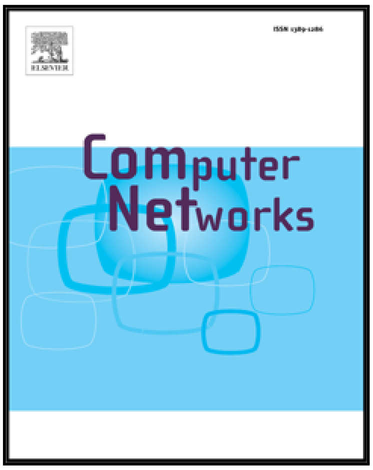
Accepted Manuscript



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PII: S1389-1286(18)30879-X
DOI: https://doi.org/10.1016/j.comnet.2018.09.007
Reference: COMPNW 6589

To appear in: *Computer Networks*

Received date: 25 March 2018
Revised date: 24 August 2018
Accepted date: 7 September 2018

Please cite this article as: Farzad Tashtarian, Alireza Erfanian, Amir Varasteh, S^{2}VC: An SDN-based Framework for Maximizing QoE in SVC-Based HTTP Adaptive Streaming, *Computer Networks* (2018), doi: https://doi.org/10.1016/j.comnet.2018.09.007

S^2VC: An SDN-based Framework for Maximizing QoE in SVC-Based HTTP Adaptive Streaming

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Abstract—HTTP adaptive streaming (HAS) is quickly becoming the dominant video delivery technique for adaptive streaming over the Internet. Still considered as its primary challenges are determining the optimal rate adaptation and improving both the quality of experience (QoE) and QoE-fairness. Most of the proposed approaches have relied on local information to find a result. However, employing techniques that provide a comprehensive and central view of the network resources can lead to more gains in performance. By leveraging software defined networking (SDN), this paper proposes an SDN-based framework, named S^2VC, to maximize QoE metrics and QoE-fairness in SVC-based HTTP adaptive streaming. The proposed framework determines both the optimal adaptation and data paths for delivering the requested video files from HTTP-media servers to DASH clients. In fact, by utilizing an SDN controller and its complete view of the network, we introduce an SVC flow optimizer (SFO) application module to determine the optimal solution in a centralized and time slot fashion. In the current approach, we first formulate the problem as a mixed integer linear programming (MILP) optimization model. The MILP is designed in such a way that it applies defined policies, e.g. setting priorities for clients in obtaining video quality. Secondly, we show that this problem is NP-complete and propose an LP-relaxation model to enable S^2VC framework for performing rate adaptation on a large-scale network. Finally, we conduct experiments by emulating the proposed framework in Mininet, with the usage of Floodlight as the SDN controller. In terms of improving QoE-fairness and QoE metrics, the effectiveness of the proposed framework is validated by a comparison with different approaches.

Index Terms—Dynamic HTTP Adaptive Streaming (DASH), Software defined networking (SDN), Scalable Video Coding (SVC), QoE.

1 Introduction

In recent years, the presence of the Internet and its applications in various aspects of our lives has exponentially increased. As mentioned in [1], video streaming traffic, which has made up the largest portion of Internet traffic, will grows to be up to 75% of the total Internet traffic by 2020. For many years, the UDP protocol has been employed to transfer multimedia traffic in the Internet. In recent years, much efforts has been spent to utilize TCP for multimedia transmission over the Internet. With HTTP, the employment of caches and also content delivery networks (CDNs) are possible, thus providing network scalability and traffic reduction. In addition to TCP's reliable transmission and cache-friendliness, streaming data with TCP allows for easy traverse of firewalls and NAT devices. As a result, deploying HTTP for multimedia transmission over the Internet has significantly risen. For instance, nowadays, more than 98% of video traffic in cellular networks is transmitting via the HTTP protocol [2].

The most widely used technique for TCP streaming is HTTP-based adaptive streaming (HAS). In this technique, a video file is divided into short duration segmented files, each of which is encoded at different bit rate levels and resolutions. Many companies have developed modifications of HAS systems, such as Smooth Streaming [3], HDS [4], and HLS [5]. In 2012, HAS was standardized by the Motion Picture Experts Group (MPEG) and named dynamic adaptive streaming over HTTP (DASH) [6]. With DASH, a video is segmented into short segments encoded at various bit rates. This information is then stored in a media presentation description (MPD) file.

There are several encoding methods for encoding a video. The two most widely used are advanced video coding (AVC) [7] and scalable video coding (SVC) [8]. In AVC-DASH, the client downloads the MPD file to obtain information from the server such as segment details, available bit rates, etc. Then, the appropriate bit rate is selected and HTTP streams these segments to the end-users. Multiple copies of a video are encoded with different bit rates and stored on the media server, thus leading to storage overhead. In contrast SVC is a layered video codec in which the video stream is encoded in a base layer and in one or more enhancement layers. The base layer provides the minimum usable quality (i.e. resolution and frame rate) for the clients. Better quality alternatives are available in the enhancement layers. SVC has several advantages over AVC, including higher web caching performance, lower bandwidth usage, and higher quality of experience (QoE) for the users [9]. In addition, as shown in [9], SVC-DASH is