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

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Subject: Statistical Analysis of Video Teleconference Traffic - II

Source: Bellcore

Purpose: Discussion

1. MODELING ISSUES STUDIED AND CONCLUSIONS

This contribution presents further results on the work presented in our previous contribution to this Experts Group (Document AVC-61). Our new results corroborate the results that we presented in document AVC-61 regarding the gamma distribution of cells per frame in video teleconferences. For the previous contribution, we analyzed a 30 minute sequence of video teleconference data to answer the following question: What statistical models characterize the data accurately and what models of video sources are accurate enough to be used in traffic studies? The traffic data (provided by Siemens) that we had analyzed consisted of a sequence indicating the number of cells per frame for 48,500 frames of a teleconference with no scene cuts and with moderate motion. Our major conclusions were: (1) The number of cells per frame for video teleconferences follows a gamma (or negative binomial) distribution. Also, the number of cells per frame is a stationary process. (2) The order 2 autoregressive model fits the data well in a statistical sense. However, for traffic studies, neither an autoregressive model of order 2 nor a two-state Markov chain model is good because they do not model correctly (either underestimate or overestimate) the occurrence of large values (of number of cells per frame) and these large values are a primary factor in determining cell-loss rates. (3) A model sufficiently accurate for use in traffic studies was constructed using the peak rate, mean, variance, and first-order autocorrelation coefficient of the traffic.

For this contribution, we analyzed two new 25 minute long (about 37000 frames) sequences of video data called "viconf" and "viphone". These sequences were provided by Alcatel in the last Experts Group meeting held in August at Santa Clara, CA. "viconf" is a video teleconference sequence with a mean of 1506.4 cells per frame (each cell is 14 octets), a maximum of 4818.0 cells per frame, and a standard deviation of 512.6. "viphone" is a video phone sequence with a mean of 1559.1 cells per frame, a maximum of 6670.0 cells per frame, and a standard deviation of 853.6.

The results of our analysis of the two sequences show that 1) The number of cells per frame for the "viconf" sequence follows a gamma (or negative binomial) distribution. **This further corroborates the result in our contribution (AVC-61) that the number of cells per frame for video teleconferences follows a gamma distribution.** 2) The number of cells per frame for the "viphone" sequence also follows a gamma distribution. However, the fit is not as good as the one for the video teleconference sequence. The "viphone" sequence has more frames with a large number of cells per frame than would be expected from the gamma distribution (the tail of the gamma distribution does not fit the empirical distribution well). This may be because there are more scene changes in "viphone" than in "viconf". 3) The autocorrelation function of both sets of data is exponential upto a lag of about 125 frames after which

the autocorrelation of the data does not drop as much as the exponential. Our analysis for the previous contribution had shown an exponential autocorrelation function and this was used to synthesize the DAR(1) model proposed in that contribution. The deviation from the exponential for these sets of data may be sufficiently small to retain the DAR(1) model as a model accurate enough for traffic studies. We intend to test this by simulation and expect to present the results in a subsequent contribution.

2. SUMMARY OF NEW STATISTICAL ANALYSIS

The histogram of the "viconf" data is shown in Fig. 1(a). The empirical density function looks negative binomial and this is validated by the Q-Q plot. The Q-Q plot, which plots the quantiles of the data vs. the quantiles of the fitted distribution, is a powerful goodness-of-fit test. The Q-Q plot for our data and the gamma distribution is shown in Fig. 1(b). The Q-Q plot shows that the fit is very good except for the right-hand tail, where the gamma distribution has too little probability.

The histogram of the "viphone" data is shown in Fig. 2(a). The corresponding Q-Q plot is shown in Fig. 2(b). Here, the fit is not as good as the one for "viconf". Again, there is too little probability at the right-hand tail (as can also be seen from the histogram).

Fig. 3(a) and Fig. 3(b) compare the autocorrelation of the "viconf" and "viphone" sequences to the exponential. It can be seen that there is deviation from the exponential when the lag is more than about 125 frames.

