ANALYSES OF CORRELATION BETWEEN CELL DELAY AND CELL LOSS IN ATM MULTIPLEX WITH VARYING QUEUE LENGTH

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1. Introduction

Asynchronous Transfer Mode (ATM) is a new technology for cell relay. It is based on cell multiplexing and switching via virtual paths and virtual channels. All the information to be transferred, voice, data, audio, video, image is decomposed into small cells with fixed length just after the traffic source. The users can negotiate transmission rate in accordance with their specific requirements. We decompose ATM network into a composition of ATM multiplexes with different distribution traffic flows, waiting queues, priorities, and servers. The ATM multiplex performs statistical multiplexing of cells from traffic sources and also forms parts of ATM switches. The aim of this work is to analyze correlation between cell delays and cell losses in ATM multiplex with different queue length.

2. A Model of an ATM Multiplex and Traffic sources

ATM multiplexes are approximated usually as a single server queue with different priority disciplines [Colliv'94], [Ginsburg], [Goleva'96], [Kadrev'98a]. The BISDN traffic is different in comparison with the traffic in telephone networks. Our model is capable to differentiate types of traffic sources. Queue length can be changed and is assumed to be less than 100 cells [Prycker'91], [Krishnan'94]. Serving discipline is FIFO (First Input First Output). In comparison with traffic sources in conventional telephone network, data networks, cable TV etc., ATM traffic sources have completely different characteristics. During ATM call, user may transmit different type of information at once- voice, data, video, audio, image with different bandwidth. It influences source traffic parameters. We demonstrate here reusable model of ATM traffic source that will give us an opportunity to explain different sources and type of calls with finite set of parameters [Goleva'98], [Kadrev'98a], [Kadrev'98b]. A trial to define analytical model of ATM traffic source can be seen in [Lee'94], [Hui 90], [Goleva'96].

3. Simulation Model

A simulation model of ATM traffic sources and single server queue is proposed (Figure 1). The standardized decomposition process of all the information from traffic source into cells is considered. It contains call level, burst level, and cell level. The modelled services are telephone, e-mail, ftp, slow video (low density video) and HDTV. The calls follow continuously as well as bursts. The cells are generated with given rates. We consider this to be the worst case approximation from the traffic point of view. In the model we may change the number of sources, their type, the distribution of calls λ_{call}, bursts $\lambda_{burst/pause}$, type and distribution of cells $1/\lambda_{cells}$, queue length, servicing time τ_{serv}. A group of traffic sources is defined. It consists of one telephone ($1/\lambda_{cells}$ =17 ms), one e-mail ($1/\lambda_{cells}$ =1 ms), one ftp ($1/\lambda_{cells}$ =1 ms), one video ($1/\lambda_{cells}$ =1 ms) and one HDTV user ($1/\lambda_{cells}$ =200 μs). The multiplex serves a cell with a fixed rate τ_{av}=3 μs/cell.

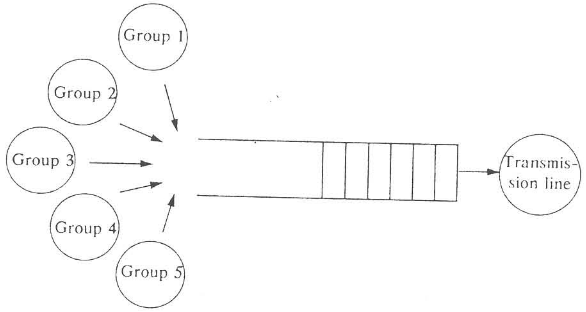

Fig. 1. Simulation model

With this model cumulative and individual cell losses and cumulative and individual cell delays for different type of traffic sources and services are obtained. Queue length, its maximal and average length, number of cells lost and number of waiting cells, mean waiting time for all cells and mean waiting time for waiting cells as well as the distributions of these parameters are evaluated. All the results obtained pass special procedure that applies Student criteria with 5% accuracy and 0.95 interval of confidence.

