DISCRETE PERFORMANCE MODEL OF ATM MULTIPLEXER
WITH ON-OFF AND CBR SOURCES

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Abstract - The paper addresses the analysis of a single multiplexing node in ATM networks. It presents analytical models for evaluating the performance parameters of a multiplexer that has N independent and identical ON-OFF type input sources, M independent Constant Bit Rate inputs, and an output channel with finite buffer. The channel speed is assumed to be an integer times of the source speed in ON state which equals to speed of the CBR sources. A bidimensional Homogeneous Discrete Time Markov Chain is introduced where the two dimensions describe the number of ON sources and the number of cells in the finite buffer at a given time. Two time scales are defined in order to ensure accurate results in calculating the performance parameters, e.g. cell loss and cell delay. Three alternative models of the cell arrival process are discussed and the performance parameters are derived.

Key words: Discrete-Time Markov Chain Models, ATM Multiplexer, Buffer Dimensioning, Performance Evaluation.

1. Introduction

Asynchronous Transfer Mode (ATM) networks are widely considered to be the new generation of high speed communication systems both for broadband public information highways and for local and wide area private networks. Over recent years there has been a great deal of progress in research and development of ATM technology, but there are still many interesting and important problems
to be resolved such as traffic characterisation and control, routing and optimisation, ATM switching techniques and provision of specified quality of service.

The ATM is a packet-like switching and multiplexing technique in which messages are split into short fixed-length (53 Bytes) packets called cells. Cells may be lost or may suffer delay for different reasons, while they are transmitted from the source to the destination. The buffer overflow in an intermediate switching or multiplexing node can be one of the reasons of the loss or delay. The tolerance for cell loss or delay varies with the type of carried traffic. For example, packetized voice traffic allows relatively high cell loss probability but it has little tolerance to the delay while data can tolerate some delay but they are very sensitive to the cell loss.

In this paper, the problem of multiplexing is addressed. Namely, the special case of multiplexer at the input border of ATM network with M inputs transmitting on Constant Bit Rate (CBR) (Example on CBR applications are real-time applications like Interactive Video and Audio, Video or Audio Distribution, and Audio Library or Video on Demand) [5], N identical ON-OFF sources (e.g., real-time or nonreal time bursty connections), and one high speed output. Similar problems have been studied in many papers providing both analytical and simulation results, however, most of them assume a continuous time or fluid flow model of the system which is only an approximation of the real situation and mainly for one kind of sources.

Anick et al [1] considered the general data handling problem assuming continuous time model with exponential distributions for both the ON and the OFF intervals. The time unit was taken as the average of the ON intervals. The information unit was taken as the incoming information per time unit. In their model the server capacity was a given (not integer) value and the buffer size was infinite. The equilibrium buffer content distribution and its moments were derived for the model. Numerical results for the overflow probability of a predefined buffer backlog were presented as well.

Kosten [10] studied a similar model assuming a finite number of different groups of ON-OFF sources, but the time unit was not defined. Similar achievements were presented (eigenvalues-eigenvectors, buffer content distribution, ...) and numerical results for two groups of sources were given.

Daigle and Landford [6] used the same model of [1] to study the problem of packet voice communication system. While Halfin [7] modified the previous model and allowed finite and infinite number of ON-OFF sources and a state-dependent Poisson message arrival with general packet length distribution. The results were provided with Laplace-Stieljes transforms for the equilibrium buffer