Burstiness Bounds Based Multiplexing Schemes for VBR Video Connections in the B-ISDN

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Abstract

We consider variable bit rate video connections in the B-ISDN where the quality of service in terms of data loss and network delay must be guaranteed using appropriate congestion control mechanisms. We follow a preventive traffic control strategy based on the notion of traffic contract and connection accecptance control. We suggest that video connections be characterized by a set of burstiness constraints that define the traffic contract. We show how video coders can ensure that their output conforms to the traffic contract thus avoiding data loss at the user-network interface. Based on these burstiness constraints, we propose simple and easily implementable ressource allocation schemes that allow the QoS parameters to be guaranteed.
Keywords: B-ISDN, Traffic Control, Mpeg, Burstiness Function, GCRA, QoS Guarantee, VBR.

1 Introduction

The Broadband ISDN is expected to provide an efficient solution to the transport of Variable Bit Rate (VBR) video traffic. Statistical multiplexing of video traffic, however, has proved to be a rather difficult problem in terms of resource management and traffic control. While it is widely accepted that a statistical multiplexing gain can be achieved from the superposition of independant video sources [9], [10], appropriate traffic control procedures remain to be designed to ensure the Quality of Service (QoS) required by video applications.

We assume traffic control is restricted to preventive actions which aim to guarantee QoS standards by admission control and policing [14]. New connections are set up only if their declared traffic, added to existing traffic, would not lead to congestion. The source traffic must be policed to ensure that the traffic declaration is adhered to. This is the principle adopted for the B-ISDN (with the exception of the newly defined ABR service class).

Network performance depends on traffic characteristics. Many models have been proposed to characterize VBR video traffic [10], [15], [18]. Most of these models are based on specific video trace and cannot be easily policed by the network (see Heeke [9] for a policeable model based on a Markov chain).

In this paper we propose the use of a non-stochastic parameters as traffic descriptor for VBR video. The burstiness function defines a set of bounds on video traffic burstiness. These bounds are both enforceable at the coder and controllable by the network.

The paper is organized as follows: In section 2 we discuss the ability to control ATM multiplexer performance and introduce the burstiness function of a video traffic. In section 3 we describe the Mpeg standard and its rate control algorithms. In section 4 we show how Mpeg coders can enforce their output to fit in the traffic contract and how conformity can be controlled by the network. Section 5 presents multiplexing schemes based on the traffic contract parameters and allowing QoS guarantees.

2 Multiplexer Performance and QoS

ATM network performance cannot be studied in isolation from its impact on video communications. For video connections, data loss rate and network delay are the main QoS parameters.

The effect on end to end image quality of packet loss is not yet well defined. The effect of cell loss is not only dependent on the average cell loss rate but also on the distribution of the cell losses over time. Periods of high cell loss due to network congestion can have a serious detrimental impact on image quality.

Delay requirements clearly vary depending on the application. For interactive video communication applications a maximum end to end delay of some 250 ms is appropriate while a much longer delay would be tolerable for a user simply watching a video sequence. This delay must be known beforehands to be able to dimension the decoder playback buffer. It is for these reasons that a number of video applications (especially interactive video) require a guaranteed service that ensures the cell loss rate and multiplexer delays to be within some negotiated values.

There clearly arises a need for compromise between network efficiency and image quality. In the following we consider the relation between traffic characteristics and network multiplexer performance and discuss the possibilities for traffic control to guarantee QoS standards.

Studies on the performance of ATM multiplexers handling variable bit rate traffic show that there are broadly two types of congestion leading to cell delays (e.g., [19]).