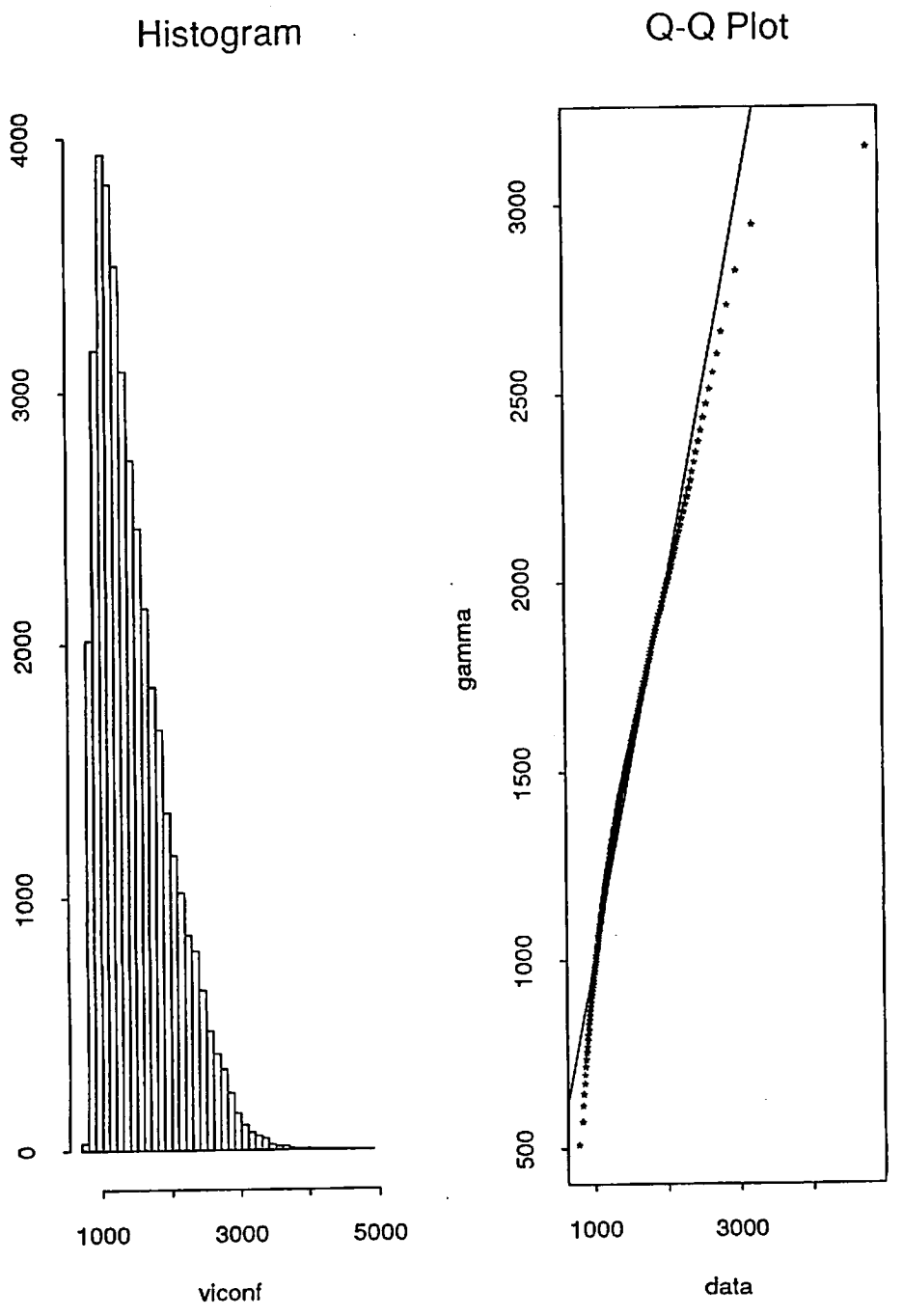

Figure 1: Fig.1(a) Histogram and Fig. 1(b) Q-Q Plot for "viconf" Data

Figure 2: Fig.2(a) Histogram and Fig. 