A Simulation Study of Using ER Feedback Control to Transport Compressed Video over ATM Networks

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Abstract

Transporting video over asynchronous transfer mode (ATM) networks has been an active area of research. The Variable Bit rate (VBR) service in ATM networks is primarily designed and used for real time application like compressed voice and video. Due to compressed video is inherently bursty, the bandwidth could not be efficiently utilized. The explicit rate (ER) flow control designed for Available Bit Rate (ABR) service provides a powerful control scheme to network congestion that it may be modified to VBR service for utilise the bandwidth and control the Quality of Service (QOS) of real time video or voice. In this paper, we present a simulation study of using modified ABR flow control algorithm Enhanced Proportional Rate Control Algorithm (EPRCA) to support compressed video over the ATM network, and compare its performance with VBR transmission. .

Keywords: Compressed video, feedback control.

1 Introduction

Multimedia network is getting very important. Real time VBR traffic in ATM faces significant challenge. The real-time VBR service category is intended for real-time application, those requiring tightly constrained delay and delay variation, as would be appropriate for voice and video applications. Rt-VBR connections are characterised in terms of a Peak Cell Rate (PCR), Sustainable Cell Rate (SCR), and Maximum Burst Size (MBS). Sources are expected to transmit at a rate which varies with time (ATM Forum Technical Commitee 1996). If the peak rate to average ratio is high, the bandwidth utilization will be very low for VBR service.

ER feedback control has been proved effective for congestion control for high-speed networks. Lakshman, etc. proposed a scheme for transmission of VBR compressed video over ATM using the ER feedback control (LAKSHMAN, T. V. et.al. 1997). However it is not clear what a feedback control scheme should be employed. In this paper, we present a simulation study of using ABR flow control scheme-EPRCA to support compressed video.

2 ER feedback control

Several approaches to congestion control for ABR service in ATM networks have been considered. Among all proposed congestion control mechanisms for ABR service, closed-loop feedback control that allows the network to control the cell emission process at each source is commonly agreed to be the most effective solution (ATM Forum Technical Commitee 1996, L.ROBERT 1996, R. JAIN, et.al. 1996, K.-Y. SIU, H.-Y. TZENG 1994).

EPRCA is lead by the merger of PRCA with explicit rate scheme at the end of July 1994 ATM Forum meeting. The EPRCA is simply described as follows.

- The source send n data cells then send a Resource Management (RM) (CCR, ER, CI, ...,) cell, and then proportionally and continuously decrease their Allow Cell Rate (ACR).
- The switch computes a mean allowed cell rate (MACR) after receive a forward RM cell by MACR= (1-AV)*MACR+AV*CCR, where AV is the average ratio.
- If the switch receive a backward RM cells, it will set ER= Min (ER, 7/8*MACR) if it is congested.
- If the source receive a RM feedback, then set ACR= Min (ACR+AIR, ER, PCR) for CI=0;

In the scheme, CCR is current cell rate. CI is Congestion Indication.

In this study, we modify ABR EPRCA to VBR named as VEPRCA. The source and the destination share the same algorithm as defined for ABR. We use a buffer at the source to store the compressed video so that it could adjust its cell rate (CCR) upon receiving each RM cell.

3 Simulations

An extensively modified ATM simulator NIST simulator is used to examine the performance of the VEPRCA. The video source is generated by a trace from MPEG-2 transport streams. The mean bit rate of the entire trace is about 4.632 Mbps. The peak cell rate is 9.667 Mbps.

The peer-to-peer network (Fig.1) is used in the simulation. The distance of Inter-switch Link are set to 1000km (L12), with a capacity of 23.437Mbps. All other links are with 100Mbps capacity and 0.1km distance. The propagation delay is assumed to 5 μs per kilometer. The parameters are set as following: AIR= 0.053, RDF=0.0039, RIF=0.212, AV=0.0625, MRF=0.25, ERF=0.9375, DPF=0.875, HT=45 cells, LT=40cells. We assume there is a big queue (2000cells) at the source.

We compare the performance of VBR transmission with and without VEPRCA. In the VBR transmission without VEPRCA, compressed video traffic is segmented into cells and sent to ATM at its peak rate. In the VEPRCA transmission, compressed video data will be stored at a host buffer and send them at a specified rate adjusted based on the feedback of the RM.

