# Chapter 16 Analysis and Modeling of H.264 Unconstrained VBR Video Traffic

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## ABSTRACT

In future communication networks, video is expected to represent a large portion of the total traffic, given that especially variable bit rate (VBR) coded video streams, are becoming increasingly popular. Consequently, traffic modeling and characterization of such video services is essential for the efficient traffic control and resource management. Besides, providing an insight of video coding mechanisms, traffic models can be used as a tool for the allocation of network resources, the design of efficient networks for streaming services and the reassurance of specific QoS characteristics to the end users. The new H.264/AVC standard, proposed by the ITU-T Video Coding Expert Group (VCEG) and ISO/IEC Moving Pictures Expert Group (MPEG), is expected to dominate in upcoming multimedia services, due to the fact that it outperforms in many fields the previous encoded standards. This article presents both a frame and a layer (i.e. I, P and B frames) level analysis of H.264 encoded sources. Analysis of the data suggests that the video traffic can be considered as a stationary stochastic process with an autocorrelation function of exponentially fast decay and a marginal frame size distribution of approximately Gamma form. Finally, based on the statistical analysis, an efficient model of H.264 video traffic is proposed.

## INTRODUCTION

Multimedia applications and services have already possessed a major portion of the today traffic over

computer and mobile communication networks. Among the various types of multimedia, video services (transmission of moving images and sound) are proven dominant for present and future broadband networks.

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Raw video data has very high bandwidth and storage requirements making its transmission and storage impractical and economically unaffordable. For this reason, a lot of research has been performed on developing techniques that exploit both temporal and spatial redundancy in video sequences, in order to succeed efficient data compression.

From the advent of video coding, two main encoding schemes were proposed and are still in use: The Constant Bit Rate (CBR) and the Variable Bit Rate (VBR) modes. The choice of VBR mode for video services over communication networks prevails against CBR mode due to a number of advantages such as

- Better video quality for the same average bit rate without the need to adjust the quantization parameters during the encoding as in CBR
- Shorter delay since the buffer size in the encoder side can be reduced without encountering an equivalent delay in the network
- Increased call-carrying capacity due to the fact that the bandwidth per call for VBR video may be lower than for equivalent quality of CBR source.
- Although a CBR transmission mode makes the network management easier, mainly due to the predictable traffic patterns, on the other hand it prevents a possible traffic gain via statistical multiplexing, which means that does not efficiently exploits the available capacity of the transmission channel as VBR does.

Efficient network utilization and constant picture quality can be achieved by VBR mode. However, when transmission and statistical multiplexing of VBR-coded video traffic is considered over a shared medium, like the Internet, the improvement in network utilization cannot be determined only by the compression ratio. VBR coding results in large fluctuations in bit rate and high correlation among the bit rates in successive time intervals due to the video content and the abrupt scene changes (Yegenoglu, 1993). This complex nature of VBR-coded video traffic creates a challenge in the efficient design of communications/transmission networks and the associated traffic control. Therefore an accurate traffic study is necessary for the prediction of the network performance. A method of doing this is to perform real experiments using existing networks and actual sources. However, testing real networks is quite impractical, while performing tests with real video clips, although it is possible, the deduced results may be very video-content specialized and therefore not general and scalable. Thus, major surge of interest in the topic of VBR video traffic modeling has appeared, because it provides information on how VBR mode affects network performance and besides is a useful tool for traffic engineering of communication networks in order to optimize admission control, to perform shortterm traffic forecast and optimize buffer lengths.

Generally speaking, an analysis of video traffic is required in order to develop an efficient video traffic model. Such models can be evaluated (Alheraish, 2004) by the fact that they must satisfy some criteria, namely: They must match certain characteristics of a real video sequence, such as probability density function, mean, variance, peak, autocorrelation etc. Moreover, the deduced generated video traffic must be similar to real video data, in order to be able to be used for predicting a desired performance metric (i.e. delay, buffer, size etc.). Furthermore, the proposed models should be simple and able to generate video traffic with low computational power.

Early studies in unconstraint VBR models examined various characteristics of VBR video traffic, such as differences in successive frame sizes and cluster lengths (Chin, 1989) or scene duration distributions (Verbiest, 1988). Also recently introduced efficient modeling tools and techniques of VBR MPEG-1/H.261 coded video 15 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/analysis-modeling-264-unconstrained-vbr/53181

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