a given service, with a view to the elimination of cross-subsidization between services.

This calls for the use of various approaches which most adequately, efficiently and proportionately reflect the allocation of costs ascribed to the services provided. The approaches most commonly used are based on traffic levels or staff numbers.

–   The approach based on traffic corresponds to the allocation of costs in proportion to the traffic generated by the different communications being carried over the network (incoming, outgoing and intra-network).

–   The approach based on the distribution of staff among the various services corresponds to the allocation of costs in proportion to the distribution of the efficient operator's staff among the various services. For this approach to work, each of the efficient operator's staff members must be assigned to the services corresponding to his or her duties, in accordance with the performance of his or her main activities.

–   A variation on the previous approach is that of distribution by remuneration, which corresponds to the allocation of costs in proportion to the remuneration paid to the efficient operator's staff assigned to each service.

Implementation of the allocation approaches in the tariff model depends on demand, subscriber and traffic projections, and above all on the classification of staff members according to their duties.

The outcome of this process will be a framework of allocation approaches with the percentages in which the costs will be allocated to the different services provided by the network.

Once the approaches and the values of the allocators have been determined, it must be decided how the different approaches are to be used to distribute the costs to the different services provided by the network. The implementation of the different approaches under each of the efficient operator's cost headings is known as an allocation matrix.

2.2.9 Self-financing equation

The total cost of the operator comprises the efficient operator's investment and operating costs for the project, taking into account depreciation and residual value of assets, taxation and costs of capital.

The total relevant cost for the purpose of setting tariffs will be calculated for the size of the operator stemming from the average volume of provision of the various services during the period of validity of the tariffs and for the telecommunication infrastructure planning time-frame.

The final tariffs will be those which, when applied to the projected demand of the regulated services of the efficient operator for the tariff period, generate revenue which covers the total cost, thereby ensuring self-financing.

As was mentioned at the beginning of this report, it is possible, although not very probable, that in natural monopolies the efficient tariff generates revenue in excess of the total cost. This would imply that application of that tariff would provide the monopoly operator with above-normal benefits. One way to prevent this from happening is to downwardly adjust the tariff on the basis of incremental cost until it becomes equal to the total cost, in the same way as is done for an upward adjustment.

In cases where the operator offers more than one regulated service, there is more than one way to achieve the self-financing adjustment. Where the revenue derived from the efficient tariffs applied to the corresponding regulated service are insufficient to cover the total long-run cost, those tariffs must be adjusted such that the self-financing condition is satisfied. Where the operator provides more than two regulated services, there may be many ways to achieve the adjustment.

In terms of regulation, the most commonly-used forms of adjustment are:

–   proportional adjustment

–   efficient or Ramsey-type adjustment.

With proportional adjustment, each efficient tariff is increased by a common factor until self-financing is achieved. The main property of this type of adjustment is that the end or adjusted tariffs are in the same proportion to one another as were the efficient tariffs. In other words, the price signal based on the marginal cost is maintained.

The other type of adjustment used is known as the Ramsey adjustment. It engages applying tariff increments such as to minimize the social loss resulting from the application of prices above the efficient level. Given that the distortion or loss is measured in terms of the drop in demand produced by the higher tariff, the Ramsey solution proposes higher increases in those services for which the demand is more inelastic in relation to the price. The resulting tariffs will therefore be proportional to the marginal cost and inversely proportional to the demand elasticity of the corresponding service. From the point of view of the information needed by the regulator, the Ramsey adjustment is more demanding than the proportional adjustment inasmuch as it calls for information on the price elasticity of the demand (own and crossed) for all of the operator's regulated services, whereas such information is very often not available.

2.2.10   Methodology for calculating tariffs for regulated services

The main tasks to be carried out in this module are the following:

a)   Overall integration of modules.

b)   Sensitivity analysis of variables in the model.

c)   Calculating the final level of tariffs to propose.

This module serves to integrate all of the modules in order to produce total costs and expenditure associated with the efficient cost model and hence carry out the final calculations necessary to obtain the tariff levels derived from the model.

The integration stage is developed and implemented on a continuous basis through the modelling process. Thus, for all practical purposes, the efficient cost model will always be a visible unit, despite the internal coexistence of the above-mentioned modules.

One thus calculates the tariff levels and determines either the incremental development cost and total long-run cost, or the annuity, depending on the methodology it is decided to use, as well as the final tariffs to be proposed for the regulated services. To this end (if necessary and relevant), tariff areas may be defined, based on criteria of homogeneity of costs of services provided in the coverage areas considered, so as to minimize cross-subsidies between areas while preserving tariff transparency for consumers.

When working with the methodology for calculating tariffs for the services provided on the telecommunication network simulated by the efficient operator, the following steps have to be taken into account:

a)   Expansion project

The expansion project is a project that the efficient operator must put in place in order to satisfy the increase in demand for regulated services during the corresponding period of validity of the tariffs or planning time-frame, having regard to market penetration, categories of subscriber and their respective levels of consumption. The project may also take account of non-regulated services where appropriate.

b)   Incremental development cost

The incremental development costs are established on the basis of the estimated characteristics for the efficient operator, expected demand and competitive technological evolution.

The incremental development cost associated with the expansion project is determined as the amount equivalent to the annual revenue which, having regard to investments, costs and expenditure relating to the efficient operator's activities in respect of the expansion project, and taking into account the useful lifetime of the associated assets, the taxation rates and the cost of capital, is consistent with a net discounted value of the expansion project equal to zero, as shown in the following equation:

$$-\sum_{i=1}^{N}\frac{I_i}{(1+K_0)^i}+\sum_{i=1}^{N}\frac{(y_i-c_i)*(1-t)+d_i*t}{(1+K_0)^i}+\frac{vr}{(1+K_0)^N}=0$$

where:

i : tariff year

N : planning time-frame

I_i : investment in the project in year "I". Investment in year 5 is taken into account only if it generates revenue in that year

K_0 : cost of capital

y_i : incremental cost of developing the expansion project equivalent to the annual revenue in year "i" for VAN=0

c_i : annual operating cost of the operator in year "i"

t : tax rate

d_i : depreciation in year "i" of investments in the project

vr : residual value of the operator's assets in the final year

In constructing the cash flow, consideration may be given to the use of lead times or physical reserves to ensure the timeliness of investments.

c)   Incremental or marginal tariffs

The incremental or marginal tariff for a service corresponds to the tariff which, being applied to the expected demand for a given regulated service of the efficient operator during the tariff period, generates revenue equivalent to the incremental development cost associated with that service.

A set of tariffs is determined for each tariff area:

$$\sum_{i=1}^{N} \frac{\sum_{j=1}^{a} q_{ij} * p_{ij}}{(1+K_0)^i} = \sum_{i=1}^{N} \frac{y_i}{(1+K_0)^i}$$

where:

q_{ij} :   anticipated demand for service "j" in year "i", associated with the expansion project

p_{ij} :   efficient tariff for service "j" in year "i"

y_i :   incremental development cost of the expansion project in year "i"

K_0 :   cost of capital

a :   quantity of service components

d)   Reinvestment project

The reinvestment project is the project that must be put in place in order for the efficient operator, which starts out from zero, to be able to satisfy the total demand for regulated services during the corresponding period of validity of the tariffs or planning time-frame, having regard to market penetration, categories of subscriber and their respective levels of consumption. The project may also take account of non-regulated services where appropriate

e)   Long-run average or total cost

The long-run average or total cost corresponds to the efficient operator's investment and operating costs associated with the reinvestment project, taking account of depreciation and residual value of the assets, tax rates and costs of capital.