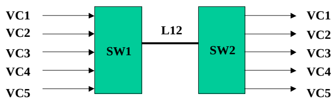

Fig.1. The peer-to-peer network.

Without VEPRCA, it is found that 27.6% of sending cells dropped at the switch. No loss happened for the case with VEPRCA. Cell delay of VC1 with and without VEPRCA is shown as Fig.2, and Fig.3, respectively. VEPRCA reduced the cell delay efficiently. If we calculate delay jitter as the maximum variation in delay experiences by message in a signal session [4], then the delay jitters of each VC with and without VEPRCA are compared in Fig.4. The VEPRCA reduce the delay jitter from about 50.9ms to 3.4 ms.

The effective throughput is defined as the ratio of throughput to maximum possible throughput, where throughput is the receive rate, the maximum possible throughput is the MPEG source rate. Fig.5 shows the effective throughput with and without VEPRCA.

Through the results, we could see that the VEPRCA could efficiently reduce the delay, delay jitter, and improve the effective throughput. Consider the frequently variation of compressed video, a variable source adaptation control scheme combine with ER feedback control could be an efficient approach.

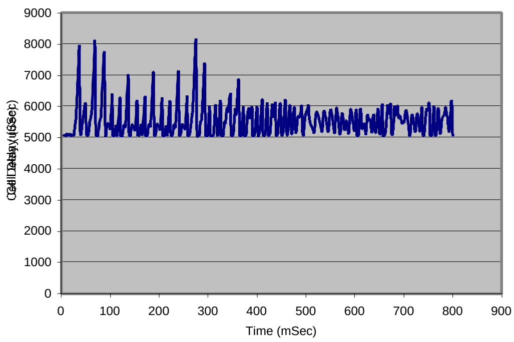

Fig.2. Cell delay of VC1 with VEPRCA.

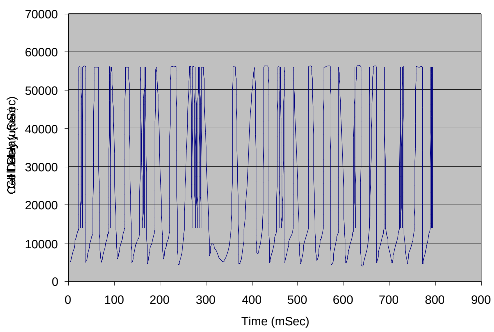

Fig.3. Cell delay of VC1 without VEPRCA.

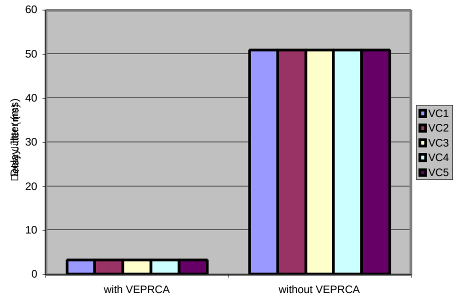

Fig.4. Delay jitter with VEPRCA and without VEPRCA.

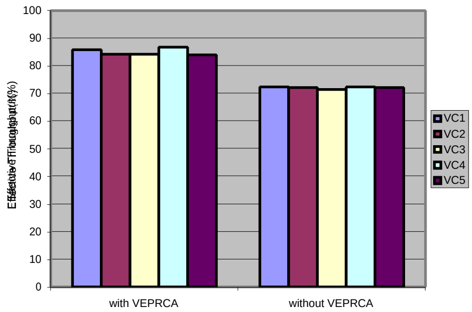

Fig.5. Effective throughput with VEPRCA and without VEPRCA.

4 Conclusion

In this paper, we present a simulation study of using ABR EPRCA to transmit compressed video over ATM network. To make network congestion, we set the mean traffic load to capacity of inter-switch link is about 95%. The simulation results show that EPRCA could efficiently reduce the cell delay, delay jitter, and improve the effective throughput. Through this study, we conclude that the ER feedback control could provide an efficient control for bursty video traffic. A variable source adaptation control scheme combine with ER feedback control could be considered as further study.

5 Acknowledgment

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6 References

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