2(b) Q-Q Plot for "viphone" Data

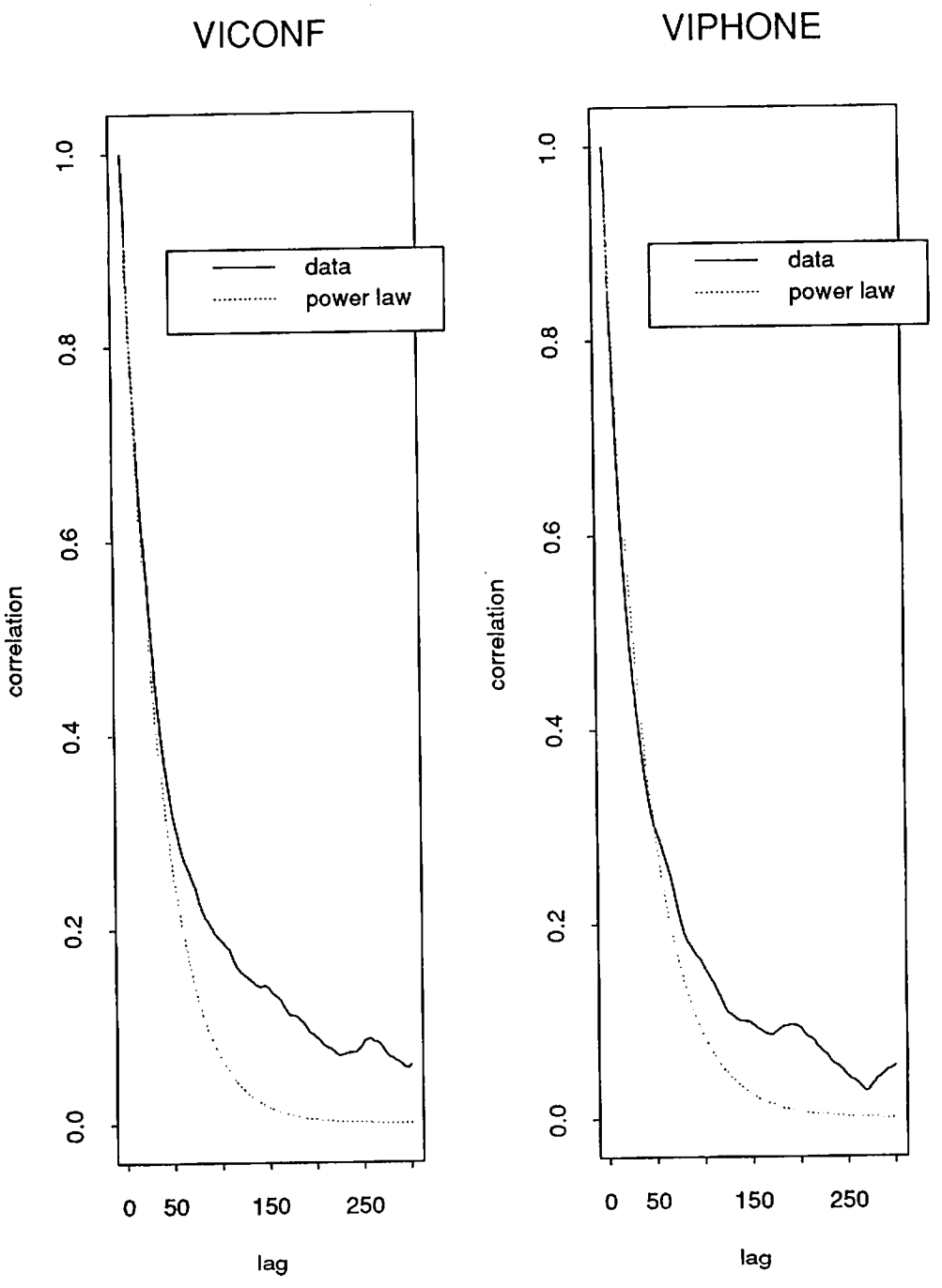

Figure 3: Comparision of the autocorrelation of the data to the exponential