The relevant long-run average or total cost for the purposes of tariff-setting is calculated for the size of the operator based on the average volume of the various services provided during the period of validity of the tariffs, as shown in the following equation:

$$-\sum_{i=0}^{N} \frac{I_i}{(1+K_0)^i} + \sum_{i=1}^{N} \frac{(Y_i - C_i)*(1-t) + D_i *t}{(1+K_0)^i} + \frac{VR}{(1+K_0)^N} = 0$$

where:

i :   tariff year

N :   planning time-frame

I_i :   investment in the project in year "i"

K_0 :   cost of capital

Y_i : total long-run cost of the operator in year "i"

C_i : annual operating cost of the operator in year "i"

t : tax rate

D_i : depreciation, in year "i", of fixed assets in the project

VR : residual economic value of the operator's assets in the fifth year

In constructing the cash flow, consideration may be given to the use of lead times or physical reserves to ensure the timeliness of investments.

f) Definitive tariffs

The definitive tariff is that which, when applied to the anticipated demand for a given regulated service of the efficient operator during the tariff period, generates revenue equivalent to the total long-run cost associated with that service.

Once applied to the anticipated demand for the useful lifetime of the efficient operator's assets, the definitive tariffs are obtained by increasing the incremental tariffs until,, they generate revenue equivalent to the corresponding average or total long-run cost, thereby ensuring self-financing. The aforementioned increases must be determined such as to minimize the inefficiencies introduced. To this end, it is necessary to determine, within the average or total long-run cost, those components that can be ascribed to each of the services in order that the increase in the efficient tariffs should be consistent with the cost associated with providing each of them. The definitive tariffs may not include cost elements that cannot be ascribed to those services.

If the definitive tariffs fall during the period in question, the adjustment for self-financing must fulfill the following conditions:

a) The average revenue level must correspond to the average financial year of the tariff period;

b) The revenue equivalent to the total long-run cost must be verified, as the case may be, by means of the following equation:

$$\sum_{i=1}^{N} \frac{\sum_{j=1}^{a} Q_{ij} * P_{ij}}{(1+K_0)^i} = \sum_{i=1}^{N} \frac{Y_i}{(1+K_0)^i}$$

where:

Qij : anticipated demand for service "j" in year "i", associated with the reinvestment project

Pij : definitive tariff for service "j" in year "i"

Yi : total long-run cost of the operator in year "i"

a : number of services

In no case may the definitive tariff be lower than the respective incremental tariff.

2.2.11 Tariff proposal

To summarize the foregoing, the efficient operator model for a given telecommunication network will be able to propose tariff regulations for the areas in question, projected services and periods of

consumption, and, ultimately, a tariff structure appropriate to the case at hand and consistent with the analysis of the regulatory recommendations described in the following section of this proposal.

2.2.12 Tariff indexing mechanisms

Finally, once the investment and operating cost levels for the efficient operator have been determined, it is necessary to classify and group the assets and associated expenses on the basis of a pattern of change or fluctuation behaviour affecting future behaviour. Each identified group must be associated with an objective indicator that is openly available and generated by an independent body, to enable determination of the impact on the final tariff of a fluctuation in a given cost. For example, the price or inflation index could have an impact on the wage bill of the efficient operator.

In general, the tariff indexing mechanism should serve to reflect any changes in cost structures, such that the tariff structure adapts to changes occurring in the State economy, to which end it is essential:

– that an index be produced for each service;

– to base oneself on published factor price indices;

– that the resulting index be representative of the efficient operator's cost structure.

3. APPLICATIONS OF EFFICIENT OPERATOR MODELS

This chapter presents the applications and results obtained in the recent development of efficient operator models for the telecommunication sector, in the fixed and mobile markets of Chile, Venezuela and Colombia.

In order for the reader to have an adequate understanding of the context in which the region's various regulatory bodies are operating, the regulatory and legal frameworks of each country are discussed below.

3.1 Chile

In the case of Chile, the General Telecommunication Act – Act 18.168 of 1982 and the subsequent amendments thereof – establishes the sector's regulatory framework. As at general rule, it provides that public service licensees are free to set their own tariffs for services provided to the public. However, it also provides for two exceptions to this general rule[3], those exceptions relating to services provided by public service licensees and intermediaries through interconnections to metering, invoicing, charging and collection services provided by the public service licensees to carriers. In both cases, there is an obligation to provide services at regulated tariffs. On the one hand, the tariffs in respect of services provided through interconnections enable the licensees in question to recover the cost of usage of their networks; and, on the other hand, the tariffs in respect of administrative services serve to ensure that those services operate properly.

Fulfillment of the legal provisions falls to the Chilean regulatory body, the Subsecretaría de Telecomunicaciones (Subtel)[4], which operates under a mandate from the Ministry of Transport and Telecommunications and, for the purposes of tariff regulation, on a joint basis with the Ministry of Economy, Development and Reconstruction. The procedure followed for setting tariffs is comprehensively laid down in Section V of the Act and is backed up by regulations governing the

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[3] Services affected solely by operation of the Act, Articles 24 bis and 25.

[4] www.subtel.cl

procedure, publicity and participation of the licensees, the authority and interested third parties wishing to express their opinions.
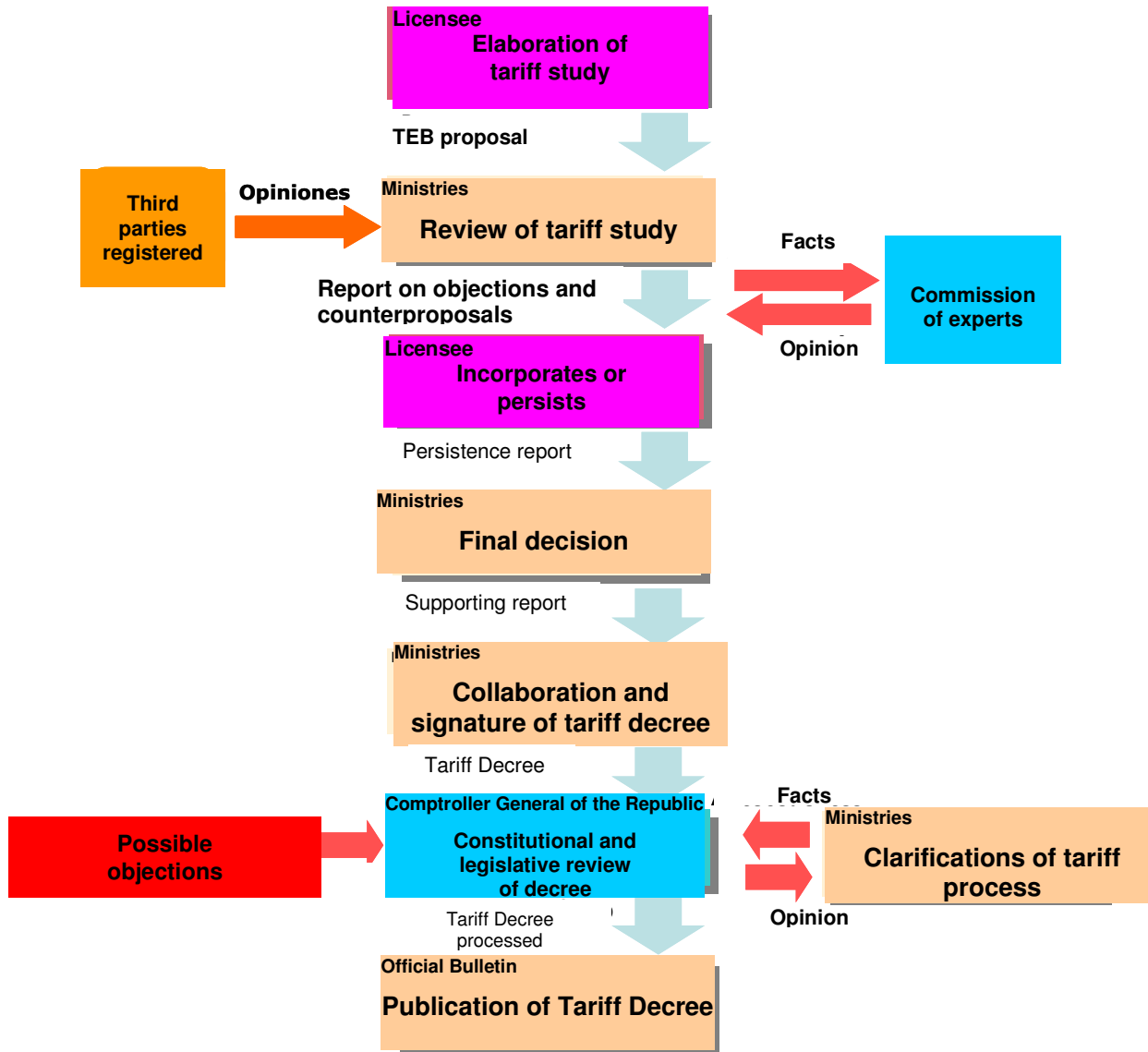
The tariff regulatory procedure is divided into two stages. The first stage corresponds to the establishment of the technical and economic bases for specifying the services subject to tariff-setting, the analysis period and time-frame for the study, tariff areas, demand projection approaches, network optimization approaches, technologies, cost-data sources, base date for currency references, deflation approaches, residual value, useful lifetime's of assets, tariff indexation indices, and any other aspect it is considered possible and necessary to define prior to conducting the tariff study and establishing the general approaches and calculation methodology for the purpose of determining the tariff indexing structure, level and mechanisms for the services subject to tariff-setting. Figure 2 below shows a flow diagram of events relating to this procedure.

