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Transitions in Live Video Streaming Services

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ABSTRACT

This work shows a demonstration on the work of the Collaborative Research Center 1053 pursuing Multi-Mechanism Adaptation for the Future Internet. Our prototype shows a live video streaming system on mobile devices featuring P2P and Client/Server delivery concepts. The focus is to showcase seamless transitions between those mechanisms, depending on the given system state. For this, our system streams video from a central server to mobile devices connected by a WiFi Access Point. The system adapts, automatically or manually, in a seamless manner to changing environmental conditions between a P2P based streaming system and a client/server distribution scheme. The transitions and the system state are monitored and visualized on a central UI.

1. INTRODUCTION

Today, a variety of events attract large number of live streaming viewers. For some of these live streams access rates can be predicted up-front, others show a more spontaneous but fast increase in the number of the parallel viewers. Our research demonstration and the research project addresses those spontaneous rarely predictable events. In those scenarios delivering high quality video streams in time can not be guaranteed - especially if addressing mobile networks.

We propose in this demonstration an adaptive streaming system, that showcases a set of mechanisms to mitigate these limitations. The system is composed of P2P and C/S (Client/Server) delivery mechanisms that can be switched at run-time. We call the replacement of whole networking mechanisms, such as streaming mechanisms, transitions. Those transitions enable the streaming system to adapt to a large range of scenarios and conditions such as sudden increase or decrease in number of users. This demonstration illustrates that the replacement of a whole delivery mechanism can be achieved seamlessly.

2. STREAMING OVERLAY

Modern streaming services have to handle high scalability demands. In most cases, a simple C/S system offers the resources required by streaming users but is not scalable to thousands of parallel views. The Peer-to-Peer (P2P) dissemination paradigm on the other hand offers a promising scalability as every client contributes resources to keep the system working. However, P2P systems are expensive in terms of overhead and control based on the number of concurrent accesses. In contrast to existing hybrid P2P-based video dissemination services such as ToMo [1] or mTreebone [2] this demonstration shows a transition-enabled framework for networking mechanisms on basis of a live video streaming service. Transition-enabled means in this context that C/S as well as different P2P-based video dissemination protocols can coexist and are used when environmental conditions favor their selection. The framework is not limited to an exchange of topologies such as it is demonstrated in this work, but allows to switch arbitrary networking mechanisms if they comply to specified interfaces.

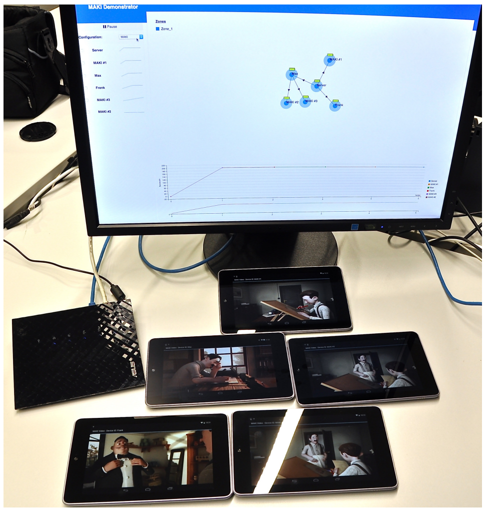
This demonstrations implements an adaptation mechanism to seamlessly switch between two content dissemination mechanisms: a central C/S and a decentralized P2P-based dissemination. By this it circumvents issues resulting from significantly varying environmental conditions. Streaming should be continued in a consistent quality for all users even though the operations on the network change. The used P2P system is based on Wichtlhuber et al.'s TRANSIT system [3]. The C/S system follows a classical star topology, where joining nodes contact a server and are delivered with small video segments, so called chunks by only this central source. The P2P-based mechanism allows to retrieve video chunks from the server but additionally from each available other node. Therefore, a tracking functionality is hosted on the central server to exchange node information. As [3] has shown in live streaming scenarios: The tree topology is beneficial to reduce delay between streaming nodes. Thus the system aims to arrange clients in a tree topology, but allows an hybrid video chunk exchange in cases of high churn or chunks are dropped due to the unreliable UDP transmission. Thus each client can request chunks in a mesh-like manner from each other node. Transitions and mechanism reconfiguration is shown between C/S and P2P, but also the P2P-based system allows replacement of tree and mesh-topologies.

3. PLANNING AND EXECUTION

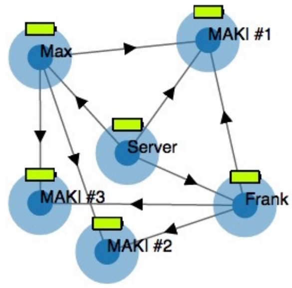
Besides the streaming overlays and mechanisms the demonstration prototype of the research project includes a monitoring, planning and execution framework allowing sound decisions on when to transition between networking mechanisms. Therefore, the prototype implements a centralized monitoring approach. It allows to gather metrics from each streaming device on network speed, current device properties and streaming quality to the central video server which visualizes the topology and associated metrics. Furthermore, the monitoring component measures the node statistics, e.g. count of nodes involved in streaming one specific live video, the throughput on the up- and downlink, energy of each client and the streaming quality measured in the number of stalls. Based on the metrics measured, transition rules can be defined to switch individual networking mechanisms. In a P2P-based video streaming system this involves topology and its management, scheduling or neighborhood management.

4. SCENARIO AND DEMONSTRATION

The demonstration software of the Collaborative Research Cluster 1053 illustrates the rising need for efficient video delivery to mobile devices. It offers a toy model including one central video streaming server represented by a laptop, the wireless network depicted by the WiFi Access Point and five Nexus 7 tablets accessing video from the central server. The central, resource-limited video streaming server offers a continuous video live stream. Depending on the interest in the content nodes join the network to watch the stream. The first clients joining the network streaming retrieve video in a continuous high quality fashion. As more and more nodes are joining the network, the available resources are depleted. The system as explained in Section 2 is designed to replace whole mechanisms and streaming approaches without interfering with the application layer in this case the video playback. As the system is centrally monitored, it can identify a resource bottleneck. When detecting a bottleneck, it selects an appropriate mechanism for high scalable video streaming - our P2P overlay. This automatic switch ensures continuous playback even though the underlying streaming mechanism is replaced. In a demonstration setting the automatic monitoring is disabled and everyone can test the differences with or without the transition concept. Based on a toggle button users can en- or disable the transition-capable streaming system. If the transition capabilities are disabled the user will see reoccuring stalling as the central server's upload capacities are limited. A central visualization as depicted in Figure 1b illustrates metrics of each device as well as aggregated up- and download capacities. Additionally, the current streaming topology is depicted allowing users to easily identify whether the system is currently streaming in C/S or P2P mode. The audience can at any time pick one of the five tablets and follow the live stream. An overview on the central streaming server represented by a laptop and the five Nexus 7 tablets representing the mobile streaming nodes is given Figure 1a.



(a) Demonstration setup



(b) Overview of the streaming topology

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