

# Chapter VII

## Extreme Rate Distributed Video Transcoding System

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### **ABSTRACT**

This chapter provides a comprehensive awareness and understanding of research efforts in the field of extreme rate-distributed video transcoding. The basic concepts and theories of rate control methods such as requantization, temporal resolution reduction, spatial resolution reduction, and object-based transcoding are introduced. We will identify each rate control scheme's strengths and weaknesses and provide a distributed video transcoding system architecture that uses multiple transcoding techniques in the creation of an extreme rate video. Experimental results show that the appropriate use of multiple transcoding schemes retains a better quality video in an extreme rate control. At the end of this chapter, we will identify unsolved problems and related issues and will offer suggestions for future research directions.

### **INTRODUCTION**

Video transcoding is a method that converts a compressed video signal into another signal with a different format. It also can change bit rate, frame rates, and/or frame size of the original video. Due to the irreversibility of video quality, original contents should be prepared in their highest quality, and users need to watch the videos on various devices such as HDTV, personal computers, cell phones, and so forth. There are two ways to play the original video in a target player; a target player processes the original video suitable to the target device, or the original video is transcoded into another video suit-

able for the target device before the video is played in the player. Most current players that are running on a computer use the first approach; however, it relies heavily on the target device's capability and cannot adapt to an environmental change such as network congestion, network bandwidth changes, and so forth. The second approach, transcoding an original video suitable to a given target player, provides wide adaptability. But if the transcoding happens in a server, it can only provide limited adaptability. It cannot quickly adapt to network resource changes. Transcoding a video on the fly provides greater adaptability and reduces burdens on a server or a player.

The prepared original content is transcoded for matching a target device's display capability and/or for the status of communication links on the fly from a video server to the display device. The diversity of the display device creates a huge gap between a high-end display device and a low-end one. Transcoding of HDTV contents to a cell phone video requires about 185 times compression (Perkins, 2002; Video Technology Magazine). The heterogeneity of communication links adds more challenges to adaptive video transcoding, especially in wireless communication networks where communication resources and characteristics keep changing. Furthermore, video transcoding is considered a computation-intensive task. A video is considered a real-time content that should be delivered and played in a timely manner. More than 0.1% of packet loss or more than 200 ms delay in transmitting a video cannot be tolerated to play the video properly.

To meet these requirements, the video transcoder reacts quickly for the network link status change and should produce the transcoded video stream on time.

Distributed video transcoding provides quick responses to the environmental changes by providing more computational power to the transcoder as well as by providing location advantages for network resource restrictions.

Extreme rate distributed video transcoding focuses on two major areas: (1) scheduling of the transcoding task to distributed transcoding nodes to provide better transcoding time and reduce jitter and (2) extreme rate control to transcoding from very high-quality original video content to a video for a device with extremely limited capability.

This chapter provides (1) basic video compression mechanism for extreme rate control, (2) speed enhancement methods in node transcoding, (3) distributed transcoding architecture, and (4) task scheduling for transcoding time and jitter reduction in distributed transcoding.

Most current video processing standards are based on discrete cosine transform (DCT) and motion vector-based video compression algorithms. This chapter describes methods based on MPEG, but they can apply to the other standards.

## **BACKGROUND**

### **Comparison of Rate Control Methods**

There are four major rate control methods: requantization, spatial resolution reduction, temporal resolution reduction, and object-based rate reduction. The requantization method changes quantization steps in the re-encoding process. A spatial resolution reduction method changes a video frame size. A temporal resolution reduction method drops some frames to reduce the bit rate of a video. An object-based rate reduction method applies requantization and/or temporal resolution reduction methods on a specific object in a video for reducing a bit rate in a video. Each method will be described in detail in the following sections.

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