An Empherical Analysis Of Batching Policies For Distributed VoD System

Ahlam S.A. Ansari [1], Nafisa M. Mapari [2]
Computer Engineering Department, M.H. Saboo Siddik College of Engineering

Abstract

Media plays a vital role in today's world, with the advanced technologies recently developed in the areas of high-speed networks and multimedia, video-on-demand (VOD) service is considered as the emerging trend in al ways of life. Better quality video, as well as efficient way to send and receive them is necessary. Quality of video, streaming time of video and the bandwidth required makes a lot of difference. Hence we have done an empirical study of different types of batching techniques to minimize the start-up delay of video demanded.

1. Introduction

Recently, video-on-demand (VoD) has become a new media service for providing entertainment to customers. In a VoD system, customers can choose a movie to watch at any time they wish via public communication network. In order to serve the customers in a strictly on demand basis, current VoD systems dedicate a transmission stream for each viewer. As a result, the network and I/O bandwidth of the server will be quickly exhausted and thus limit the number of customers served by the system. Using batching customers are grouped together. Multicasting is used to minimize the bandwidth requirement. A number of batching techniques [1]–[7] have been developed in recent few years and an empirical study have been done on different batching techniques.

2. Video-on-Demand Architecture

The basic architecture of a VoD system consists of:

1. Video Encoder
2. Video Server
3. Directory Server
4. Client
5. Network

The Network connects all the other VoD system components together as they are distributed geographically. The encoder accepts the video input and then uploads it on the video server after compressing/encoding the video stream received. The video server is a server with huge amount of disk space to accommodate day by day increasing videos in segments, not as a single file. The directory server keeps the index file which points to all the segments of those videos in video server, and these videos are published to the client so that they can access it. The fig 1 shows the architecture of basic VoD system.

3. Types of Video Services

a. Broadcast / Multicast Video Service

The multicast facility of modern communication networks [2] offers an efficient means of one-to-many data transmission. The basic idea is to avoid retransmitting the same packet more than once on each link of the network by having branch routers duplicate and then send the packet over multiple downstream branches. Multicast can significantly improve the VoD performance.

Passive receive with no control except selecting the channels. One channel is needed per movie / programme.

