Review of Some Interconnection Charging Models

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Abstract – **In this the review of two most used interconnection charging models is presented. We focus on two representatives of paper bottom-up and top-down approach in creating model for interconnection calculation. As a typical bottom-up model the World Bank and European Commission created models based on Long run average incremental cost. On the other hand ITU created COSITU model based on top-down approach.**

Keywords – **interconnection charging, bottom-up, top-down**

I. INTRODUCTION

The economic cost of interconnection is generally the starting point in establishing economically efficient interconnection prices. In many jurisdictions, regulators set interconnection prices based on Long Run Incremental Costs (LRIC). There are numerous methods of estimating LRIC. Approaches to modelling LRIC can be broadly categorized as bottom-up and top-down modelling approaches. Bottom-up models include scorched earth or scorched node methods. The whole question of tariffs is crucial to the development of telecommunications, since it is tariffs that will mercilessly make or break anyone setting out in this sector. Negotiating tariffs or rates is hence a delicate matter, whether it is for a new operator entering a liberalized market or a regulator wishing to set affordable tariffs for national calls without compromising competitiveness among operators. Many other questions may be raised in this regard. Various cost concepts exist and are formulated in models (LRIC, LRAIC, FLEC, TELRIC, TSLRIC, CCA, FDC, etc.). Each concept presupposes the availability of a quantity of data without which the results obtained would be no more than vague estimates, however complex the models used.

This paper is organized as folows. After the introduction in section II is Word Bank/European Comission model presented. The major sections of that model are presented in section III. Section IV and V are related to ITUs model COSITU.

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II. WORLD BANK/EC MODEL

The models produced by the World Bank and European Commission (EC) are very similar concerning costing principles and functionality. They both present an adaptable bottom-up model built under a "scorched node" assumption. A "scorched node" assumption requires that the model be constrained by the incumbent's existing switching centres [1]. The model created by the EC was freely available at [2].

Bottom-up models rely on a series of economic/engineering assumptions to dimension a network capable of meeting the busy hour demand in a network. Demand includes existing billed minutes and call attempts, but also other calls on the network such as call set-up time, unsuccessful call attempts, margins for growth and an allowance for capacity utilisation.

The costs produced from a bottom-up LRIC model should approximate those costs that would be incurred by a new entrant investing in a network today that could carry the incumbent operator's traffic. In other words, the costs produced are those that would be incurred were an operator to rebuild the incumbent operator's network, using existing switching centres.

As bottom-up models assume that the capital and operating expenditure required to meet demand is new, there should not be any inefficiencies in the network. This is strength of the approach, since the efficient levels of costs used in the model should provide an incentive to operators to operators to increase their own efficiency [3].

A bottom-up LRIC model provides considerable scope for debate about the type of network that would evolve if an incoming operator were re-build the incumbent's network (subject to the "scorched node" constraint). This debate is most evident in two areas — the optimisation of switching nodes and the configuration of the transmission network.

Illustrative results are provided in [4] for those counties where the model was tested. These results are based on data provided to the project team and, where these data were incomplete, on assumptions made by the project team. The results have not been subjected to detailed scrutiny by the incumbent operators in the relevant Member States and are provided as an illustration of the outputs of the model rather than as fully tested estimates of efficient levels of interconnection cost.

This model could be tested according the robustness of the results in two main ways. First, by identifying the variables in the model which have the greatest influence on the results. Sensitivity analysis is then conducted on these variables to provide the reader with a sense of how the results vary with changes in key assumptions. Second, by reconciling the results of the model against the results produced by a top-down model and by an independent bottom-up model

III. WB/EC MODEL SECTIONS

The model is made up of four closely inter-related sections — optimisation, network assumptions, costs, and calculations. These sections then produce results, both in terms of the unit cost of network elements and the interconnection services defined by the European Commission.

A. Optimisation

This model adopts the "scorched node" assumption, which means that we model the incumbent's current switching centres. This assumption, however, can be modified by changing the nature of the equipment at an existing location. The starting point in the model, therefore, is to identify the total number of "nodes" or switching centres and then to determine the optimal mix of those nodes. This process is referred to as "optimisation" and can be undertaken in two different ways in the model [5]. First, NRAs can request a node database from their incumbent operator, which lists each node and the total number of PSTN equivalent lines connected to that node. Once a threshold size of a remote concentrator is identified, the model will assign the most appropriate equipment to each node. Second, NRAs can use a ratio-based approach which determines the number of nodes required to serve a Member State with a given surface area and population density. The model then builds up the number of remote concentrator units (RCUs), local switches and tandem switches. These approaches can only approximate the optimal mix of nodes, since this will depend partly on specific geographical features. The actual mix will also depend on a number of factors such as the extent of digitalisation, whether incumbents offer other services such as cable television, and the view of the incumbent of the optimal length of the local loop. A third option for the users of the model is to ignore the optimisation options provided and to include in the model their view of the efficient number of nodes, based no doubt on discussions with incumbents and other operators as well as their assessment of the level of optimisation that has already taken place.

