Chapter 3
Pervasive Streaming via Peer-to-Peer Networks

Majed Alhaison
University of Ha’il, Saudi Arabia

Antonio Liotta
Eindhoven University of Technology, The Netherlands

ABSTRACT

Media streaming is an essential element of many applications, including the emerging area of mobile systems and services. Internet broadcasting, conferencing, video-on-demand, online gaming, and a variety of other time-constrained applications are gaining significant momentum. Yet, streaming in a pervasive environment is not mature enough to address challenges such as scalability, heterogeneity, and latency. In a client-server system, streaming servers introduce computational and network bottlenecks affecting the scalability of the system and mobile client exhibit intermittent behavior and high-latency connections. This chapter explores ways that several proposed peer-to-peer (P2P) streaming systems deploy to address some of these challenges. An initial introduction on P2P network fundamentals and classifications provides the necessary background information to focus on and assimilate the different mechanisms that enable scalable and resilient streaming in a pervasive environment. The most interesting developments are presented in an accessible way by revisiting the features of common P2P streaming applications. This approach helps in identifying a range of burning research issues that are still undergoing investigation.

INTRODUCTION

In recent years, Peer-to-Peer (P2P) networking has gained much consideration after its successful achievement from its file sharing ability such as BitTorrent (Liu et al., 2008) and, more recently, in multimedia streaming. The concept of P2P networking is realized by encouraging the end users to contribute to the network resources and act as client and server simultaneously. That is, each user can upload and download directly from/to other users avoiding central entities. The motive behind is the cooperation among them to overcome various limitations of the more conventional Client-Server
(CS) paradigm to attain user and bandwidth scalabilities. At its early times, P2P Computing was considered as a file sharing platform across different networks and environments. Over the time, P2P TV has gained both academic and industrial attention as the next potential killer technology for streaming multimedia to the public. Overlay networks play an important role as the deployment infrastructure of different P2P applications. The underlying mechanism is based on the distribution of streams or files through an application-level overlay, including the user terminals in the role of peers, i.e. content distribution relays.

Following this introduction, the chapter is organised into four main sections. The first provides a quick overview of general knowledge on video streaming delivery platforms. The following two give more emphasis on Unstructured and Structured P2P systems respectively presented from the video streaming viewpoint. The fourth section provides an analysis of recent advances on P2P streaming. The focus of that section is on the identification of those features that enable efficient streaming even on highly dynamic networks like P2P. The chapter concludes with the authors’ point of view and an outlook for the use of those systems to pervasive streaming.

**VIDEO DELIVERY PLATFORMS**

The Client–Server Model is the opposite extreme of Peer-to-Peer Computing. However, the latter can be viewed as the evolution of the former. In a CS-based streaming setting, the client initiates a connection with the video source address and the server replies back by directly delivering the content. Though simplicity and manageability are two major advantages of this scheme, its weaknesses pushed its evolution to P2P Networks. As all the content is located and provided by a single central entity, any failure of that entity may deactivate the whole streaming service to any client. There is a plethora of unpredictable either accidental (e.g. power cut-offs) or deliberate (e.g. security attacks) reasons for these failures. Traffic bursts are also conditions that these architectures are not designed to handle. Sudden increases of content requests from clients can quickly consume all the resources of the server and force it to drop any excessive load. In an effort to tackle those problems, system administrators increased the initial investment and maintenance costs by building very powerful, highly secured infrastructures that only very specialized personnel could operate. They quickly became unscaleable systems that few could afford (Androutsellis-Theotokis & Spinellis 2004; Liu et al. 2008) and without even providing guarantees for service quality and reliability in case of flush crowds. The need for a more distributed architecture drove the development of Content Delivery Networks (CDNs) (Pallis & Vakali 2006).

The main concept behind CDNs is the use of many strategically placed video content delivery servers on the edges of the internet. Any video is delivered by the closest server to the requesting client. Initially, the server pushes all the content to its counterparts. Clients access a content server and if that is not the closest one, its requests are redirected to the nearest one. From the server perspective, this mechanism is a load sharing approach and from the client perspective it reduces the start-up delay. As a locality-aware mechanism, it also saves the network from traffic as streams tend to have the shortest possible paths. One of the real-world video streaming applications over the internet that exploits this mechanism are YouTube (Hossfeld & Leibnitz 2008), MySpace (myspace), Veoh (VEOH), and Akamai (akami). Due to its higher resource distribution level, compared to the client-server model, companies can save some of their operational costs and handle more requests. However, maintaining multiple servers across the planet introduces higher costs in designing and maintaining the system. For instance, the decision to place the servers at the most appropriate location includes incoming traffic monitoring, distributed maintenance units or even system
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