

Optimizing User QoE through Overlay Routing, Bandwidth Management and Dynamic Transcoding

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Abstract

More and more, multimedia services are being accessed via fixed and mobile networks. These services are typically much more sensitive to packet loss, delay and/or congestion than traditional services. In particular, multimedia data is often time critical and, as a result, network issues are not well tolerated and significantly deteriorate the user's Quality of Experience (QoE). We therefore propose a QoE optimization platform that is able to mitigate problems that might occur at any location in the delivery path from service provider to customer. More specifically, the distributed architecture supports overlay routing to circumvent erratic parts of the network core. In addition, it comprises proxy components that realize last mile optimization through automatic bandwidth management and the application of processing on multimedia flows. In this paper we introduce a transcoding service for this proxy component which enables the transformation of H.264/AVC video flows to an arbitrary bit rate. Through representative experimental results, we illustrate how this addition enhances the QoE optimization capabilities of the proposed platform by allowing the proxy component to compute more flexible and effective bandwidth distributions.

1. Introduction

In recent years, we have witnessed an expansive growth in the networked access of multimedia services. Compared to traditional services, like web browsing and e-mail, these services impose much stricter requirements on the transportation network in terms of packet loss, congestion, delay and jitter. For instance, interactive applications such as VoIP and online gaming require a low delay to guarantee

a fluid operation. As another example, packet loss has severe consequences for video streaming services since it will rapidly degrade playback at receiver-side due to the introduction of visual artifacts. Complicating matters even further is the fact that, due to the recent popularization of mobile computing, service providers are increasingly targeting not only fixed but also mobile customers. Since fixed and mobile devices as well as networks have largely divergent capabilities, a highly heterogeneous usage environment is created, which in turn results in growing service dependability as well as adaptation requirements.

Unfortunately, the current generation of networks is not always capable of guaranteeing that the requirements imposed by multimedia services are satisfied. For instance, the Internet only provides best-effort routing, meaning no guarantees are given regarding the throughput, packet loss and delay that will be experienced by network packets. The access part of a client's network connection can also cause severe problems, mainly due to its limited bandwidth capacity. In particular, compared to the core of the network, the so-called last mile is usually much less capacitated. As a result, insufficient last mile bandwidth may be available to support all services which a client is currently using (or even to receive all content that is being exchanged as part of a single multimedia service). This will likely give rise to congestion and hence also an increase in packet loss and delay in case adequate techniques for the adaptation of network traffic are lacking.

Based on these observations, we believe current networks are often unable to provide users of multimedia services with an acceptable usage experience or, more formally, Quality of Experience (QoE). In our previous work we therefore proposed an overlay platform which supports full end-to-end user QoE optimization by employing a two-tier approach [4]. On the one hand, the proposed architecture enhances data dissemination in the network core by providing an overlay routing service which ensures re-

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