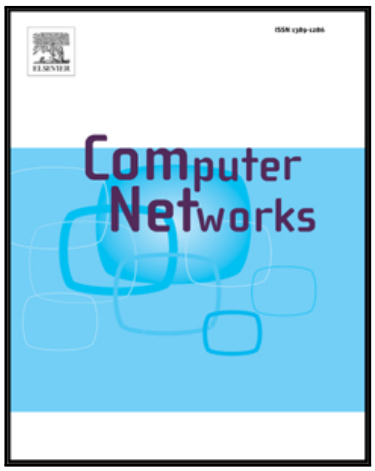

Joint-Family: Adaptive BitRate Video-on-Demand Streaming over Peer-to-Peer Networks with Realistic Abandonment Patterns.

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Joint-Family: Adaptive BitRate Video-on-Demand Streaming over Peer-to-Peer Networks with Realistic Abandonment Patterns.

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Abstract

Previous studies of peer-to-peer (P2P) video-on-demand (VoD) are performed separately from studies utilizing adaptive bit rate video since the techniques seemingly tackle orthogonal goals. Additionally, previous policies used by P2P VoD do not account for viewer abandonment of video during download and playback. Through analysis, we show that the popularity of a P2P swarm and seed staying time significantly affects the achievable per-receiver download rate. Specifically, we identify conditions under which popularity affects swarm efficiency, contradicting a typical misconception in previous work, and we show that abandonment under these previous policies significantly increases playback interruptions. In light of these observations, we propose Joint-Family, a protocol that supports HTTP-based adaptive bitrate streaming for on-demand videos using P2P techniques. Joint-Family accounts for user video viewing behavior, such as abandonment, to improve the quality of experience for the viewer. Peers in Joint-Family simultaneously participate in multiple swarms to exchange chunks of different bitrates. Joint-Family takes advantage of abandonment by converting peers to "partial seeds"; this increases system capacity. Joint-Family adopts chunk, bitrate, and peer selection policies that minimize occurrence of interruptions in the presence of abandonment while delivering high quality video and improving the total capacity of the system. Using traces from a large-scale commercial VoD service, we compare Joint-Family with existing approaches for P2P VoD and show that viewers in Joint-Family enjoy higher playback rates with minimal interruption, irrespective of video popularity.

Keywords: Peer-to-peer video-on-demand, HTTP adaptive streaming, viewer engagement, abandonment

1. Introduction

The ever-increasing demand placed by streaming video traffic across both wired and wireless networks has been managed by two seemingly complementary approaches: HTTP-based adaptive bitrate (ABR) [1, 2], and peer-to-peer (P2P) delivery [3–5]. ABR encodes a video at multiple bitrates, and maximizes the video bitrate within the available bandwidth, delivering a higher fidelity video over HTTP when possible, and dropping to lower quality rather than causing an interruption of playback of the excessively high bitrate video. MPEG-DASH [6] is an ISO/IEC standard for ABR. While layered coding such as scalable video coding (SVC) [7] is another approach for adaptive streaming, SVC has had difficulty in being implemented in the real world due to coding complexity and bitrate overhead (discussed more in Section 5). We focus on ABR in this work.

P2P-based systems are a popular alternative to deliver on-demand video, improving the viewing experience by utilizing the uplink capacity of the downloading peer nodes, thereby increasing overall system upload capacity. Even traditional Content Distribution Network (CDN) providers such as Akamai are experimenting with and deploying P2P-based delivery of video content [8].

Intuitively, P2P and ABR seem poorly suited to work together, because peer viewers watching the video at differing rates are presumably unable to exchange video segments (chunks) with one another. Thus, intuition suggests that enabling ABR reduces the peers' ability to share video chunks with one another. We show in this paper that, contrary to current intuition, ABR and P2P effectively combine to leverage both of their strengths: P2P techniques improve upload capacity, and ABR enables the highest quality viewing at that capacity while minimizing interruptions.

In addition to the ABR and P2P combination, we focus on a user viewing pattern called **viewer abandonment**

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