B. Network Assumptions

Once the approach to optimisation has been determined, the network needs to be dimensioned to meet the demand for the network. This is determined by measuring the existing demand for the network and adding the unbilled share of traffic such as call set-up time and unsuccessful call attempts, and margins for growth. Capacity utilisation is also taken into account at this stage.

Once existing demand has been adjusted to include the above factors, the total demand is attributed to each switching and transmission elements using "routeing factors". Routeing factors show how intensively each network element is used for each type of call. For example, a local call may, on average use less than one RCU, between one and two local switches, and less than one tandem switch. The usage of the transmission network is determined in a similar manner or can be derived from switching routeing factors.

The network needs to be dimensioned in order to carry the conventional "busiest hour" level of traffic. It is not dimensioned to carry an unrepresentative surge.

C. Calculations

The dimensioned traffic in the network is then used to determine the number and mix of equipment required. The number of busy hour call attempts, for example, is used to determine the variable cost of the processor. Busy hour minutes are used to determine the number of ports and size of the switchblock for switches, as well as the demand for circuits in the transmission network [6]. Other major determinants of network equipment in the model are the following:

- the number of nodes (which determine the site costs and the fixed cost of the processor);
- the number and size of leased lines (which affects demand for circuits in the transmission network); and
- the length of duct in the network (which affects the costs of infrastructure).

Other factors that will affect the results calculated through the model include routeing factors, the extent of duct sharing in the network, and the depreciation methods used by incumbents. Model users can conduct sensitivity analyses to determine the robustness of the model to changes in many of those variables.

D. Costs

The model then applies a unit cost to each category of equipment required in the network to meet the dimensioned demand. This provides the total forward-looking investment costs which are then annualised to determine the capital charge for the year. The costs in the model should been collected from a number of sources including telecom operators in the EU and from publicly available models. In some cases, we have been required to use own judgement backed by engineering advice.

It is not intended that the costs in the model be viewed by NRAs as any form of best practice costs. They have been provided in the model as defaults that could be used in the absence of specific data to provide a broad indication of individual costs in the network. There are likely to be significant differences as operators in some countries will be able to access volume related and other discounts and we would urge NRAs to engage interested parties in a consultation process to refine the cost estimate provided as defaults.

Other costs included in the model are:

- network related operating costs;
- non-network capital and operating costs;
- cost of capital;
- working capital.

IV. COSITU

COSITU is an example of a top-down cost model. COSITU is based on enhanced fully distributed costing principles, as adopted in the ITU-T D series of recommendations [7].

COSITU is a practical tool from ITU's Financing Strategies Unit to automate: the calculation of costs, taxes related to the exchange of international traffic (accounting, settlement and termination rates), interconnection rates between local operators, and tariffs for national and international telephone services taking into account the impact of Universal Service Obligations decided by public authorities.

This software can be applied to both fixed and mobile services. COSITU requires the following input data: investment and expense data from accounting systems, current cost data to convert historical capital asset costs to current costs. For example, when accounting records report the purchase price of a switch, the model calculates the cost of the switch at current purchase prices, inputs for depreciation and cost of capital. Where the inputs needed to estimate the cost of capital are not available, COSITU benchmarks these to countries or firms of comparable risk, and traffic demand and routing data.

COSITU produces unit costs and prices for international, sub regional, and regional calling. COSITU can account for the effects of universal service funding, taxes and any access deficit as mark-ups over current unit costs, to calculate interconnection prices.

To the extent that accounting and demand data are available, COSITU's basic modelling framework can be used to model interconnection costs for both fixed and mobile networks. COSITU embodies the following principles:

Transparency: Information used in the cost derivation process should be openly available, so that external analysts can comprehend the final rate.

Practicality: The demands of the costing methodology with respect to data availability and data processing should be reasonable, to keep the costing exercise economical yet still useful.

Causality: The model should demonstrate a clear cause-and-effect relationship between service delivery, on the one hand, and the network elements and other resources used to provide the service, on the other hand, taking account of relevant cost determinants (cost drivers).

Contribution to common costs: The cost calculation should provide for a reasonable contribution to common costs.

Efficiency: The cost calculation should provide a forecast of cost reductions that are likely to result from more efficient use of resources over time.

V. Classification and Definition of Services for which COSITU Calculates Costs

The classification of the services for which COSITU calculates the cost is given in Figure 1.

