Application of Parametric Cost Estimation Model to Telecommunication Networks

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ABSTRACT

The parametric cost estimation approach has proved to be an efficient method for analyzing complex systems such as spacecraft, missiles, ships, buildings, etc where cost varies according to a number of parameters. The cost to provision a telecom network also depends on a number of parameters; but little research effort has been applied to estimate cost using this approach. In estimating the cost of a telecom network, most published research has considered two parameters; distance and bandwidth of a link and ignored the effects of other parameters. We have modelled the cost based on distance, bandwidth, geographical terrain and technology simultaneously using a parametric cost estimation methodology applied to real data obtained from the Indian Telecom Company, BSNL. Using the model, we show how a cost optimized network can be designed given the real world constraints. The applicability of our model to determine revenue sharing mechanism for an international call is also demonstrated. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: Cost Estimation; Cost Model; Capacity Distance Conflict; Interconnection Pricing; Network Planning; Network Cost Optimization; Parametric Cost Estimation; Parametric Model; Revenue Share; Telecommunications

INTRODUCTION

The origins of the parametric cost estimation model date back to the Second World War when US Department of Defense (DoD)

wanted a quick and accurate estimate of the cost to build aircraft of different capacities (Brundick, 1995). The model helped DoD to re-engineer business processes and reduce overall cost. Since then the model has been

extensively used for estimating the financial cost for civil infrastructure such as buildings ("Parametric Cost Estimating", 2008) and complex systems such as spacecraft, space transportation systems, aircraft, missiles, ships, and land vehicles (Mahr & Richardson, 2003; Meisl, 1993; "NASA Cost Estimating Handbook", 2008).

The model has proven to be effective in the practical world where cost varies according to a number of parameters and is now widely applied in equipment system cost estimation (Jiang, et. al., 2007). However the model's application in telecom networks is rare; Somani et. al (2004) have developed a model for WDM (Wavelength Division Multiplexing) networks to compare the cost between multi-fiber and single fiber links. The work has demonstrated a tradeoff between the cost of multi-fiber and the cost of a single fiber with a wavelength converter. This is not however applicable for a network with heterogeneous links such as SDH (Synchronous Digital Hierarchy) on Optical Fiber Cable (OFC), microwave and satellite. Cost Models for a heterogeneous network can potentially serve a number of purposes such as estimation and optimization of financial cost (i.e. capital and maintenance expenditure) to provision the network and price the services (e.g. interconnection service) which are provided through the network.

The published literature naturally focused on both the above aspects but from two distinct disciplines; engineering and economics. However none of the works have followed the approach of a parametric model and there appears to be no published work to estimate or optimize the cost of a telecom network (of heterogeneous link technologies) using parametric models either. Engineers tend to be more concerned about the network cost optimization and have focused on modeling the cost to provision a telecom network based on distance and bandwidth of the interconnected links (Bley, et. al., 2004; Cabral, et. al., 2007; Harmatos, et. al., 1999; Mudchanatongsuk, et. al., 2008; Pioro, et. al., 2001; Sigurdsson, et. al., 2004; Yoon & Current, 2008;). In contrast, economists estimate the cost of an existing network to decide the prices (e.g. interconnection price) having made a number of assumptions. The assumptions include: the same technology ("An Analytical Cost Model", 2000; Kennet & Sharkey, 2001) for a country wide network, which is clearly untrue in the real world situations.

The interconnection price is the money charged by operators between themselves when a service such as a voice call is provided by more than one operator. Ideally the revenue generated from a call should have been shared according to the cost incurred by the respective operators. There is no quick and easy mechanism to decide the interconnection cost when the call originates and terminates at different geographical regions (e.g. an international long distance call). A preliminary study from a regional tariff group within the ITU ("ITU Regional Tariff Group", 2000) has indicated that even within the same country the cost of terminating international calls may differ by about 35 percent depending upon the volume of traffic, transmission media and technology of a particular route. In a heterogeneous geographical terrain a combination of link technologies (shown in Figure 1) such as OFC, Microwave and satellite are employed depending upon distance and bandwidth requirements. We show that there are certain scenarios where terrain and the associated technology of the link are the main parameters influencing the cost rather than distance and bandwidth.

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