Figure 2: Procedure for the establishment of technical and economic bases
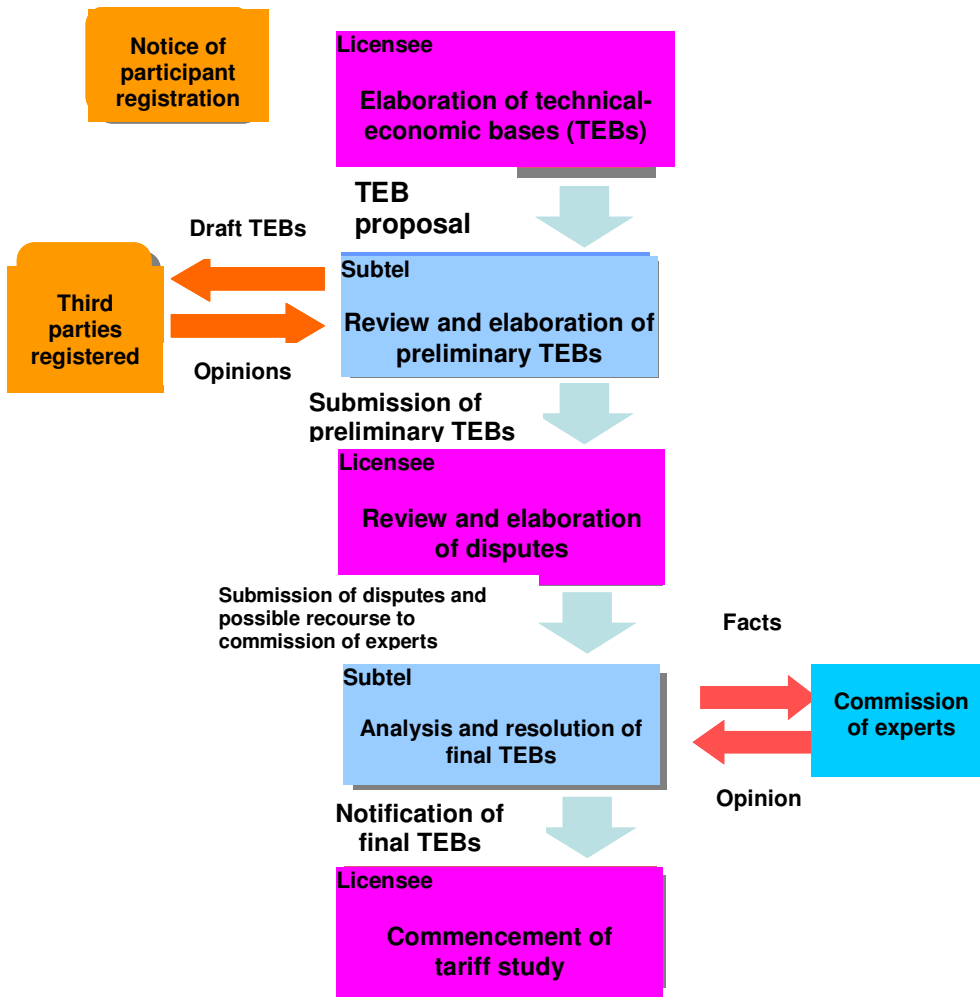
The second stage corresponds to the tariff process per se, and covers a tariff study underpinning the regulated tariffs and the subsequent stages of observation and adjustment with the regulatory body. Figure 3 below contains a flow diagram of the events relating to this procedure.

Figure 3: Procedure for the setting of regulated tariffs

```
                            Licensee
                            Elaboration of
                            tariff study

                            TEB proposal

Third          Opiniones    Ministries
parties       ─────────▶    Review of tariff study            Facts
registered                                                   ────▶   Commission
                            Report on objections and                 of experts
                            counterproposals                  ◀────
                            Licensee                          Opinion
                            Incorporates or
                            persists

                            Persistence report

                            Ministries
                            Final decision

                            Supporting report

                            Ministries
                            Collaboration and
                            signature of tariff decree

                            Tariff Decree

                            Comptroller General of the Republic   Facts
Possible                    Constitutional and          ◀────  Ministries
objections    ─────────▶    legislative review                 Clarifications of tariff
                            of decree                           process
                            Tariff Decree              ────▶
                            processed                   Opinion
                            Official Bulletin
                            Publication of Tariff Decree
```

The main principles established by the legislation on tariff-setting are as follows:

– User tariffs must reflect the costs of providing the services.

– Tariffs must be such as to avoid the existence of cross-subsidies between services and tariff areas.

– Use of the efficient operator model must generate incentives to encourage the actual licensee to make technological improvements to its network and to the regulated services in order to enhance their efficiency.

– The tariff-setting process must be such as to ensure that any efficiency gains enjoyed by the operator as a result of its enhanced management and technological development are passed on to the consumer.

The concept of efficient operator is set forth in Articles 30A and 30F of the Act, in which regard the following considerations are to be borne in mind

–   Only regulated services are to be provided.

–   Only those costs that are essential to provision of the services are to be quantified.

–   The technology used must be commercially available.

–   The quality of the services provided must be maintained.

–   The costs of each service must be determined: investment and operation, including cost of capital.

–   In the event of indivisibility of the project with respect to the non-regulated services, only a portion of the costs, corresponding to the proportion in which the assets are used, is to be quantified.

As a general rule, the legislation provides for tariff-setting at marginal cost associated with the incremental development cost – Article 30 of the Act. This calls for determination of the expansion plans for each service in each tariff area, resulting in an incremental development cost (IDC) for each of them. An exception to the rule occurs where there are no expansion plans, in which case one has to determine the marginal long-run cost.

Efficient tariffs – Article 30E of the Act – are obtained such as to generate revenue equivalent to the IDC (CMg). In the event of there being more than one regulated service in a given tariff area, the equilibrium condition must be such that the marginal rates of return are the same. On the other hand, if the expansion project provides non-regulated services, only a portion of the IDC, corresponding to the proportion in which the assets are used, must be used.

In the event that economies of scale are found to exist in the provision of the regulated services, the definitive tariffs are determined – Article 30F of the Act – with an increase in the efficient tariffs until the total long-run cost (TLRC) is achieved. The TLRC – Article 30C of the Act – corresponds to the costs associated with the project for replacement of the efficient operator's assets, in accordance with the average volume of provision of the various services. The final tariffs must be adjusted such as to minimize the inefficiencies introduced. On the other hand, if the efficient operator provides non-regulated services, only a portion of the TLRC, corresponding to the proportion in which the assets are used, must be utilized.

3.2   Venezuela

In the Bolivarian Republic of Venezuela it is the Comisión Nacional de Telecomunicaciones (CONATEL) which ensures compliance with the relevant legal provisions and serves as the regulatory body for the sector, in accordance with the policies laid down by the Ministry of the People's Power for Telecommunications and Informatics.

Under the Basic Law on Telecommunications, interconnection is an obligation on the part of the operators of public telecommunication networks, the aim being to ensure that users obtain more and better services.

