Workshop : Computer Networks

Title : The Jitter Delay Guarantees by Buffer Control in Multimedia Environments

Abstract： In applications of multimedia networks, Transmissions involving data, audio, graphics, video, images, and animation are provided. The QoS (quality of service) guarantees the above medias are stringent topics. A good QoS has the ability to reserve resources within network and terminal devices to ensure that certain perceptual performance measures are meet. For QoS guarantee, the technique by using buffer compensation is necessary. The decision problem about how large the buffer size for selections is an interesting issue. At this paper we are concentrating on the compensation of jitter delay at the destination by using buffer control. If the buffer size is too large, the system resources are wasting, in another aspect, too short buffer will not guarantee the system performance requirements. In this paper our propose an simple formula on calculating an adequate buffer size for delay jitter control at the destination node by Chernoff bound methods, the jitter is properly controlled without wasting too much unnecessary resources and the performance is guaranteed in the real time multimedia environments.

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Keyword ： Jitter Control, QoS, Chernoff bound

The Jitter Delay Guarantees by Buffer Control in Multimedia Environments

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time multimedia environments.

I. INTRODUCTION

In multimedia environments, good QoS can guarantee the requirements of services. Especially in the real time transmissions, the service quality is mainly determined from the QoS parameters. The general attributes of QoS parameter includes reliability, bandwidth and jitter. We are concentrating on jitter control at here. A complete concept of jitter graph consists the set of jitter nodes and jitter links[5], but it takes too much costs for jitter control at each node on internet networks. We assume a simple queueing model for jitter control as shown in Fig-1. Usually, Jitter is defined as the variation of inter-cell delay at destination [1]. Formally two measures of jitter delay are defined [4]. The first one is "delay jitter", second is the "rate jitter". The former (as shown in equation (1)) accounts for maximum difference in total delay of different packets, where the goal is to minimize the difference between delay times of different packets. The latter (as shown in equation (2)) cares the maximum and minimum inter-arrival time, it's goal is to minimize the difference between inter-arrival times.

$$J_d^m = \underset{0 \le i,k \le n}{MAX}\{| t_i - t_k - (i-k)X_a |\} --------- (1)$$

$$J_r^m = \underset{0 \le i,j < n}{MAX}\{| (t_{i+1} - t_i) - (t_{j+1} - t_j) |\} ------- (2)$$

in which $m = \{t_i\}_{i=0}^{n}$ is the set of time sequence and X_a is the inter arrival time.

The above two measures are all belong to non-work-conserving policies. At here we focus on the technique of jitter delay control at the destination. The advantage of jitter control is transforming the traffic into smooth pattern for getting better performance guarantees and meanwhile more system resources are saved. One effective solution on buffer size calculations by Chebyshev has been provided [3], it is very fast and simple in designing applications by this method, however it will diverge in some aspect. In this paper we provide another solution on buffer size calculation, our solution on jitter bound is strictly tight. Economically, in consideration of saving system resources, the Chernoff method can gives a strong approximation on buffer size estimations. The rest of this paper is organized as follows. In section II, a detail mathematical analysis is calculated for Chernoff bound method. Numerical results for buffer size comparing with Chebychev method is indicated in section III. Section IV concludes the paper.

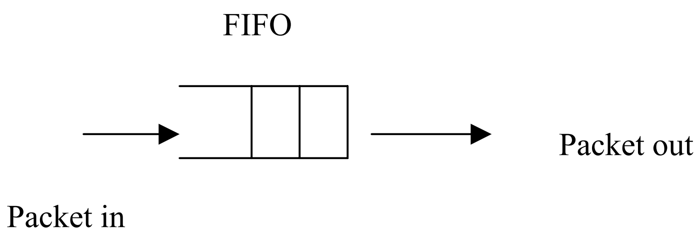

Fig-1 Jitter control queue diagram

II. BUFFER SIZE CALCULATIONS

For simplicity, we divide multimedia into two kinds of types, they are main and slave streams. The main stream is an independent stream and the slave stream the characteristic of slave stream is depended on master stream. We only calculate the relationship between buffer size and jitter bounds of master stream. The slave stream can be treated in the same manner. For the main stream, the delay jitter is defined as the deviation from the expected value as following:

$$T_I = D_I - M_I$$

where symbols T_I, D_I, M_I indicate the delay jitter, network delay and expected value of the I'th session of stream. For satisfying QoS and system synchronization requirements, the probability specification is defined as

$$P(|J_I| \geq T_A) \leq \delta$$

in which $P, J_{I,} T_A and \delta$ indicate the probability, jitter quantity, maximum allowable jitter quantity, and error bounds for guaranteeing system requirements. If the buffer size is represented by B (note the amount calculated here have already converted into time unit for simplicity) then

$$J_I = 0 \quad \text{if } |T_I| \leq 0.5B$$

$$J_I = T_I - 0.5B \quad \text{if } \quad T_I \geq 0.5B$$

$J_I = T_I + 0.5B$ if $T_I \le -0.5B$

note the parameter 0.5B means half of buffer size is obtained for best jitter guarantee[4]. According to the Chernoff bounds [6] we obtain

$$P(|J_I| > T_A) = P(|T_I| > T_A + 0.5B) \text{---------------(3)}$$

from Chernoff bounds property, we have

$$P(|T_I| > T_A + 0.5B) < \frac{E[EXP(tT_I)]}{EXP(T_A + 0.5B)t} = \delta \text{----(4)}$$

after some algebra manipulation, the expected buffer size is

$$B = 2*[LOG(\frac{E[EXP(tT_I)]}{\delta t}) - T_A] \text{----------------(5)}$$

III. NUMERICAL RESULTS AND DISCUSSIONS

The buffer size requirements for a given jitter bound between Chebychev and Chernoff bounds are shown in Fig-2. the jitter delay is assumed to be negative exponential distribution for simplicity. The mean value equals 4, and maximum jitter bound is taken to be 3. The numerical results are run under the MATLAB R12 tools. From Fig-2, it is evident the former is an strictly increasing function as the bounding factor (we define the bounding factor as square root of the reciprocal of error bound) , when bounding factor approaches to a large number, it will approximately be divergent. The latter is much more smooth, it increases slowly and approximately convergent to some limits. This indicates the Chernoff bound method gets much better results. Other traffic type of jitter delay can be treated in the same way and the results will have the same characteristics.

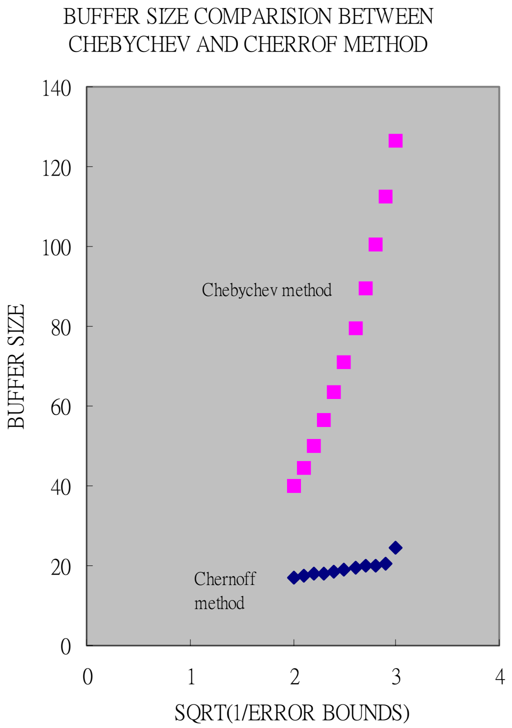

Fig-2 Buffer Size Comparison

IV CONCLUSIONS

For delay jitter control at the destination, estimation buffer size by Chernoff bound is very powerful and robustness. Our results are more accurate and better than Chebyshev bound. the results can be extended to multivariable system. In this paper an optimal resource utilization of buffer size is calculated to guarantee the QoS performance and the multimedia stream is played back smoothly at the destination with the minimum cost of resources.

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