4. Results

The results obtained with the simulation model present the correlation between cell losses L (Figure 2-10) and cell delays T (Figure 11-18) as a function of number of traffic sources N (from 10 to 70) and different queue length L_q (1, 5, 10,..,60 cells). Cumulative (SUM) and individual values are presented for every service type (VOICE for telephone, EMAIL and FTP for data services, VLOW for slow video and VHIG for HDTV. Specific results is seen for $L_q \geq 10$, when L=0 for N=10. When $L_q \geq 20$ the curves for any service except telephony (VOICE) became similar. Cumulative cell losses decrease when $L_q \geq 20$ and are 0.7% for L_q=60. It is visible that as a value and curve characteristics HDTV service (VHIG) is the most critical one. Cell losses for the services which generate small amount of cells when L_q is also small (0, 1, 5) almost do not depend from number of traffic sources N. It is not true for the services which generate high cell streams. The correlation of cell losses for services with different cell rates is kept when Lq increases. Cell losses are proportional on the cell rates. The character of cell loss curves is the same for the system without or small queue (Lq=1, 5, 10).

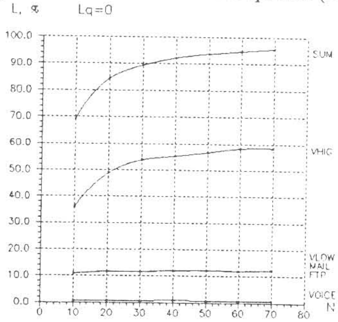

Fig 2. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=0.

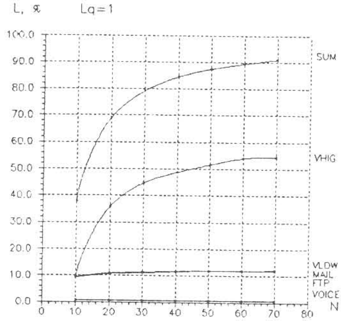

Fig. 3. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=1.

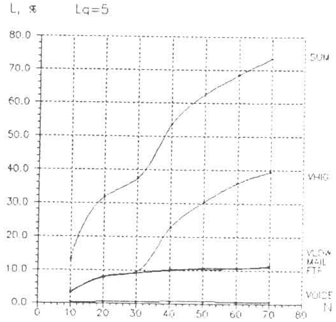

Fig. 4. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=5.

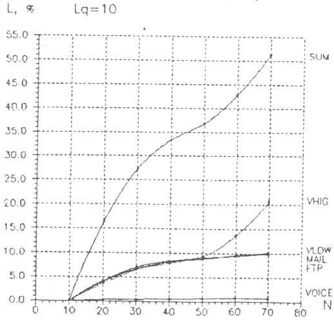

Fig. 5. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=10.

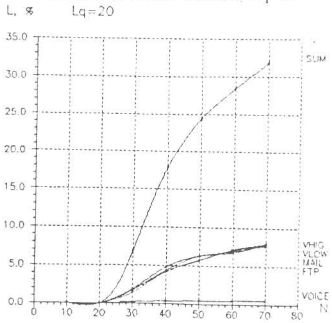

Fig. 6. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=20.

Cell delays increase for the services with different rates and when Lq also increases. On Figures 11-18 Tq is a mean waiting time only for waiting cells. It is almost constant for Lq≤10. When Lq>10 Tq depends on number of traffic sources N. When Lq=60 cell delay values are grouped in accordance with source rates.

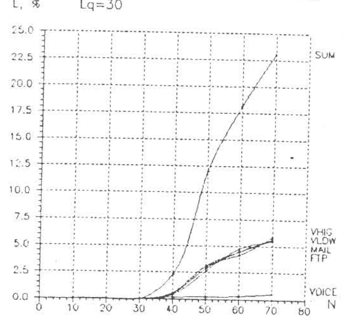

Fig. 7. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=30.

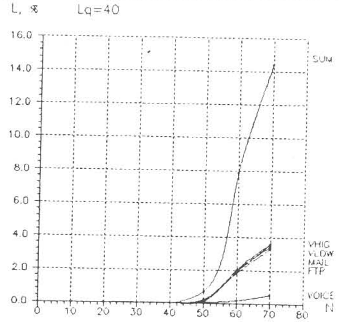

Fig. 8. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=40.

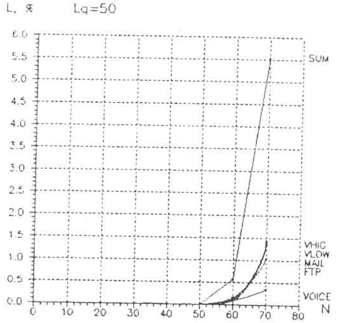

Fig. 9. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=50.