Interconnection has been defined as the physical and logical connection of public telecommunication networks for the exchange and termination of traffic between two operators, enabling interoperative and continuous communications between their users.

Interconnection refers to the setting of interconnection charges on the basis of arrangements which enable the party providing the interconnection to recover its costs and secure a reasonable return. In cases where the operators in question are unable to reach agreement on the corresponding charges, the regulations provide that CONATEL may order the establishment of the interconnection, laying

down the technical and economic conditions therefor, to which end a long-run incremental cost model has to be elaborated.

This being the case, CONATEL has recently drawn up long-run incremental cost models in respect of the charges for use of the fixed and mobile telephony service, with a view to facilitating agreements between operators. These models have been designed to balance the objectives of broadening service coverage and reducing interconnection charges such that users will benefit both from greater service coverage and possible tariff reductions.

It is worth mentioning, by way of an example, that when determining the termination charges on mobile networks the following factors, among others, are taken into account:

– Broadening mobile telephony service coverage to population centres with over 500 inhabitants

– The territorial deconcentration and infrastructure investment policies of the Ministry of the People's Power for Planning and Development

– The costs involved in attracting and retaining customers are associated with the marketing of mobile terminal equipment enabling citizens to access the service through inexpensive terminals

– Charges have been applied taking account of an inclusive public policy, with the establishment of special interconnection charges for public telephony.

Since 2001, and prior to the elaboration of its model, CONATEL established charges for use of the mobile telephony service by means of an indicative method based on an international comparative study which took into account the average of the four lowest values or best practices from a basket of countries comprising Chile, Colombia, United States, Greece, Mexico, Peru, South Africa and Sweden, this practice being known as "benchmarking".

Now, however, the legislation in force requires that such reference frameworks be replaced by the establishment of charges through a long-run incremental cost model with unbundling, in accordance with the generally accepted economic theories and principles to the effect that inefficient costs are not to be included in the calculation. This charge is the reference that CONATEL will use whenever it is required to intervene in accordance with the Basic Act on Telecommunications and Interconnection Regulations.

To this end, in December 2006, CONATEL published the "Report on the Long-Run Incremental Cost Model for Fixed Network Usage Charges", together with "Administrative Decision 881" containing reference values for the determination of interconnection charges for use of the local fixed, national long-distance and international telephony services, using a methodology based on incremental costs with unbundling and application of the bottom-up approach.

Similarly, in 2007, CONATEL designed and simulated the efficient network of a operator providing mobile telephony services, for handling of the traffic received from mobile telephony operators and the traffic received from interconnection, unbundling the network elements involved in each case, i.e. identifying and separating the capacities and physical components of the network in order to cost those elements. This methodology was founded on a valuation of the modelled operator's assets based on their replacement cost; in other words, account was not taken of the historical cost of acquisition but rather the cost of efficiently installing a new network. The findings were published in the Report on the Long-Run Incremental Cost Model for Mobile Telephony Service Usage Charges.

3.3 Colombia

The project, known as "Design of a methodology for the review, definition and monitoring of mobile network access charges in Colombia", was entrusted by the United Nations Development Programme (UNDP), at the request of the National Department of Planning, to the University of Chile's Mathematical Modelling Centre.

The general aim of this project was to put forward a methodology for the development of an economic regulatory framework governing mobile telecommunication network access charges in Colombia. This included an analysis of the status of the telecommunication market, both domestic and external, definition of the main lines of regulatory policy and, ultimately, development of a model to enable the definition and monitoring of mobile network access charges in Colombia. The foregoing, together with a series of regulatory recommendations put together by the group, was presented as a whole within the proposed methodology.

The project was divided into the following four stages. Stage one: definition of the overall intention. Stage two: designing the methodology. Stage three: development of the model inherent in the methodology. Stage four: development of a number of regulatory recommendations. The following paragraphs contain a brief description of each of the stages.

The first stage of this project served to define the general framework for implementing the design of the methodology requested, and involved a market analysis of the telecommunication situation in Spain, the United Kingdom, Sweden, Colombia, Chile, Mexico and Peru. Based on the experiences of the countries studied, the situation in the Colombian market and the practical and theoretical considerations relating to regulation of the mobile network access charge, the regulation of the access charge was recommended, as the use of the forward-looking cost-based pricing of the total service long-run incremental cost (TSLRIC) .

The second stage involved the design and implementation of the cost model for the definition and monitoring of mobile network access charges in Colombia. The model was designed in conceptual terms using UML (Unified Modelling Language) and expressed solely in mathematical terms, with all of the formulations necessary for determining the variables involved.

The third stage saw the delivery of the software used to implement the cost model for calculating mobile network access charges, together with the corresponding documentation, including details of the input data required for calculations, and specifications pertaining to use and administration of the software.

In the fourth stage of this project, and on the basis of international comparisons, the proposed methodology and the results generated by the efficient cost model, the mobile network access charges for Colombia were recommended, together with other regulatory recommendations. The technical and final design adjustments were made to the mobile network efficient cost model; a sensitivity analysis was made in regard to the results generated by the model; possible differences in the access charges calculated on the basis of technological differences within the networks were determined; proposals were made in regard to criteria to be taken into account when taking decisions to apply one or more call access charges in the mobile services network, having regard to international regulatory practices and considerations such as time periods (peak and off-peak hours), differing technologies, different companies, etc.; mobile network access charges for Colombia were recommended by minute and by capacity, these being items currently provided for under the regulations in force, as were the methods for their review and monitoring; and regulatory recommendations were made with a view to generating a new regulatory framework for mobile network access charges in Colombia.

4.   RESULTS OF EFFICIENT OPERATOR MODELS

4.1   Cost of capital rate

This chapter presents the results obtained in applying the methodology used for estimating the cost of capital rate for regulatory purposes in the context of local and mobile services in the telecommunication market.

In the case of Chile, in the latter part of 2003, the Subsecretaría de Telecomunicaciones (Subtel) determined the cost of capital rate (CCR) using a single methodology which, by taking account of parameter changes, maintained a uniform level for public telephony service licensees subject to tariff regulation.

In the case of Venezuela, CONATEL implemented two long-run incremental cost models for fixed and mobile network usage charges, in which it determined the CCR using the CAPM methodology.

The results of the CCR levels applied to the various telephone companies since 2004 are as follows:

Table 1: Capital cost rate used for regulatory purposes

| Operator	Country	Sector	Year	CCR	Risk-free rate	Beta (β)	Risk premium
Entel PCS Entel Móvil Smartcom Telefónica Móvil Bellsouth	Chile	Mobile	2003	**10.92%**	0.35%	1.04	10.16%
Centennial Multikom	Chile	Trunking Digital	2004	**10.92%**	0.35%	1.04	10.16%
CTC GTD Telesat Manquehue CMET EntelPhone VTR Broadband [1]	Chile	Fixed	2004	**9.49%**	0.35%	0.90	10.16%
TelSur TelCoy	Chile	Fixed	2004	**10.10%**	0.35%	0.96	10.16%
CTR RTC	Chile	Rural	2003	**10.92%**	0.35%	0.90	10.16%
CANTV	Venezuela	Fixed	2006	**13.52%**	-	-	-
Movilnet Movistar Digitel	Venezuela	Mobile	2007	**12.15%**	3.9%	1.05	7.87%

1) - Network unbundling process

4.2   Demand for telecommunication services

Models for estimating the demand for telecommunication services may be determined using different methods and organized according to the information available. Econometric models may be attempted to recognize growth patterns or behaviours observed in other countries with similar characteristics.

The information should be organized according to the objectives for application of the results for regulatory purposes, and the following aspects at least should be taken into account:

–   A zoning arrangement should be adopted within the efficient operator model according to the geographic distribution or grouping to ensure adequate representation of the demand estimate, which will depend to a large extent on the availability of information for efficiently and effectively characterizing the different variables and parameters which make up the model.

–   The demand estimate can be divided into two major estimate models, namely access and traffic. The total network traffic is derived from these independent estimates. Although these variables are not independent, over short estimate periods they prove in practice to be fairly accurate estimates.

