M. Krause - Streaming multiple videos over wireless home networks

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The thesis addresses the following question: What is the optimal way of streaming multiple videos over wireless home networks with the best possible quality for the users? The thesis offers a solution for a video streaming server that can handle video streaming in a fair way to satisfy all the video users in the home network.

Our solution combines bandwidth awareness, bit-rate adaptation in the spatial domain, high reactive bit-rate adaptation in the temporal domain, and the implementation of an objective quality metric to determine the best streaming strategy. Aspects of such an adaptive video transmission are the following: The consideration of the human visual system, the feasibility of the solution in existing networks, and the feasibility of spatial and temporal domain video encoding methods.

First, we investigated several TCP flavors and queuing policies by real-life measurements as well as simulations to analyze the bandwidth sharing quality of TCP in simple heterogeneous and homogeneous computer networks. We showed that bandwidth sharing depends on the used TCP flavor and the queuing algorithms. We were able to show, that starting times and starting order are irrelevant for the achievable throughput due to the TCP congestion control algorithms inherent to every TCP flavor. We show that fairness is achievable, if the used hardware is identical, however for the used hardware, the fair share was achieved at high variation, i.e., the fairness was assumed only on a large time scale.

Following that, we have shown that TCP fairness in homogeneous networks leads to a reduction in quality for the high quality video stream whereas the low quality video stream was able to be almost completely streamed.

On the basis of the experiments, the thesis defines the notion of Video Fairness. Video Fairness is a utility fairness that is based on the quality of the video instead of on the bit rate. Video Fairness aims to deliver all videos with fair quality not necessarily fair bitrates. Therefore video streams can be penalized below their TCP fair share (MAX-MIN fair share) in order to give others their fair video share.

We identified how to adjust the TCP parameters so that in a real system we can achieve fairness at the wanted level.

To ensure the best possible quality for a single stream within the bit rate that is video fair, we have derived 9 principles that represent the most important factors in determining the quality of a streaming video. We specifically address the limitations of temporal adaptation are reached and other methods need for video adaptation have to be applied.

We combined the results to obtain an adaptive video server that performs its adaptations not merely on the basis of bandwidth but that takes the video fairness of the resulting video and its quality at the receiving device into account.

1 Krause, M.: ‘Experiment on multiple video streaming over in home networks’. Proc. Wicom 2008, Dalian, 2008

2 Krause, M., Hartskamp, M.v., and Aarts, E.: ‘A Quality Metric for Use with Frame-rate Based Bandwidth Adaptation Algorithms’. Proc. Human Vision and Electronic Imaging XII, San Jose, 2008