Chapter 60
Streaming Coded Video in P2P Networks

Muhammad Salman Raheel
University of Wollongong, Australia

Raad Raad
University of Wollongong, Australia

ABSTRACT

This chapter discusses the state of the art in dealing with the resource optimization problem for smooth delivery of video across a peer to peer (P2P) network. It further discusses the properties of using different video coding techniques such as Scalable Video Coding (SVC) and Multiple Descriptive Coding (MDC) to overcome the playback latency in multimedia streaming and maintains an adequate quality of service (QoS) among the users. The problem can be summarized as follows; Given that a video is requested by a peer in the network, what properties of SVC and MDC can be exploited to deliver the video with the highest quality, least upload bandwidth and least delay from all participating peers. However, the solution to these problems is known to be NP hard. Hence, this chapter presents the state of the art in approximation algorithms or techniques that have been proposed to overcome these issues.

INTRODUCTION

Mission Critical Communication Systems and their related Multimedia Services plays a vital role in different sectors of life which includes; Disaster Recovery, Intelligence control and various utility sectors. Hence, to provide a reliable communication, it is important to consider strict set of requirements as compared to wired or wireless communication systems. A mission critical system may be used to support low bandwidth data communication such as voice or text services or it may be used to support more bandwidth killing applications such as video streaming services. Each service comprises of different set of challenges and requirements such as voice services, requires an acceptable delay and packet loss for reliable quality of voice. Whereas, the text service is more delay tolerant, hence it has less bandwidth issues as compared to other real time applications. Similarly, video or multimedia streaming over the internet encounters delay, latency and bandwidth issues.

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This chapter discusses the state of the art in dealing with the resource optimization problem for smooth delivery of video across a peer to peer (P2P) network comprising of different coding techniques to support the basic requirements of a mission critical system to support multimedia. A multimedia stream comprises of a combination of a speech, audio, text, animation or video content that is transmitted on request to the destination node. There are a number of different media streaming architectures that have been proposed such as; the traditional client server based architecture (Hareesh K & Manjaiah DH, 2011); the media is streamed through a central server to clients upon request. However, a large number of users may not be accommodated due to high bandwidth bottleneck at the server. To overcome the bandwidth issues, another well-known solution being the content distribution network (CDN) architecture was proposed (Zhijie S, Jun L, Roger Z & Athanasios VV, 2011). In CDNs, dedicated servers are deployed at different geographical locations to accommodate a large number of requests from the users. However, the disadvantage of CDN's architecture is that it produces large signalling over-head. Therefore, the authors provide a distributed architecture known as a peer to peer (P2P) network that depends on the network user's resources to share the multimedia content especially video delivery over the internet (Anh TN, Baochun L & Frank E, 2010). Each node in the network behaves as a sender, a receiver or a relay node to forward the content from one peer to another peer. Each peer joins the network to form an overlay architecture. The advantage of using P2P networks is its self-adaptive and self-configuration properties which reduces the overall load at the server and increases the network bandwidth.

Furthermore, a P2P network is a mixture of several heterogeneous peers (nodes with variable upload and download bandwidths) connected with each other to form an overlay. Hence, it requires a sender peer to store and send multiple versions of a similar content. But P2P networks can be further utilised to deliver a variety of content and in conjunction with other application level techniques such as video coding and more specifically coding that encodes video into different layers. The multiple versions of the video content are generated using different video coding techniques such as multiple descriptive coding (MDC) (Vivek KG, 2001) or scalable video coding (SVC) (Zhengye L, Yanming S, Keith WR, Shivendra SP & Yao W, 2009). In MDC, the video is encoded into several different descriptors whereas the quality of the video depends on the number of descriptors received. The descriptors are then forwarded over multiple paths to the destination node such that each descriptor can be decoded independently. However, the authors discuss that by applying MDC over video content incurs considerable bit rate overhead and is computationally complex. On the hand, in SVC, the video is encoded into a base layer and several enhancement layers where the quality of the video depends upon the number of layers received. The base layer carries the basic information of the video whereas the enhancement layers are used to further improve the quality of a base layered video. Hence, each higher layer is dependent over the lower layer. The overall advantage of using SVC over MDC is that it quickly adapts to current network conditions with considerably less overhead complexity.

The chapter is divided into following sub sections. Section II comprises of a brief overview of P2P networks, its applications, challenges and types. Section III gives an overview of video coding techniques such as SVC or MDC. Section IV extends the study towards video streaming across P2P streaming architectures that consider streaming the video using a single source. Section V and Section VI studies the usage of SVC and MDC techniques for streaming video across P2P networks. Moreover, the usage of seed servers, helper nodes and cloud servers is discussed that helps to improve the quality. Section VII provides a comparison of the all the proposed models discussed in the previous sections. Finally, Section VIII concludes the chapter with a discussion about the limitations in the state of the arts and some possible solution.