Prototype Implementation of a Proxy Caching System for Streaming Media Objects

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ABSTRACT

Existing techniques for caching Web objects are not appropriate for the multimedia streaming service. In this paper, the authors focus on the proxy caching problem specifically for multimedia streaming objects. A prototype design and implementation of a proxy caching system – HUSTProxy is proposed. The main contribution of HUSTProxy is its ability of partial video caching, sending rate control and providing a more rational prefix caching size determination. These techniques are implemented in our design and are discussed in detail in this paper.

Keywords: multimedia transfer; partial video caching; prefix caching; proxy caching; startup latency; streaming media

INTRODUCTION

With the fact that streaming applications consume network bandwidth along the client-server path for the entire session, the traditional client-server architecture for streaming continuous media objects could not scale to a large number of clients. To achieve scalability and deliver high quality streams, multimedia content should be maintained close to interested clients. Proxy caching is a client-oriented solution for large-scale delivery of high quality streams over the Internet. A proxy cache stores recently accessed resources in the hope of satisfying future client requests without contacting the server, which in turn reduces the load on the network and server, and also accommodates the scalability. Furthermore, since a proxy is located close to its clients, caching of popular streams at a proxy can effectively avoid network bottleneck and then substantially reduces...
service response time. Figure 1 shows the connection diagram with server-proxy-client architecture over the Internet. Most recent research on proxy caching focus on handles generic Web objects, such as Harvest (Chankhunthod, 1996) and Squid. However, the existing techniques for caching Web objects are not appropriate for the continuous streaming media services because video files are usually much larger than other Web documents. Compared to Web caching techniques, evaluation of proxy caches for multimedia streaming objects is still immature; design and evaluation of multimedia proxy caching mechanisms clearly require substantially more investigation.

This paper presents the design and implementation of a multimedia proxy caching system, which contributes to reduce server load, network load and service start-up latency, named as HUSTProxy. The name HUST is come from the abbreviation of our university. Although the design is fairly flexible to accommodate control and data transfer protocols used by different vendors, we have implemented our proxy system using RTSP (Real Time Streaming Protocol) (Schulsrinne, 1998) as the control setup protocol and RTP (Realtime Transport Protocol) (Schulzrinne, 1996) as the data transport protocol. Different from earlier works, we emphasize partial caching and partial replacement techniques. Because the video and audio objects are too larger compared to other Internet objects, storing the entire contents of several long streams would exhaust the capacity of a conventional proxy cache. The instead way is caching just a portion of each requested stream. In particular, we propose that proxy caches only a fix set of frames at the beginning of each popular stream, and the replacement scheme is from the end portions of an unpopular stream. Combining with prefetch techniques implemented in our design, the proxy caching disk space can be dramatically decreased. In addition, due to the unpopular steam has not been replaced entirely, which would also enhance the hit ratio for user request. Another contribution of server-proxy-client architecture is its ability to adjust the sending rate to client based on the available bandwidth between the proxy and interested clients’ path. Our study complements this effort to perform rate control; the effectiveness of this proposal is validated through experimental results from prototype implementation. As expected, by increasing the data sending rate to requested clients, the service start-up latency can be improved accordingly. Additionally, we propose a new definition of popularity of a cached stream compared with earlier work in this paper.

The rest of this paper is organized as follows. The next section gives a briefly reviews of related work. The third section discusses the main issues in the design of multimedia streaming proxy, and presents our solutions. The fourth section describes the design and architecture of our proxy caching system. The fifth section validates our implementation through various experiments, and presents the preliminary results. In the last section, we present the conclusions and directions for future work.

RELATED WORK

Caching techniques have been widely used for traditional Web content such as HTML pages and image files (Chankhunthod, 1996; Abrams, 1995). With the emergence of streaming media applications on the Internet, interest in effective streaming media delivery techniques has increased dramatically.
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