–   In the efficient operator model, the demand for access (fixed telephone lines or mobile telephony subscribers) must be assigned to coverage or service areas according to the zoning arrangement adopted.

–   The traffic demand projection model must take account of the different types of traffic in the network under study. A distinction must at least be drawn between internal, outgoing and incoming traffic, and traffic routed to different networks such as local, mobile, national long-distance and international. Each of the traffic types will enable adequate determination of the network elements involved in each communication.

Figure 4: Example of procedure adopted in the implementation of a model for estimating the demand for telecommunication services
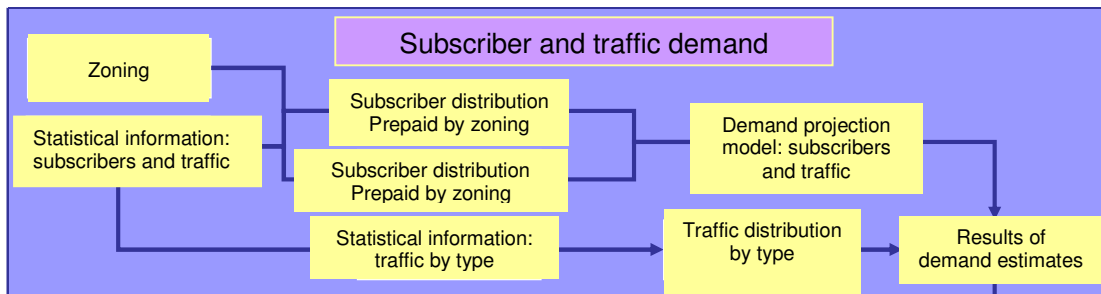
Source: CONATEL, Report on the Long-Run Incremental Cost Model for Mobile Telephony Service Usage Charges

The following figures provide examples of a number of situations relating to the models for estimating the demand for telecommunication services.

**Figure 5: Example of geographic segmentation of the demand of
an efficient mobile operator model in Chile**
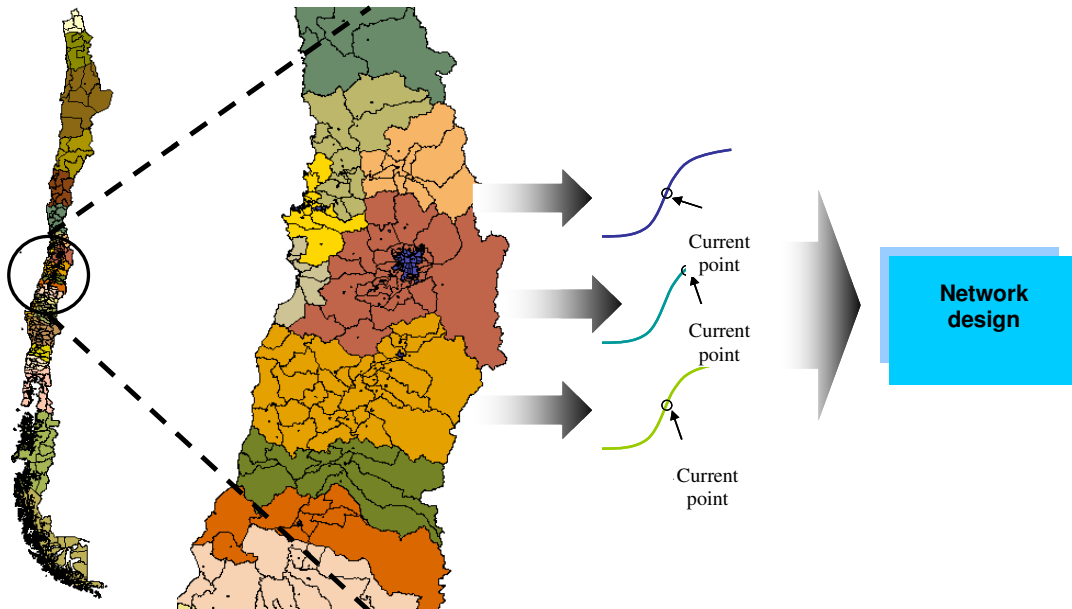
Source: Case of Chile - Model efficient mobile operator, interconnection charges in the period 2003-2008.

Figure 6: Example of market evolution and subscriber distribution by region
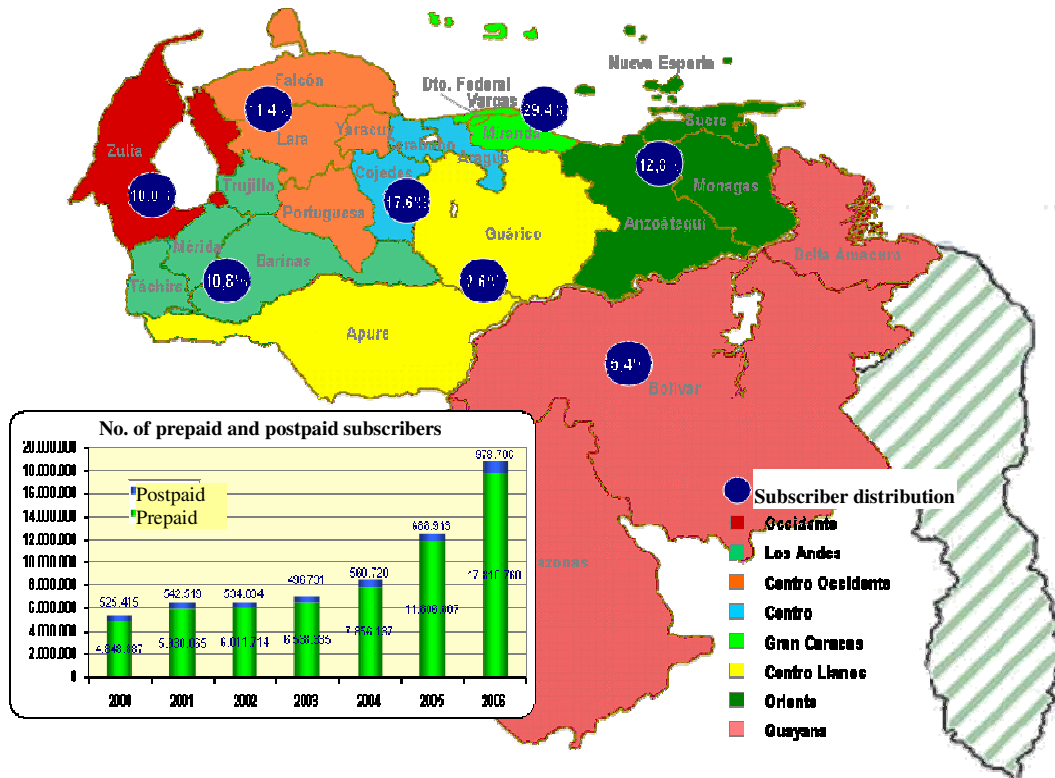
Source: CONATEL, Report on the long-run incremental cost model for mobile telephony service usage charges

4.3 Telecommunication network design

The network design module is developed on the basis of the subscriber demand estimate, traffic, quality of service considerations, mathematical modelling methodologies and common telecommunication network design practices.

This design enables determination of the required quantities of each network component, on which basis, together with the installation and operating costs of those components, it is possible to calculate the investment and expenditure levels associated with the network infrastructure. The communications network thus designed must include the entire infrastructure necessary to provide services over a network.

It is important to select and implement the most efficient technology commercially available at the time of developing the efficient operator model and implementing the network design methodology, in the interests of keeping the investment and operating costs to a minimum.

There are many variables and parameters which have an impact on network design, the main ones being demand estimates, level of detail used, quantity of information available, quality of service considerations and, of course, technical and economic constraints.

The network design methodology generally calls for consideration of the following aspects:

–   The mobile network design methodology includes definition and mathematical formalization of the algorithms used for calculating the quantity of the elements making up the network.

–   The network elements are quantified according to network levels or layers, in particular the access level, access transmission and transmission between switches, the level of switches and transmission between switches and interconnections with the public network. The calculation of these global quantities and capacities of equipment and links takes into consideration certain parameters and factors which serve to reflect certain specificities and possible inefficiencies of which the design fails to take account.