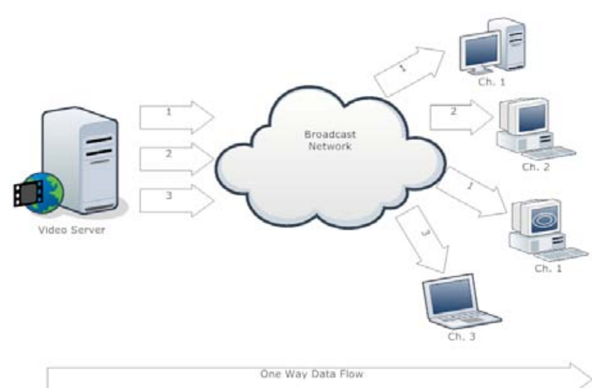

Figure 1 Broadcast / Multicast Video Service

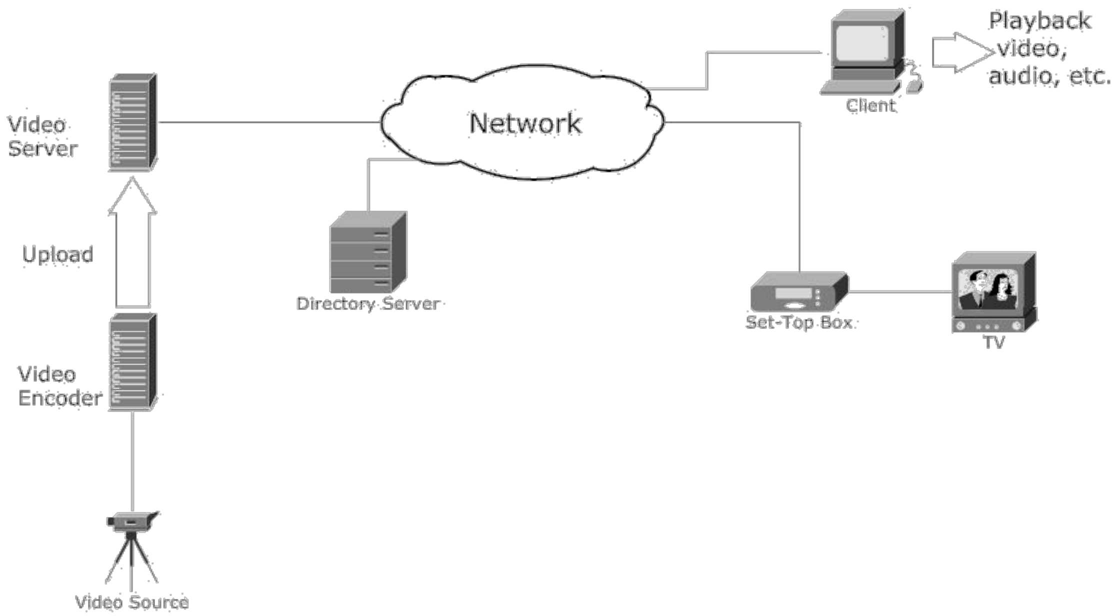

Figure 2 Architecture of a Basic VoD System

a. Near-Video-on-Demand

Near video on demand is a video delivery service that allows a customer to select from a limited number of broadcast video channels when they are broadcast. NVOD channels have pre-designated schedule times and are used for pay-per-view services. Passive receive with limited controls. System response time inversely proportional to number of required channels [2].

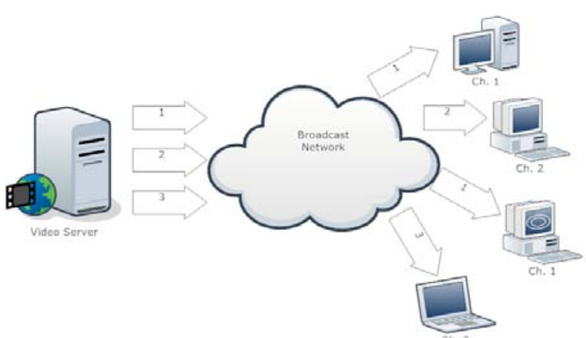

Figure 3 Near Video on Demand Service

b. True Video-on-Demand

True Video-on-Demand system uses one dedicated channel for each service request, offering the client the best TVoD service. However, such a system incurs very high costs, especially in terms of storage-I/O and network bandwidths. Full interactive ontrols, like pause/resume, seeking, fast forward, etc .

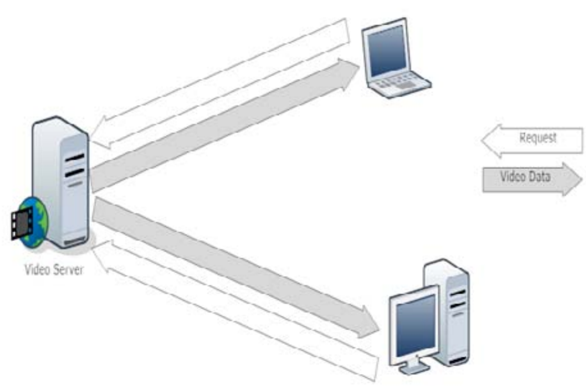

Figure 4 True Video on Demand

4. VoD Batching Policies

Requests by multiple clients for the same video arriving within a short time interval can be batched together and serviced using a single stream. This is referred to as batching. Video request is delayed for a period of time so that more requests for the same video are collected. The batch of requests is then served by a multicast video stream.

The major drawback of this scheme is that the customers have to wait for a batching interval until the video is started to play. Hence, it may increase the customer dissatisfaction if the waiting interval is too long.

Some authors have worked on reducing the start-up delay in multicast delivery systems as the major problem with the batching approach is that it introduces a significant start-up delay to the customer, which in fact contradicts the idea of on-demand service.