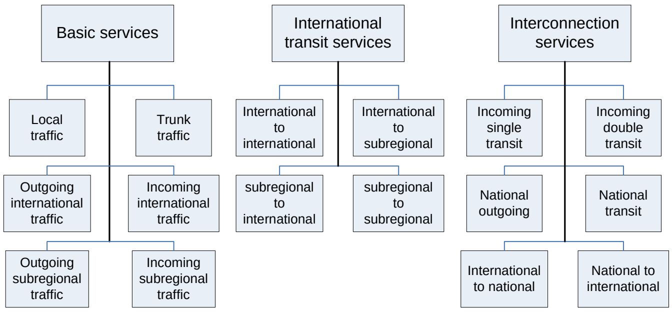

Figure 1 Classification of the services in COSITU model

Local/Urban: Traffic carried solely within the network of the operator for which the calculations are made, between users located in the same local charging area.

Trunk/Interurban: Traffic carried solely within the network of the operator for which the calculations are made, between users located in different local charging areas.

Incoming international: A call from a user located outside the national boundaries to an end user connected to the network of the operator using the international gateway.

International outgoing: A call from an end-user connected to the network of the operator using the international gateway to a correspondent located outside the national boundaries.

Outgoing sub regional: A call from an end-user connected to the network of the operator using the international gateway to a correspondent located outside the national boundaries, in a country which can be accessed by terrestrial media that are also used for trunk calls.

Sub regional incoming: A call from a user located outside the national boundaries, in a country, which can be accessed by terrestrial media also used for trunk traffic, to an end- user connected to the network of the operator using the international gateway.

International to international: A call between two non-sub regional international correspondents via the international gateway of the operator for which the calculations are made.

International to subregional: A call from a non-sub regional international correspondent to a sub regional correspondent via the international gateway of the operator for which the calculations are made.

Subregional to international: A call from a sub regional correspondent to a non-sub regional international correspondent via the international gateway of the operator for which the calculations are made.

Subregional to subregional: A call between two sub regional correspondents via the international gateway of the operator for which the calculations are made.

International to national: A call from an international correspondent to an operator without an international gateway located within the same political borders as the operator using the international gateway for which the calculations are made,

National to international: A call from an operator without an international gateway located within the same political borders as the operator using the international gateway for which the calculations are made, to an international correspondent.

Outgoing national: A call from an end-user of the network of the operator for which the calculations are made to another operator located within the same political borders as the first operator.

Incoming national, single transit: A call coming from the network of another national operator to an end-user located in the charging area of the interconnection point and connected to the network of the operator for which the calculations are made.

Incoming national, double transit: A call coming from the network of another national operator to an end-user located outside the charging area of the interconnection point and connected to the network of the operator for which the calculations are made.

National to national: Transits call between two national operators via the network of the operator for which the calculations are made.

VI. Theoretical aspect of COSITU

COSITU can accommodate both Bottom Up and Top Down approach of calculating the cost of network components, the initial stage for the bottom-up method being completed outside the model.

Whatever the methods used to determine costs and traffic, the COSITU model can accommodate them.

COSITU has, however, been optimized for use of real information from the accounts and technical data of real network operators with a view to equitable allocation of costs to the services that generate them, collectively or separately. COSITU is unaffected by technological choice, addressing directly the services sold - retail or wholesale.

Adjusted depreciation

- Linear depreciation is the rule most widely applied in the accounts of telecommunication operators.
- It is nevertheless possible to take account of the natural evolution of the price of equipment in the specific market and adjust the depreciation accordingly.
- Currency depreciation must also be taken into account:

Efficiency is calculated by combining the installed capacity; utilized capacity; average annual growth rate in number of subscribers; replenishment period.

COSITU is able to calculate the Cost of Capital, assuming a preponderant risk of inflation for telecommunication companies in developing countries, the essential components of the cost of capital as adjusted to local conditions.

The routing table is an essential instrument for cost-orientated charging. It allows allocation to every service, according to the intensity of demand it places on each one, part of the resources needed for its production. COSITU uses traffic volume (adjusted by the geographical correction coefficient) for network component cost allocation. Based on the routing table, COSITU allocates to services their share of each cost component. The corresponding real traffic volume divides the resulting cost of a service in order to obtain the unit cost of the service. At this stage, the COSITU server allows an online comparison with other telephone network operators.

In addition to calculating per minute service and network element costs, COSITU computes tariffs based on cost data, taking into consideration the following factors:

- Corporation tax;
- Contribution to a Universal Service Obligation (USO) fund;
- Effect of Universal Service Obligation (USO) policies on Access Deficit.

COSITU fosters consensus building among policy makers, national regulatory authorities and operators with respect to tariffs. Both cost-based and cost orientated tariffs can be calculated. COSITU offers market actors a practical means to settling disputes.

VII. Conclusion

In this paper the short review of two most used models for interconnection charging are presented. First one, with two possible forms, was created by the World Bank and European commission. It is built based on bottom-up strategy. The second, COSITU, is created by the International Telecommunication Union and it is based mostly on top-down approach.

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