–   When defining the quantity and total capacity of each type of equipment, as well as the total capacity of the transmission links to meet the demand, coverage and quality conditions, the various elements have to be costed.
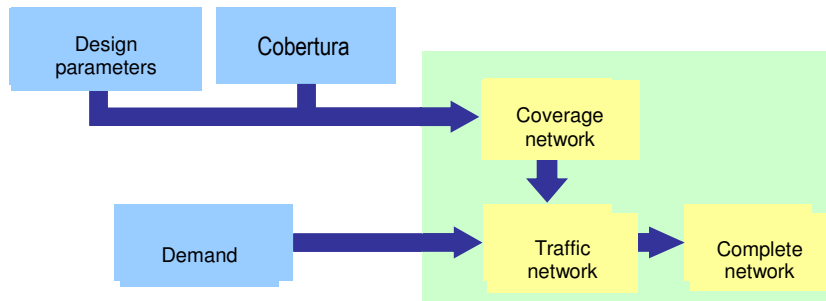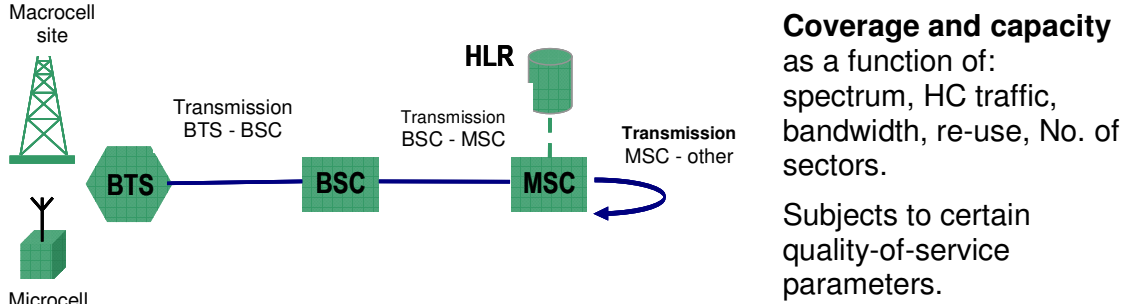
Figure 7: Example of the procedure adopted when implementing the configuration and design of telecommunication service network elements
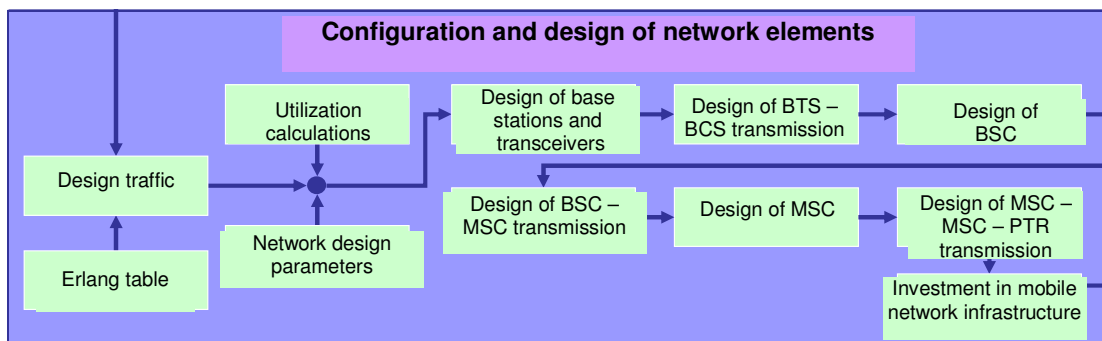
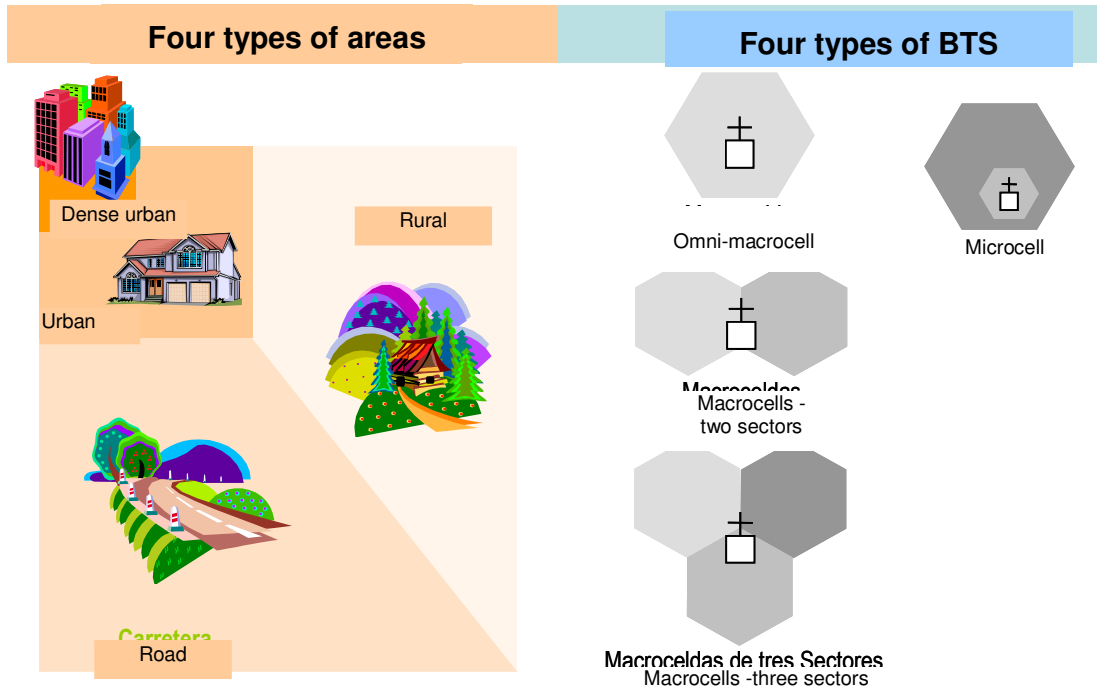Source: CONATEL, Report on the long-run incremental cost model for mobile telephony service usage charges

The following are a number of explanatory figures by way of examples of the different stages involved in the design of a telecommunication services network.

**Figure 8: Example of network design - Coverage and capacity**

Coverage and capacity as a function of: spectrum, HC traffic, bandwidth, re-use, No. of sectors.

Subjects to certain quality-of-service parameters.

Source: Case of Chile – Efficient mobile operator model, interconnection charges, period 2003-2008

**Figure 9: Example of network design - Types of area and cell**

Source: Case of Chile – Efficient mobile operator model, interconnection charges, period 2003-2008

Figure 10: Example of network design - Coverage requirements
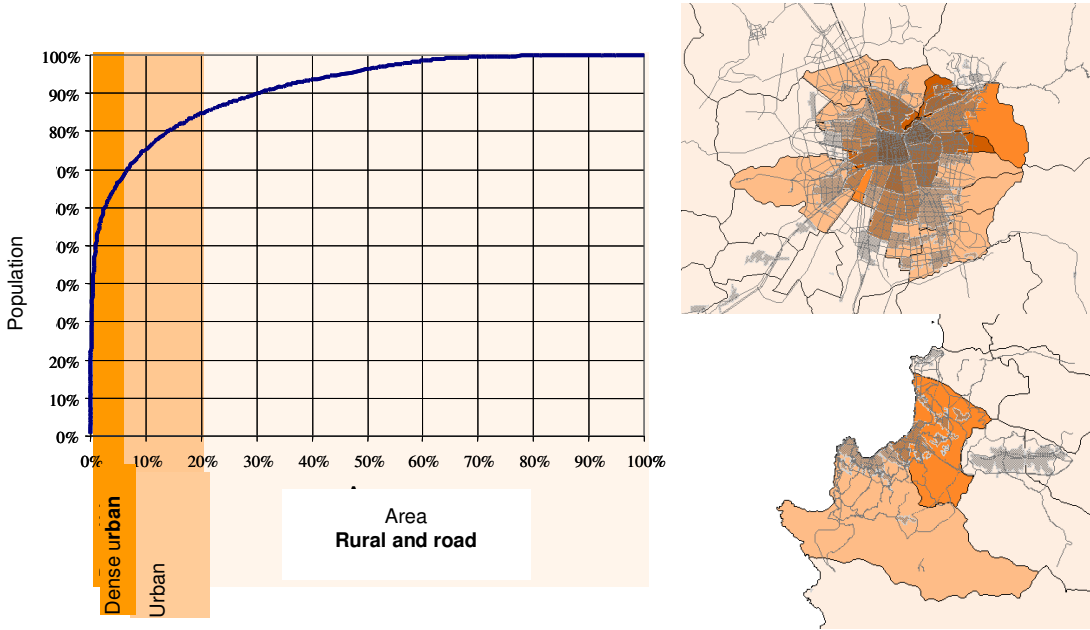
Source: Case of Chile – Efficient mobile operator model, interconnection charges, period 2003-2008

