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Bandwidth estimation for aggregate traffic under delay QoS constraint based on supermartingale theory

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Abstract:

Bandwidth estimation for network traffic plays an important role in various communication network applications. Due to the diversity presented by the network services, exploring theory and methods to measure bandwidth of superposition of traffic flows has great practical significance. In this paper, we propose a supermartingale approach to calculate bandwidth for aggregate traffic under delay Quality of Service (QoS) constraint. The concept of supermartingale bandwidth is put forward to define the required bandwidth of traffic, which measures bandwidth more accurately. The communication network carrying mixed services is modeled as a queuing system with aggregate arrival traffic. Supermartingale method enables the complex queuing system analysis. Based on the stopping time theory of supermartingale, remarkably tight bound of delay-violation probability for aggregate traffic is derived. Subsequently, we estimate the bandwidth according to delay QoS requirement and traffic characteristics. Searching program for bandwidth estimation is designed. Simulation results show that the estimated bandwidth through supermartingale model is more accurate and smaller than effective bandwidth, especially when arrival traffic has bursty feature. Although this approach is presented for the analysis of two typical arrivals, the proposed model is applicable to general aggregate traffic.

Keywords: bandwidth estimation, aggregate traffic, supermartingale theory, queuing model.

1. Introduction

Bandwidth estimation for network traffic is a classical problem in communication networks. Due to the randomness of arrival traffic, it is inherently difficult to estimate bandwidth accurately. Furthermore, communication networks carry different classes of traffic, which requires different Quality of Service (QoS). The QoS requirements of traffic also make bandwidth measurement not an easy job. The essence of bandwidth estimation is to evaluate the load a network is bearing when traffic flow passes through the network. The statistical characteristics of traffic arrival are not enough to reflect the real network load. For instance, a bursty traffic source with small average arrival rate may need a big bandwidth to guarantee the stringent QoS. Therefore, bandwidth estimation should both consider arrival characteristics and QoS provisioning simultaneously. In order to calculate bandwidth under QoS constraint, an effective mathematical model which could integrate arrival process, service process and QoS requirements is

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