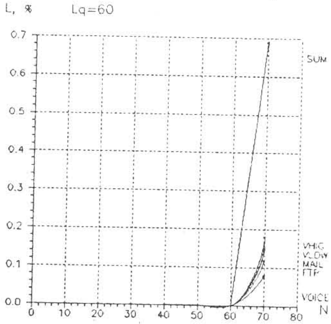

Fig. 10. Cell loss L, Lq - queue length, N - number of traffic sources, Lq=60.

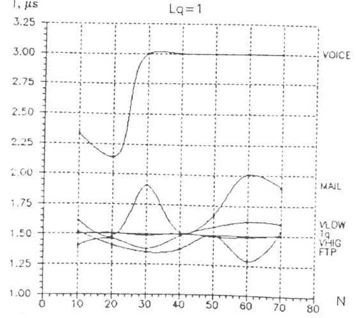

Fig. 11. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=1.

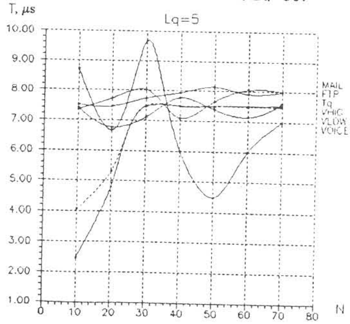

Fig. 12. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=5.

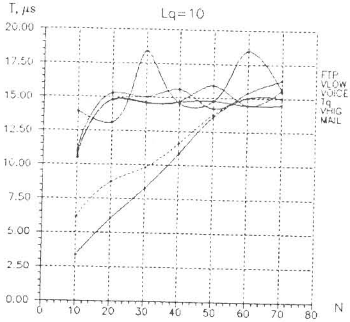

Fig. 13. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=10.

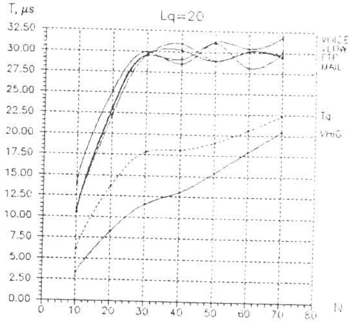

Fig. 14. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=20.

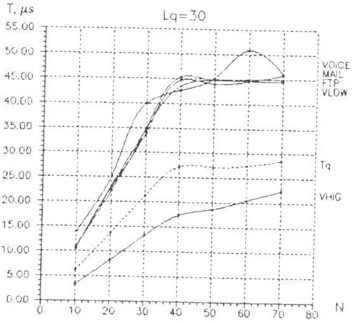

Fig. 15. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=30.

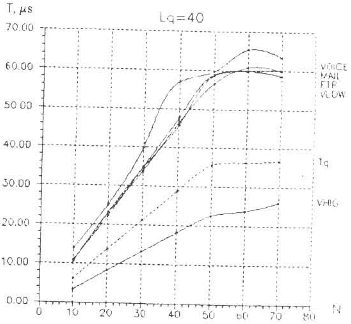

Fig. 16. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=40.

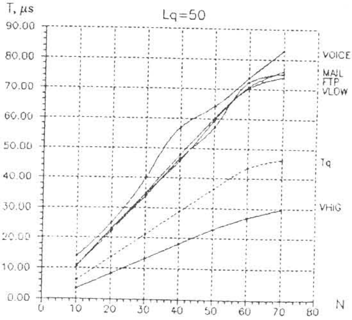

Fig. 17. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=50.

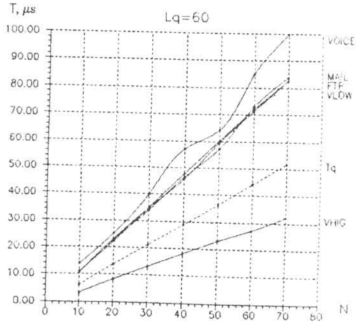

Fig. 18. Waiting time T, Lq - queue length, N - number of traffic sources, Lq=50.

5. Conclusion

This paper presents a correlation between cell losses and cell delays in ATM multiplex derived with simulation model. We model five different rate CBR traffic sources and change queue length. The serving discipline is FIFO without priorities. In this sense we consider our work as a part of complex performance evaluation of an ATM multiplex with priorities, different serving disciplines, serving times etc. The individual and cumulative cell losses for single server with and without queue are presented as well as cell delays for every modelled service. When queue length overcome given value cell delays and cell losses depend more on number of traffic sources. Cell losses depend on queue length more in comparison with cell delays.

6. References

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