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Chapter VII

Video-on-Demand: Scalability and QoS Control

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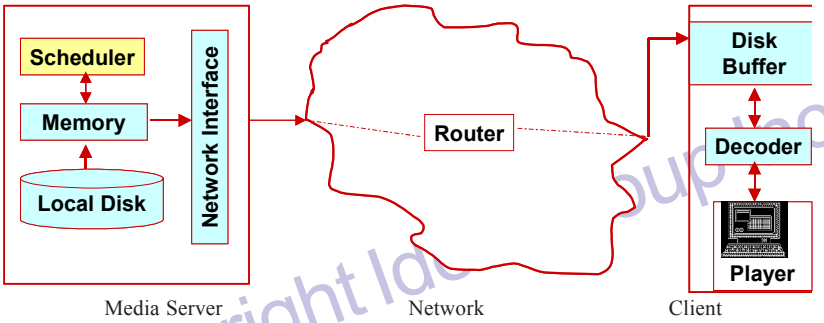
Video-on-Demand (VoD) systems face scalability problems and Quality of Service (QoS) issues due to the need to satisfy numerous requests for several different videos given the limited bandwidth of the communication links. In order to provide scalable solutions and guarantee given QoS requirements, existing VoD proposals can be roughly divided into two categories: (a) scheduled multicast, and (b) periodic broadcast. In this chapter we propose (a) a novel scheduled multicast scheme based on a time-dependent bandwidth allocation approach, (b) a Trace-Adaptive Fragmentation (TAF) scheme for periodic broadcast of Variable Bit Rate (VBR) encoded video, and (c) a Loss-Less and Bandwidth-Efficient (LLBE) protocol for periodic broadcast of VBR video. We have designed, simulated and evaluated the proposed schemes, and the simulation results demonstrate the benefits, flexibility and feasibility of the proposals.

INTRODUCTION

With the popularity of the Internet, the advent of high-speed network and the improvement of data compression technology, Media-on-Demand (MoD) and in particular VoD, is becoming a major application of future digital networks. In pure-VoD, a dedicated unicast stream is established for each user request. Pure VoD does not scale well with the user population. It becomes very expensive and no QoS can be guaranteed due to the traffic congestion when a large number of concurrent requests have to be accommodated in a limited bandwidth environment. Obviously, VoD systems face scalability problems and QoS issues. To provide scalable VoD with guaranteed QoS, new efficient protocol architectures must be employed.

This chapter appears in the book, Distributed Multimedia Databases: Techniques and Applications by Timothy K. Shih.

Figure 1: The General Picture of Media-on-Demand.



BACKGROUND

Media-on-Demand

MoD refers to media services in which a user is able to request from a server any media content at any time, as is illustrated in Figure 1. It encompasses many applications such as video-on-demand, news-on-demand, distance learning, home shopping, training programs, etc. The following discussion focuses on VoD, but the principles are equally applicable to other media objects.

Throughout this chapter we shall make the following assumptions about the VoD architecture: a dedicated link, such as cable, satellite or the Internet using Resource ReSerVation Protocol (RSVP), is used to distribute the video data from the video server to the user. The prerecorded videos are stored at the video server. The server reads the video data from local high-performance storage media. Each client consists of a "set-top box" and secondary (disk) storage to read and write the video data. The user who wishes to watch a particular video starts receiving the video data transmitted by the server, and the video data can be cached at the user's disk before it is decoded and displayed.

CBR vs. VBR

Video sources are typically encoded (i.e., compressed) in order to reduce their storage and bandwidth requirements. One approach to video encoding, called Constant Bit Rate (CBR) encoding, produces a data stream with nearly constant bandwidth. Typically, CBR encoding operates by modifying the quantization scale, on-the-fly, during compression in order to maintain constant bit rate at the output of the encoder. The variable quantization causes the encoded video to be of variable quality. For open-loop Variable Bit Rate (VBR) encoding, the quantization scale remains constant throughout the encoding process, which often produces a highly variable bit rate. For a given video and for the same perceptible quality level, the bit rate for CBR video is typically two times or more the average bit rate of VBR video (Saparilla, Ross & Reisslein, 1999). In addition, VBR encoding schemes are becoming commonplace (MPEG-1 and MPEG-2) and extensive libraries of video material are already available in VBR form. Therefore, there is potential to obtain further performance improvements by using VBR video.