Optimizing User Quality of Experience through Overlay Routing, Bandwidth Management and Dynamic Trans-Coding

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ABSTRACT

Accessing multimedia services via fixed and wireless networks has become common practice. 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). Therefore, the authors 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. This paper introduces a trans-coding service for this proxy component which enables the transformation of H.264/AVC video flows to an arbitrary bitrate. Through representative experimental results, the authors 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.

Keywords: Dynamic Rate Shaping, H.264/AVC Video Trans-coding, Network Traffic Shaping, NIProxy

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INTRODUCTION

In recent years, a popularization of the net-worked access of multimedia services has occurred. Compared to traditional services like web browsing and e-mail, these services impose much stricter requirements on the transportation network. For instance, interactive applications such as VoIP and online gaming demand a low delay to guarantee a fluid operation. As another example, packet loss negatively impacts video streaming services since it will rapidly degrade playback at receiver-side due to the introduction of perceptual distortions. Complicating matters even further is the fact that, due to the recent trend towards 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.

Empirical experience has proven that current generation networks are 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 level of service that will be experienced by network packets. The access part of a client’s network connection is another possible source of complications, mainly due to its bandwidth capacity constraints. Insufficient last mile bandwidth may be available to support all the user’s active services (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 argue that current networks frequently fail to provide customers of multimedia services with an acceptable usage experience or, more formally, Quality of Experience (QoE). In our previous work we therefore introduced a two-tier over-
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