Figure 11: Example of mobile telephony network coverage in 2009 and 2011
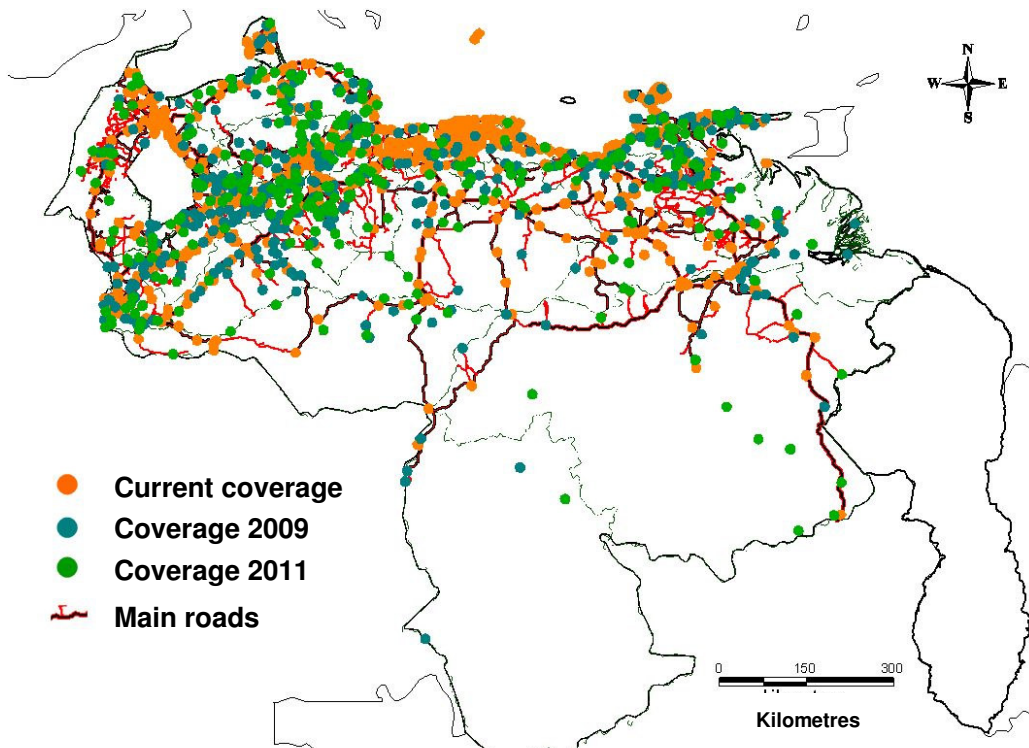
Source: CONATEL, Report on the long-run incremental cost model for mobile telephony service usage charges

## 4.4	Administrative investment

Administrative investment will depend to a large extent on the efficient operator's staffing and equipment levels and on its need for self-development, as well as the demand in terms of specific requirements for normal network operations and adequate protection of the infrastructure.

In general terms, the methodology for determining administrative investment calls for consideration of the following aspects:

–	The building investment necessary to ensure the accommodation of all the staff needed to perform all the duties relating to the supply of the telecommunication service, including costs in respect of construction, fitting out, safety and security and land.

–	Consideration must also be given to the costs associated with the premises to be used for customer care activities and contacts with the public at large, in addition to which it is necessary to quantify the construction of the technical network premises associated with switches and concentrators, and the land areas on which they are to be sited.

–	The investment necessary to ensure that the efficient operator's staff is able to perform its duties and activities must include: office furniture and equipment, microcomputing facilities, access network and communications, and network, administrative and commercial management systems.

Figure 12: Example of the procedure adopted for the determination of administrative investment
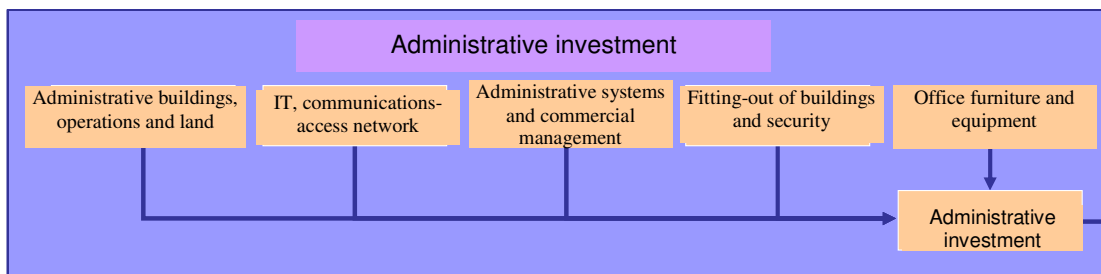
Source: CONATEL, Report on the long-run incremental cost model for mobile telephony service usage charges

## 4.5	Salary costs and operating expenses

When calculating salary costs and operating expenses associated with the activities performed by the efficient operator in providing its telecommunication services, the following aspects need to be taken into account:

–	The organizational structure and staffing numbers associated with the efficient operator must be designed and quantified on the basis of the human resources data provided by different telecommunication companies. The various units that will be required in order for the operator to perform its work must be identified on the basis of the information gleaned from different market sources.

–	In each administrative unit of the organizational structure thus designed, it will be necessary to define the workstations associated with the definition of specific responsibilities, activities and functions within the organization.

– The staffing requirements must be dimensioned on the basis of a growth approach or drivers, which generally have to do with the level of demand to be met by the efficient operator.

– Once the organizational structure of the operator has been determined it is necessary to determine the salary level for each specific post. This can be done through the process of post classification, on the basis of the required professional profile, functions and activities performed and relevant data from the labour market.

– In addition to salary, it will be necessary to determine the additional benefits to be paid to each worker in accordance with the country's social and labour legislation.

Figure 13: Example of the procedure adopted for determining salary costs and operating expenses
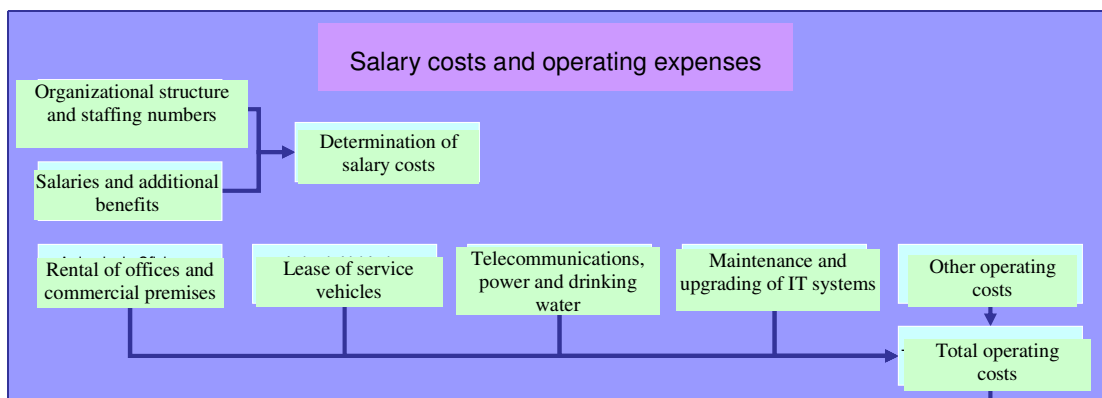
Source: CONATEL, Report on the long-run incremental cost model for mobile telephony service usage charges

The efficient operator's operating expenses correspond to:

– the costs of basic services and consumption of electric power and drinking water in the administrative premises;

– the telecommunication costs associated with use by the staff of local telephony, Internet and mobile telephony services;

– the costs of maintaining and upgrading IT systems, including licence usage and hardware upgrades;

– the costs of vehicles for the operator's operational and non-operational units;

– other expenses relating to the supply of basic office inputs needed for the functioning of the efficient operator and its staff.

