BUFFER REQUIREMENTS IN ATM NETWORKS WITH LEAKY BUCKETS

Ljiljana Tra jkovic and Shlomo Hal n

Bellcore
445 South Street

Morristown, NJ 07962
ljilja@bellcore.com sh@bellcore.com

Abstract

For an ATM network with guaranteed Quality of Service,
we present trac scenarios showing that the bu er size allo-cation requirements at various hops through the network may grow unexpectedly high for a zero loss Quality of Service. This occurs even if one uses Peak Load Allocation and the trac pat-terns entering the network are well regulated and conform to the agreed rates.

I. Introduction

High speed packet networks will support diverse trac such as voice, data, image, and real time video. In such a het-erogeneous environment, di erent services will demand a range of Quality of Services (QoS) [1]. Some applications require no packet loss, while others are sensitive to packet delay or to packet delay-jitter. One of the goals of a good admission control scheme for ATM networks is to guaran-tee contracted performance for heterogeneous services while optimally using network resources (bandwidth) [2], [3], [4], [5], [6], [7], [8], [9], [10].
An ATM network with guaranteed QoS may support Virtual Channels (VCs) of various bandwidth allocations. We assume that the sources on the outskirts of the network have pre-shaped trac patterns that conform to the Con-nection Trac Descriptor speci ed by the Generic Cell Rate Algorithm (GCRA) [11], [12] or Leaky (or Token) Bucket [13]. One ATM layer QoS that a network will provide is guaranteed service. This service will guarantee agreed upon low losses for customers who adhere to agreed Peak Cell Rates (PCR) de ned by the GCRA. We show, by con-structing possible trac scenarios, that the bu er size al-location requirements at various hops through the network may grow unexpectedly high for a zero loss QoS even if the trac entering the network is well regulated and conforms to the agreed PCR, and Peak Load Allocation is used.

II. Bu er Size Allocation Requirements

ATM networks consist of various Network Elements: MUXs. DMUXs, and switches, that might have input or output bu ers. The bu ering of arriving packets can be performed per VC (or per Virtual Path) or per link. These mechanisms will determine bu er size allocations require-ments for zero packet loss. In our examples we consider switching nodes (for simplicity named MUXs and DMUXs) with output (shared) bu ering per outgoing link, as shown in Figure 1(a) and (b). (Note that certain switch architec-ture possess both input and output bu ers, as well as in-ternal bu ers designed as recirculating queues of cells that

are being processed.) While packets belonging to distinct VCs can be distinguished based on their VC eld in the ATM cell header, they are bu ered as they arrive on a link together with packets with distinct VC elds. A dif-ferent bu ering strategy, such as one with per VC output bu ering in a switching node, will alleviate the problem we describe, but will be more complex to implement. Further-more, distributed bu ering always requires larger bu ers than a common bu ering scheme.

Consider two types of trac streams shown in Figure 2(a): a fast stream A arriving to a MUX point at rate 74:88 Mb/s, and ve slow streams B arriving at rate 14:976 Mb/s each, as shown in Figure 2(b). We assume a FIFO or a round robin service at the input ports. We also assume that the cells belonging to the slow VCs arrive simultaneously and are served rst. The cells belonging to the fast VC that arrive between the successive arrivals of the cells from slow VCs are served after them. The output stream L shown in Figure 2(b) will then have the pattern shown in Figure 3. One can see the clustering of cells belonging to the fast VC.

an ATM switch was taken into account for the sake of gen-erality.) The bu er size required to assure no loss is equal to i1T � o1(m � s), where m = i1T

i1+i2

. Note that the bu er
size allocation requirement is proportional to the ratio of the fast and slow VCs.

interleaving would be a Weighted Fair Queueing [2] of cells belonging to VCs of di erent bandwidths.