An Aggressive Admission Control Scheme for Multimedia Servers*

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Abstract

In this paper, we have proposed two types of admission control algorithms for multimedia storage servers: Future-Max *(FM) and* Interval Estimation *(IE). The FM algorithm uses the maximum bandwidth requirement of the the future to estimate the bandwidth requirement. The IE algorithm defines a class of admission control schemes that uses a combination of maximum and average bandwidth within each interval to estimate the bandwidth requirement of the interval. The performance evaluations done through simulations show that the server utilization and the quality of service are improved by using the FM and IE algorithms.*

1 Introduction

A multimedia storage server (MSS) should ensure that the retrieval of media streams occur at their real-time rate [1]. As the total bandwidth from the storage devices attached to the server via network to clients is fixed, an MSS can only support a limited number of clients simultaneously [1]. Determination of the acceptance/rejection of a new request are done through the admission control algorithm. The admission control algorithm checks if the available bandwidth is sufficient for the total bandwidth required by the streams currently being retrieved plus the bandwidth requirement of the new request. If it is sufficient, the server can accept the new request. Otherwise, the admission of the new request may introduce distortions or jitters in the audio or video quality [2]. Based on the desired *Quality of Service* (QoS), the admission control algorithm decides whether or not to accept the new request.

In this paper, we propose a set of aggressive admission control algorithms that maximize the server utilization as well as provide high QoS.

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2 Preliminaries

The admission control schemes proposed in the literature can be classified into three categories [1]: *Deterministic*, *Statistical* and *Best Effort*.

The disadvantage of current admission control algorithms [2, 3, 4] is that they only use a few statistical data to represent the server behavior and the media streams. This method facilitates the implementation, reduces the complexity of computation, and requires less storage space. However, the streams are not modeled accurately which may lead to poor server utilization. The current policies use the worst case scenario of all the streams to employ admission control. In reality, there is a very small possibility that all the streams reach their worst case at the same time.

3 Sampling-Based Admission Control

The proposed approach relies on a closer estimation of $A(t)$, the actual bandwidth requirement. When a VBR media stream is stored, a complete and accurate description of the rate changes could be computed. This is the profile of bandwidth requirements of the VBR media stream. The server can use this information during playback for admission control.

We introduce a method based on sampling to obtain the estimated bandwidth requirement, $BE(t_s)$, with respect to the sampling interval t_s. By using the sampling scheme, we divide $[0, T]$ into several small time intervals of the same size t_s.

The bandwidth estimation based on the sampling method can be done in two different ways. The first method corresponds to the deterministic estimation and uses the maximum value within an interval as the estimated bandwidth requirement for the entire interval. The estimated bandwidth for the ith interval, denoted as $BE_{smax}(i)$, is expressed as

$$BE_{smax}(i) = \max\{A(t)\},$$
$$t \in [it_s, (i+1)t_s], \forall i \in \{0, 1, \cdots, n-1\}, n = \frac{T}{t_s}.$$

The second method is a statistical scheme that uses the average of $A(t)$ within an interval as the estimated bandwidth. This bandwidth estimation for the ith interval is denoted as $BE_{save}(i)$ and is computed from

$$BE_{save}(i) = \frac{\int_{it_s}^{(i+1)t_s} A(t)dt}{t_s},$$
$$t \in [it_s, (i+1)t_s], \forall i \in \{0, 1, \cdots, n-1\}, n = \frac{T}{t_s}.$$

By using different combinations of BE_{smax}, BE_{save} and different interval size t_s, we can get different bandwidth estimations, $BE(i)$. Thus $BE(i)$ can be expressed as a function as follows.

$$BE(i) = f(BE_{smax}(i), BE_{save}(i), t_s),$$
$$\forall i \in \{0, 1, \cdots, n-1\}.$$

3.1 Future-Max Algorithm

Future maximum bandwidth refers to the maximum bandwidth required from the current time point to the end of the playback of the media stream. The concept behind this *Future-Max* (FM) algorithm can be explained as follows. In the deterministic admission control scheme, the reserved bandwidth for a stream corresponds to its maximum bandwidth. After the playback of the portion that requires the maximum bandwidth, it is not necessary to reserve resources corresponding to the maximum bandwidth. It is definitely beneficial to use the maximum bandwidth of the portions that is not played back instead of the whole stream. The FM algorithm scans through the future intervals in order to determine the maximum bandwidth that is required in future and uses it for admission control. The sampling technique described in the previous subsection can be used to implement the FM algorithm.

3.2 Interval Estimation Algorithms

In this subsection, we propose a family of admission control policy named as *Interval Estimation* (IE) algorithm, which is based on the bandwidth estimations for each of the sampled intervals. The estimations within the intervals could be deterministic, statistical, or a combination of the two. A general expression for the bandwidth estimation of the ith sample using the IE algorithms, $BE_{IE}(i)$ is given as

$$BE_{IE}(i) = \alpha * BE_{smax}(i) + \beta * BE_{save}(i),$$
$$\text{where } 0 \le \alpha, \beta \le 1 \text{ and } \alpha + \beta = 1.$$

The value of α and β can be varied to obtained a family of admission control schemes. For the deterministic admission control scheme, $\alpha = 1$, $\beta = 0$, and the sampling time period equals to the whole length of the stream ($t_s = T$). The statistical admission control scheme based on only the average bandwidth requirement refers to the case when $\alpha = 0$, $\beta = 1$, and $t_s = T$.

When t_s gets smaller, the corresponding $BE_{smax}(i)$ and $BE_{save}(i)$ become closer to $A(t)$. Since they are the upper and lower bounds of $BE_{IE}(i)$, $BE_{IE}(i)$ will be also closer to $A(t)$. In the extreme case, when $t_s = t_{unit}$, $BE_{smax}(i)$ and $BE_{save}(i)$ are equal to $A(t)$, which also equals to $BE_{IE}(i)$. This scenario reflects the best estimate of the bandwidth requirement. Such $BE_{IE}(i)$, where $t_s = t_{unit}$, is the optimal $BE(i)$, which results in the highest server utilization and provides the highest QoS. However, the implementation complexity will be very high in such a case.

4 Performance Evaluation

We have evaluated the proposed admission control schemes through simulation experiments. Due to the space limitation, we are unable to describe our simulator and the experimental results. Readers are encouraged to read an expanded version of the paper available at http://www.ee.iastate.edu /~ prasant /ACAR/acar.html to compare the results. In almost all the cases, the proposed algorithms provided a performance improvement of about 25%-75% over the deterministic admission control scheme [5].

5 Concluding Remarks

In this paper, we have proposed a new family of admission control algorithms. These algorithms are based on a sampling technique and use an aggressive method to compare and reserve the bandwidth available at the server. Two types of admission control schemes are proposed, which are called FM algorithm and IE algorithm. Simulation results shows a large performance improvement over previously proposed schemes.

References

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