



Streaming of Continuous Media for Distance Education Systems

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ABSTRACT

Distance education created new challenges regarding the delivery of large size isochronous continuous streaming media (SM) objects. In this paper, we consider the design of a framework for customized SM presentations, where each presentation consists of a number of SM objects that should be retrieved and displayed to the user in a coherent fashion. We describe a retrieval optimizer (Prime) that captures the flexibilities and requirements imposed by the user query, user profile, and session profile. Then, it determines how this query script should be imposed against the continuous media (CM) server to reduce contention. We also provide a cost model to evaluate each proposed plan. Finally, we explain the role of memory buffering in alleviating the server bandwidth fragmentation problem. Our preliminary experimental results show the feasibility and effectiveness of our proposed model and techniques in generating near optimal retrieval.

Keywords: continuous media; distance education; media streaming; scheduling

INTRODUCTION

Distance education is the largest growing section of education in the world today. It defines a new way of interacting teaching that uses a number of different technologies to deliver the course material to remote students (usually off-campus). In order to keep in pace with the rapid developments in the field of higher education, Kuwait University established a nonprofit center specialized in the area of distance education and videoconferencing, The Kuwait University Distance Learning and Videoconferencing Center, in 2001. Such a center is a large consumer of educational technology, especially multimedia systems (MM). The audiovisual system used by

the instructors displays media from different sources, such as a dedicated personal computer, laptop, VCR, DVD, or digital camera. The media is usually delivered through the Internet, cable, or satellite television, which created new challenges regarding the delivery of continuous media (streaming), especially through the Internet.

Multimedia (MM) systems utilize audio and visual information, such as video, audio, text, graphics, still images, and animations to provide effective means for communication. These systems utilize multihuman senses in conveying information, and they play a major role in educational applications (such as e-learn-

ing and distance education), library information systems (such as digital library systems), entertainment systems (such as video-on-demand and interactive TV), communication systems (such as mobile phone multimedia messaging), military systems (such as Advanced Leadership Training Simulation), and so forth. Due to the exponential improvements (of the past few years) in solid state technology (i.e., processor and memory) as well as increased bandwidth and storage capacities of modern magnetic disk drives, it has been technically feasible to implement these systems in ways we only could have dreamed about a decade ago.

A challenging task when implementing MM systems for distance education is to support the sustained bandwidth required to display *streaming media* (SM) objects, such as video and audio objects. Unlike traditional data types, such as records, text, and still images, SM objects are usually large in size. For example, a 2-hour MPEG-2 encoded movie requires approximately 3.6 gigabytes (GB) of storage (at a display rate of 4 megabits per second (Mb/s)). In addition, the isochronous nature of SM objects requires timely, real-time display of data blocks at a prespecified rate. For example, the NTSC video standard requires that 30 video frames per second be displayed to a viewer. Any deviation from this real-time requirement may result in undesirable artifacts, disruptions, and jitters, collectively termed *hiccups*. There has been a number of studies on the design of SM servers (Berson, Ghandeharizadeh, Muntz, & Ju, 1994; Gemmel, 1996; Gemmel, Vin, Kandlur, Rangan, & Rowe, 1995; Ghandeharizadeh, Dashti, & Shahabi, 1995; Ghandeharizadeh, Zimmerman, Shi, Rejaie, Ierardi, & Li, 1997; Goel, Shahabi, Yao, & Zimmerman, 2002; Muntz, Santos, & Berson, 1997; Ozden, Rastogi, & Silberschatz, 1995; Shahabi, Zimmerman, Fu, & Yao, 2002; Zimmermann, Fu, Shahabi, Yao, & Zhu, 2001). For a complete overview of SM server design issues, see Dashti, Kim, Shahabi, and Zimmerman (2003).

In many new SM applications, the result of a user request (i.e., query) is a set of SM objects that should be retrieved and displayed

to the user in a coherent fashion. In general, these applications can be classified according to their: (1) display, and (2) presentation paradigms. The former specifies whether the application displays the SM objects in a single-pass or in multiple-passes, while the latter specifies whether the presentations are generated statically or dynamically according to user requirements (e.g., user profile, user query, etc.). Figure 1 illustrates the four classes of MM applications. The multipass class of applications do not impose new challenges in the retrieval of SM objects, because the user displays objects individually (i.e., no temporal constraints are imposed between their retrievals). However, the single-pass class of applications do impose temporal constraints on the display of the identified objects. The focus of our study is on the design of a MM system that can support single pass paradigm applications given the new challenges temporal constraints impose. To illustrate single-pass paradigm applications, consider the following examples:

- **Customized news-on-demand:** A user submits the following query: "Show me today's news." The next generation multimedia management systems (e.g., multimedia DBMS) would employ user profiles to hone such general query into a more manageable set of video clips that are displayed to the user one after the other (similar to TV news), with minimum user interaction.
- **Customized advertisement:** With the explosion of the Internet and the advent of digital broadcasting, marketing agencies want to find new ways of attracting customer's attention. One such way is to use customized advertisement, where a number of advertisements that pertain to the user's interest are displayed. One possibility is to feed these advertisements in between the news-on-demand clips or during the advertisement slots of a TV program.
- **Digital libraries & museums:** Traditionally, these applications have used the multipass paradigm. However, a number

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