4.1. Batching policy for video-on-demand in multicast environment *W.-F. Poon, K.-T. Lo and J. Feng Says:*

a. Piggybacking Approach

It merges different requests together by adjusting the play-out rate of the videos so as to reduce the start-up delay of the system. The greedy policy attempts to merge the requests as many times as possible during the entire video session in order to save more bandwidth. However, allowing more than a single merge per stream could be costly in terms of other resources. For example, if the play-out rate is adjusted in real time, a specialized hardware is required to keep up with the demand. If a replica of the video is generated in advance, since it is possible that requests can be merged during the entire video session, very large disk storage is required at the server side.

b. Double-rate (DR) batching policy

Considering the waiting time (conventional batching approach) of the customers and the complexity (piggybacking approach) of the VoD system, we develop a double-rate (DR) batching scheme that attempts to merge the customer requests in an improvised manner by means of buffering. Instead of changing the play-out rate of the video, we double the transmission rate so that the trailing customers are able to catch up with the leading customer. Once the transmitting frames of the customers are the same, they are grouped together and served by a multicast stream. In the DR batching policy, time is divided into an interval of *W* seconds denoted as the batching time. A multicast stream is opened at the beginning of each time interval. Thus, the number of multicast streams required is *(LIW)*, where L is the length of the film. To provide true on- demand service, customers arriving after the beginning of the multicast stream will be served immediately instead of waiting until the next time slot. A unicast stream is opened for the customer and the transmission rate is doubled until he/she can merge into a suitable multicast stream [9].

Advantage:

A new batching scheme has been proposed to reduce the start-up delay of VoD services in a multicast delivery system. When a new customer arrives, a unicast stream is immediately opened for the new request so that the customer does not have to wait. The transmission rate is then doubled so that the customer can catch up with the previous multicast stream.

Drawback:

It is shown that the DR batching scheme outperformsthe greedy policy of the piggybacking approach only in terms of the bandwidth requirement. As it has fixed batching time, popularity of the movies affects the performance of the VoD system.

4.2. Adaptive Batching Scheme for Multicast Video-On-Demand Systems *W.-F. Poon, K.-T. Lo, Member, IEEE, and J. Feng, Member, IEEE says:*

An adaptive algorithm is developed for providing true video on demand (VoD) services in multicast environment. In conventional batching schemes, the batching time of the system is fixed and the performance of such static schemes is highly dependent on the selection of the batching time. If the batching time is wrongly estimated, the performance of the system will be greatly degraded [10]. This algorithm tries to dynamically find the optimal batching time by the newly updated arrival rate so as to minimize the bandwidth requirement. The system performance of the adaptive approach is better than the static scheme in terms of total bandwidth requirement and customer reneging probability, especially in using long batching time for the high arrival rate.

The performance of the batching policy depends highly on the selection of the batching time. If the batching time is too long for the popular movie (high arrival rate), more streams are required. On the other hand, if the batching time is too short for the unpopular movie (low arrival rate), it reduces the batching effect and lowers the system performance. Thus, finding the suitable batching time for each movie is a crucial issue. In general, having watched the movie, the customers rarely watch it again. The popularity of the movie decreases with time. It is very difficult to accurately predict a movie's popularity and set the corresponding batching time. Therefore, the adaptive algorithm adjusts the batching time itself according to the average arrival rate of that time.

Advantage:
Adaptive algorithm enhances the double- rate batching policy so that the popularity of the movies will not affect the performance of the VoD system as the batching time can be adjusted.

Drawback:
If the batching time is wrongly estimated, the performance of the system will be greatly degraded.

4.3. Virtual Batching: A New Scheduling Technique for Video-On-Demand Servers *Simon Sheu and Kien A. Hua and Ta- Hsiung Hu says:*

In a video-on-demand (VOD) environment, batching of requests is often applied to reduce the I/O demand and increase the availability of VOD services. However, batching unfairly forces first comers to wait for subscribers arriving late at the batch. Some of these victims may become impatient and decide to renege. To address this issue, we introduce a chaining technique which allows a client station being served to forward its video data to other client stations, which requested the same video, at a slightly later time. The forwarding of data is done using the same store-and-forward mechanism of the multicast facility used in batching. With this new feature, requests arriving at a chain can be served immediately; yet they are allowed to share a single video stream [11]. Thus, chaining enjoys the benefit of batching without its side effect of causing long access latencies. By combining batching and chaining, we also design a scheme called Virtual Batching. It extends the standard chaining mechanism to allow a client station on a chain to multicast video data to other client stations which are admitted as a batch. Our simulation results indicate that this hybrid approach offers significant performance improvement. New communication strategy, called Chaining, for video- on-demand systems. Using this scheme, we generalize the conventional batching methods to allow requests arriving at a virtual batch to receive immediate services.