4.6 Tariff calculation

The final stage of the efficient operator model involves calculating the reference tariffs for the telecommunication service under consideration. This stage brings together the different demand estimates and projections, investments and costs associated with provision of the service in order to determine, by allocating the various costs, the different tariffs for the services in question. The following example sets out each of the elements involved in the tariff calculation.

Figure 14: Example of the procedure adopted for determining administrative investments
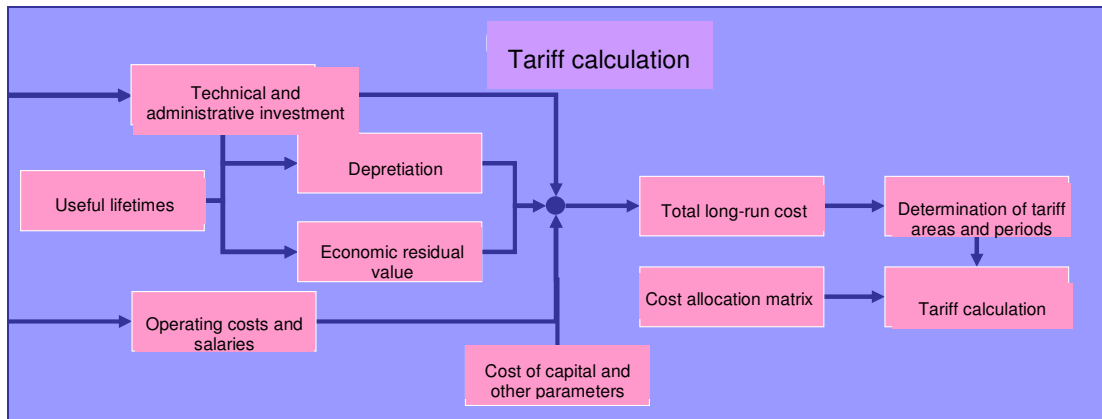
Source: CONATEL, Report on the long-run incremental cost model for mobile telephony service usage charges

5.   CONCLUSIONS AND RECOMMENDATIONS

As was mentioned at the outset of this report, regulation is the action of drawing up rules or standards by which a given market agent or market must abide in order to correct a failure or undesirable situation in the interests of a social benefit. The correction of such market failures, as has been mentioned, can be effective through the application of various tariff regulation approaches, and in this document we have analysed their main advantages and disadvantages in order to provide some context for the efficient operator method. This study "Efficient operator: Methodologies, modelling and application for tariff regulation" has presented and analysed the methodologies used in the modelling of an efficient operator, focusing on the advantages and disadvantages and looking at the results of a number of recent applications in Latin American countries.

 In simple words we have defined the efficient operator method as one which enables the determination of tariffs subject to regulation by estimating the investments necessary to satisfy the demand for the service projected to a long-term planning horizon and taking into account all of the relevant operating costs which enable provision of the services in the most efficient possible manner, using to this end planning for reinvestment in the operator with optimum telecommunication network configuration and sitting using commercial and available technologies at the time of tariff-setting.

Nevertheless, the implementation of efficient operator models by regulators calls for a number of specific actions prior to undertaking the regulation. It is with this in mind that we now present the main conclusions of this study and the recommendations aimed at enabling regulators to successfully implement regulatory models for tariff-setting based on the efficient operator.

5.1   Clear regulatory rules

a)   **Role of the regulator:** As was stated in § 2.1.2, in most Latin American and Caribbean countries, the regulator is called upon to play a variety of roles, often with opposing interests, which means that the regulator's role in terms of the imposition of corrective measures - such as price levels or quality-of-service standards - to correct a shortcoming or undesirable situation in the market, or in respect of a specific operator, in the interests of

improving the overall social well-being, must be in harmony and consistent with the sectoral objectives and economic development policy being pursued by the country in question.

b) **Stated objectives:** Tariff regulation must be carried out within a context that fully and properly reflects the country's legal, normative and social framework, and prior to its application it is very important to make clear to the telecommunication market the nature of the regulatory body's sectoral objectives and the telecommunication policy relating to the country's development.

c) **LRIC:** For the purposes of regulation on the basis of the efficient operator, the regulator must inform the market or those companies subject to regulation, for example through standards or regulations, of the economic foundations which underpin the application of long-run incremental cost methods.

d) **Regulated tariffs:** It is essential to define the regulatory framework within which the results will be used, the review mechanisms and the duration of the measures adopted. In the case of interconnection charges, there are at least two basic frameworks. In the first, companies freely negotiate an agreement or contract for the settlement of joint traffic, in which case the tariff results obtained by the regulator are used as a reference which, in the event of disagreement or dispute between the companies, can be adopted on a mandatory basis. In the second, the results obtained by the regulator are applied on a mandatory basis to the regulated operator or to the market under examination.

e) **Efficient operator model:** For regulatory purposes an efficient operator model can be developed from two different standpoints: by companies or by the regulator. Once the presentation arrangement has been selected, it is essential to establish technical and economic bases that make for objectivity in the submission of information by companies and enable preparation of the parameter and variable estimation methodologies needed for developing the efficient operator model.

5.2 Relevant information

The efficient operator model enables regulators to be comprehensively informed as to the cost structure of the operator subject to regulation, and in this way to dimension the impact of the regulatory measures to be implemented. However, in order to reduce asymmetries, it is essential to have regulatory information stemming primarily from telecommunication service and relevant input cost statistics.

a) **Configuration and design of efficient operator networks:** To establish how to arrange and design an efficient operator, the regulator has to have information regarding the siting and capacities of the main nodes of its country's network. On the basis of that information, coupled with the necessary specialized engineering knowledge, the networks are determined for optimum operation using efficient replacement technologies. In general, a good point of departure is the regulated operator's actual network.

b) **Administrative and geographic characteristics:** The country's administrative characteristics and geographic features must be seen as important information when it comes to planning the efficient operator network. Similarly, account must be taken of all available information in respect of network types, technologies and user profiles at the level of average consumption.

c) **Estimate of demand for services:** To estimate the demand for regulated services, the regulator must periodically update a series of statistics in order to have an adequate picture of the different market segments; for example, the monthly evolution of mobile market subscribers by payment system segment (prepaid and postpaid) or the number of lines in

service by administrative area in a given quarter. To estimate the demand for services subject to regulation the regulator will also need to maintain statistics on users' historical consumption levels in terms of their relevant relations with other networks. Traffic will generally need to be identified by, among other things, service (e.g. voice or data), network (e.g. fixed or mobile), routing (e.g. outgoing, incoming or intra-network) and geographic unbundling by destination

d) **Information on relevant input market costs**: To verify or determine the cost levels faced by the efficient operator, the regulator will need to have adequate knowledge of the input markets required for the pursuit of business activities in the local market. These inputs are related to, among others, the labour markets, telecommunication equipment provider markets, markets for the goods and services required for the operator's operations, and the financial market.

Last but not least, the regulator must have the authority it needs to be able to require telecommunication companies to provide the necessary information with a degree of timeliness and quality commensurate with the purposes described in this study. It is also to be recommended that regulators have access to specialized advisory services in regard to the development of regulatory models based on the efficient operator, particularly in the areas of network configuration and design, cost estimation and integration into the country's own tariff framework.

The efficient operator model must be a modular and flexible tool that can be tailored to the specific features of a given country in terms of its geography, market, skills structure and economic and social achievements, and which takes adequate account of the country's regulatory, normative and legal framework.

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