

ABSTRACT

TIAN, WENHONG. Analytical Models and Efficient Dimensioning Algorithms for Communication Systems In Randomly Changing Traffic Environments. (Under the direction of Professor HARRY PERROS).

Analysis and design of communication systems in today's dynamically changing environment face a lot of challenges. Communication systems are not static but are dynamically changing today. Queueing theory has typically been used to address queueing problems of communication networks under the assumption that the inter-arrival times and the service times are renewal processes, and the arrival rate and bandwidth requirement of each customer is constant. In today's dynamically changing environment, such as in high-speed integrated-services wired and wireless networks and Web service, these assumptions are frequently unjustified. Our research focuses on the performance evaluation and efficient resource dimensioning algorithms of communication systems. The topics investigated are either new or they have not been studied well in the literature.

This work starts with the dynamic analysis and design of a communication link when the arrivals are time-varying. We dimension a link under time-varying arrivals and transient load. We compare some methods in the literature and propose efficient ways to design the system under study.

We next consider the case when the customer's bandwidth requirements are time-varying. A novel multi-rate loss model with class-change is proposed and the blocking probability is calculated using an iterative recursive formula. The optimal dimensioning of the capacity of this system is obtained using a formula with a constant cost.

Subsequently we consider a model to analyze the integrated streaming traffic and data traffic where the data traffic is bursty with a time-varying bandwidth shared with the streaming traffic. Using priority decomposition, we proposed closed-form solution for dimensioning of both streaming and data traffic.

Finally we analyze a statistical multiplexer where the arrival process is the superposition of n independent identical bursty and autocorrelated arrival processes. We construct the superposition of these arrival processes and characterize the departure process from the multiplexer by exact Laplace transform for the first time. These results permit us to analyze and dimension the system more efficiently under study.