CCITT SGXV
Working Party XV/1
Experts Group for ATM Video Coding

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Subject: A Simulation Study of Video Teleconference Traffic in ATM Networks

Source: Bellcore

Purpose: Discussion

1. ISSUES STUDIED AND CONCLUSIONS

For this contribution[1] [2] we used a long (30 minute) sequence of video teleconference data to study by simulation the following fundamental performance issues related to VBR video transmission over ATM networks: (1) What are the cell-loss and delay characteristics for a simple network model? (2) Do different sources experience different cell-loss rates for a given delay? Does frame-interval periodicity cause any initial correlation in call set-ups to persist for long periods?

The traffic data consists of a sequence indicating the number of cells per frame for 48,500 frames of a teleconference and was obtained by recording the output of a VBR video coder during a 30 minute teleconference. A key feature of our simulation study is the use of a long sequence of "real" data. Most previous studies have used very short sequences (for instance, a few seconds) of data to address these issues. We believe that the use of such short sequences necessarily sacrifices accuracy. Our major conclusions are: (1) If we consider a single stage multiplexer with a finite buffer capacity then different sources with identical statistical characteristics can experience widely different (as much as a factor of 30 in our simulations) cell-loss rates. These cell-loss rates depend on the order in which the calls from each source are initially set-up and on the intervals between the set-ups. This difference can impact the definition of statistical multiplexing gain, and also impact network resource allocation policies. Traffic periodicity cannot be ignored and is a key factor impacting statistical multiplexing gain. (2) The differences in cell-losses experienced by different sources is due to the inherent periodicity of video traffic. A simple buffer scheduling mechanism can alleviate this source-periodicity effect. An alternative would be to do some traffic smoothing at the source.

2. IMPLICATIONS

If the average cell-loss rate is used to determine multiplexing gain, then some sources will experience cell-loss rates much better than the average whereas others will experience rates much worse than average. Furthermore, the cell-loss rates will depend on when exactly a call from a specific source is set-up in relation to calls from other sources. If the multiplexing gain is determined based on the worst-case loss-rate that a source can experience (as may be necessary to guarantee service quality), then this worst case rate may be far below the average. In this case, the network resources will be inefficiently allocated. Hence, it is important to reduçe the source-periodicity effect as much as possible.

One method of reducing the source-periodicity effect is by introducing some traffic smoothing at the coder. Another method is by an appropriate choice of scheduling policy at the multiplexer.

3. SUMMARY OF SIMULATION RESULTS

To focus our study on these two issues, we limited our attention to a single stage multiplexer model (shown in Figure 1).

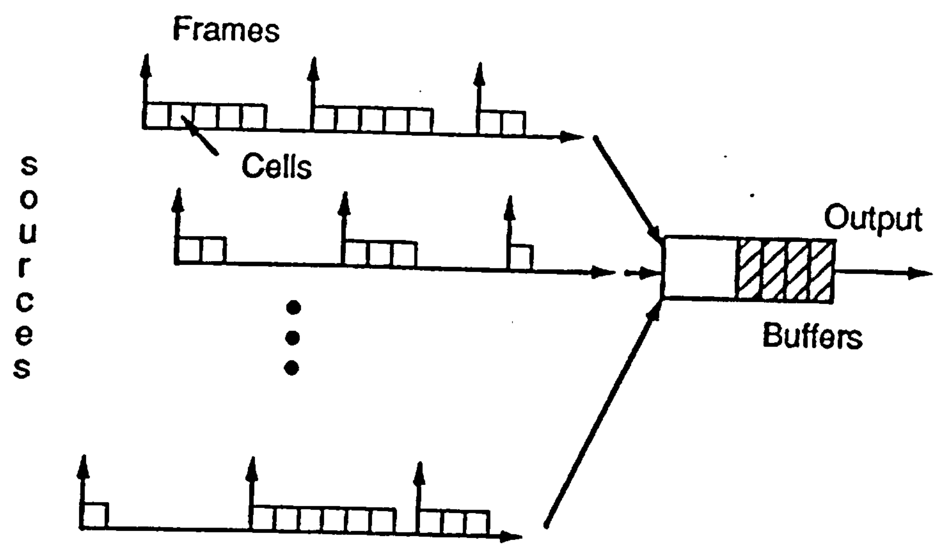

Figure 1. Single stage multiplexer

The simulation results are summarized in Table 1. The results in this table demonstrate that sources with the same statistical characteristics can experience very different cell-loss rates. The results were obtained by simulating the single stage multiplexer model with 16 input video sources. Each source was assumed to be connected to the multiplexer by a link with a peak transmission rate of 8.5 Mbps. The outgoing link from the multiplexer was assumed to have a peak rate of 45 Mbps. In all our simulations, we used a cell size of 64 octets (there is no loss of generality due to the use of this specific value). The multiplexer buffer size is determined by the allowed maximum delay that a cell can experience. Table 1 presents the cell-loss rates experienced by each of the 16 sources for two delay values - 4 ms and 5 ms (with a 45 Mbps outgoing link, this corresponds to 351 and 439 cell buffers respectively in the multiplexer).

The big difference in loss rates (evident in Table 1) is caused by preservation of the initial call-setup phases. Even though the sources have identical statistical characteristics, the arrival-instant queue lengths seen by cells from different sources are not statistically identical. If frames from a specific source are always immediately preceded by frames from other sources, then cells arriving from this source are likely to see larger queue lengths (and cell-losses) than cells arriving earlier from the other sources. Due to the fixed interframe period, the same process repeats

TABLE 1. Cell-loss rates experienced by each of the 16 sources

Source Number	Starting Time	Starting Frame	Probability of Cell Loss % times 10 sup 6%			
			Max. Delay = 4 ms		Max. Delay = 5 ms	
			FIFO Scheduling	Non-FIFO Scheduling	FIFO Scheduling	Non-FIFO Scheduling
0	15.46	299	0	1.547	0	0
1	24.23	39635	43.997	46.060	4.984	3.953
2	15.21	25256	10.999	47.434	1.031	4.125
3	31.96	5450	0	47.091	0	3.953
4	30.30	26301	72.183	47.950	4.984	4.125
5	14.35	20454	0	04.812	0	0
6	24.25	23134	120.820	47.263	11.343	4.125
7	08.77	20446	0	6.359	0	0
8	00.07	31573	0	30.592	0	3.094
9	27.15	7486	72.355	46.060	5.671	3.953
10	38.65	5788	78.887	33.685	9.453	3.437
11	02.12	5112	06.703	33.169	0	3.437
12	08.20	19213	0	1.547	0	0
13	29.62	1252	85.761	47.263	8.250	3.953
14	21.56	34430	22.686	45.028	0.344	3.781
15	21.56	24971	18.905	47.434	0	4.125

causing certain sources to experience higher cell-losses than others. Table 1 also shows that periodicity effects can be reduced by appropriate scheduling.

REFERENCES

1. D. Heyman, A. Tabatabai and T. V. Lakshman, "Statistical Analysis and Simulation Study of VideoTeleconference Traffic in ATM Networks," submitted to IEEE Journal of Selected Areas in Communications.

2. D. Heyman, A. Tabatabai and T. V. Lakshman, "Analysis of VideoTeleconference Traffic in ATM Networks," submitted to GLOBECOM 91.