Chapter 8
Peer-to-Peer Video Streaming

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ABSTRACT

The Internet as a video distribution medium has seen a tremendous growth in recent years. Currently, the transmission of major live events and TV channels over the Internet can easily reach hundreds or millions of users trying to receive the same content using very distinct receiver terminals, placing both scalability and heterogeneity challenges to content and network providers. In private and well-managed Internet Protocol (IP) networks these types of distributions are supported by specially designed architectures, complemented with IP Multicast protocols and Quality of Service (QoS) solutions. However, the Best-Effort and Unicast nature of the Internet requires the introduction of a new set of protocols and related architectures to support the distribution of these contents. In the field of file and non-real time content distributions this has led to the creation and development of several Peer-to-Peer protocols that have experienced great success in recent years. This chapter presents the current research and developments in Peer-to-Peer video streaming over the Internet. A special focus is made on peer protocols, associated architectures and video coding techniques. The authors also review and describe current Peer-to-Peer streaming solutions.

INTRODUCTION

The Internet as a video distribution medium has seen a tremendous growth in recent years with the advent of new broadband access networks and an explosive growth of media terminals supporting video reception and storage. This growth in the popularity of Internet video transmission, which resulted from the advances in video encoding solutions and the increase in the bandwidth offered by Internet providers. Moreover, this progress has also placed new challenges in cur-

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rent developments of video standards due to the heterogeneous characteristics of current terminals and the content distribution over wired and wireless networks. The widening of image definition options, followed by a rise in user expectations for High Definition (HD) content, has placed new concerns in the bandwidth and the scalability of distribution systems.

In this field, the absence of global IP Multicast protocols has led to the introduction of privately managed overlay network companies. These solutions typically implement application layer multicast tree distributions which are currently responsible for the content distribution of many content creators. With this approach, they avoid neighborhood congestion in the server's network.

With the introduction of faster access networks, together with higher processing power and storage capabilities at terminal equipments, another application layer solution has also gained popularity in recent years. This solution modifies the client-server paradigm of the initial Internet, to allow the exchange data and other resources in what is usually called a Peer-to-Peer (P2P) network. These systems constitute an overlay mesh network of peers, where each peer acts both as server (that provides service for others) and also as client (that consumes resources from other peers).

In the field of network file sharing, the first implementations of P2P systems such as Napster (2009), Gnutella (2001) and Emule (2010) have achieved great success. In these solutions however, files were only exchanged when any of the peers had the entire file. This led to the utilization of only a small fraction of the total peer upload capacity, because most users leave the system when the file is completely downloaded.

Currently, the BitTorrent protocol (BitTorrent, 2010) is one of the most popular solutions. It was designed for large-scale file sharing over the Internet, supporting scalable P2P distributions. The data to be distributed is firstly partitioned into small pieces or chunks, which are afterwards delivered in a non-sequential manner. The BitTorrent protocol considers two types of peers: seeds and leeches. Seeds are peers that have all the chunks, and leeches are peers that only have some or none of the chunks. The architecture also includes a centralized process called tracker that maintains the information about the peers that host each of the content. Therefore, each leech entering the P2P distribution requests a list of peers from the tracker, and randomly selects a subset of them to become its neighbors. It then exchanges chunks with each of these neighbors usually trying to download first the chunks that are less available, in what is known as a rarest-first policy. It also uploads content to those peers that contribute with more chunks, in what is known as a Tit-for-Tat (TFT) incentive policy.

Although the utilization of such content distribution systems has been dazed by illegal content sharing that violates author's copyrights, they are capable of supporting many benefits like load balancing, fault-tolerance, self-adaptation and self-organization.

Nowadays, the main solutions for P2P file sharing have evolved to embrace non-real-time content sharing. In fact, with adequate modifications, P2P solutions can change the way real-time video transmission will be distributed over the Internet. Notice that the absence of IP Multicast routing in the Internet is the main reason that has prevented the widespread transmission of good quality television channels worldwide until now.

BACKGROUND

Systems behaving in a peer-to-peer fashion have existed since the very beginning of the Internet, but not connoted from what is currently called by P2P.

In terms of P2P, "The Internet started as a peer-to-peer system" (Taylor & Harrison, 2009) and in fact, the goal of the original ARPANET was to connect a set of distributed resources, not in a master-slave or client-server relationship, but rather as equal computing peers using different

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