Advantage:
First comers no longer have to wait for requests arriving late at the batch. This property reduces the service latencies and therefore improves the reneging probability. This characteristic addresses the network- I/O bottleneck problem facing today's media servers.

Drawback:
This policy makes use of Batching as well as Chaining hence it is more complex. The clients should also have chaining and forwarding mechanism in order to implement Virtual Batching policy.

5. Conclusion

Double rate batching scheme reduce the start-up delay of VoD services in a multicast delivery system. When a new customer arrives, a unicast stream is immediately opened for the new request so that the customer does not have to wait. The transmission rate is then doubled so that the customer can catch up with the previous multicast stream.Adaptive batching scheme enhances the double-rate batching policy so that the popularity of the movies will not affect the performance of the VoD system as the batching time can be adjusted.Virtual Batching scheme generalize the conventional batching methods to allow requests arriving at a virtual batch to receive immediate services. First comers no longer have to wait for requests arriving late at the batch. This property reduces the service latencies and therefore improves the reneging probability. This characteristic addresses the network-I/O bottleneck problem facing today's media servers.
In order to use the advantages of virtual batching, we can combine virtual batching with double rate policy so that the late requests for the same videos can reach the late requester with double rate so that the customer can catch up with the previous multicast stream for the same video.

References

[1] A. Dan, D. Sitaram, and P. Shahabuddin, "Scheduling policies for an on-demand video server with batching," in *Proc. ACM Multimedia '94*,San Francisco, 1994, pp.391–398.
[2] Huadong Ma and Kang G. Shin, "Multicast Video-on-Demand Services", ACM SIGCOM Computer Communication Review,Volume 32,issue 1,January2002 pp 1-43,ISSN:0 146-4833.
[3]Asit Dan,Dinkar Sitaram, Parvez Shahabuddin, "Dynamic batching policies for an on- demand video server," *Multimedia Systems*, vol. 4, pp. 112–121, 1996.
[4] H. Shachnai and P. S. Yu, "Exploring wait tolerance in effective batching for video-on-demand scheduling," in *Proc.Eighth Israeli Conf.*, 1997,pp. 67–76.
[5] W. F. Poon and K. T. Lo, "'New batching policy for providing true video-on- demand (T-VoD) in multicast system," in *Proc. 1999 IEEE Int.Conf. Communications (ICC'99)*, vol. 2, June 1999, pp. 983–987.
[6] L. Golubchik, J. C. S. Lui, and R. R. Muntz, "Adaptive piggybacking: a novel technique for data sharing in video- on-demand storage servers," *Multimedia Systems*, vol. 4, pp. 140–155, 1996.
[7] C. Aggarwal, J.Wolf, and P. S.Yu, "On optimal piggyback merging policies for video-on-demand systems," in *Proc. SIGMETRICS'96*, Pennsylvania, USA, 1996, pp. 200-209.
[8] H. J. Kim andY. Zhu, "Channel allocation problem inVOD system using batching adaptive piggybacking," *IEEE Trans. Consumer Electronics*,vol. 44, no. 3, pp. 969–976, 1998. 70 IEEE TRANSACTIONS ON BROADCASTING, VOL. 47, NO. 1, MARCH 2001.
[9] D. Ghose and H. J. Kim, "Scheduling video streams in video-on-demand systems: a survey," *Multimedia Tools and Applications*, vol. 11,pp. 167–195, June 2000.
[10] W.-F. Poon, K.- T. Lo and J. Feng, "Batching policy for video-on-demand in multicast environment", ELECTRONICS LETTERS 20th July 2000 Vol. 36 No. 15
[11] Huadong Ma and Kang G. Shin, "Multicast Video-on-Demand Services", ACM SIGCOM Computer Communication Review,Volume 32,issue 1,January2002 pp 1-43,ISSN:0 146-4833