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Eprints ID : 13789

To cite this version : Tournoux, Pierre-Ugo and Tran-Thai, Tuan and Lochin, Emmanuel and Lacan, Jérôme [When on-the-fly erasure code makes late video decoding happen.](#)
In: ACM NOSSDAV, 20 March 2015 - 20 March 2015 (Portland, Oregon, United States)

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When on-the-fly erasure code makes late video decoding happen

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ABSTRACT

This paper proposes “LD-Tetrys” (Late Decoding Tetrys), a solution based on an on-the-fly erasure code that attempts to solve the problem of late decoded packets usually considered as lost by a video client. LD-Tetrys has the following advantages: i) it drastically improves the tradeoff between throughput and QoE without modifying the codecs or adding complexity at the encoder side ii) it allows an easy and robust configuration. The only cost is a minor modification of the decoding process and a slight increase in the video decoding complexity. Last but not least, LD-Tetrys requires a much smaller playout buffer to obtain the same perceived video quality, bringing benefits for interactive applications.

1. INTRODUCTION

Video transmission has been dominating our current Internet traffic. As per Cisco forecast, consumer Internet video traffic will be 69 percent of all consumer Internet traffic in 2017, up from 57 percent¹ in 2012 [?]. The delivery of multimedia content is an active research area, especially for real-time and delay-sensitive applications which are being targeted by RMCAT and WebRTC IETF research groups [?, ?]. The significant growth in video traffic is explained by the spread of high speed networks (e.g., 3G/LTE, fiber to home), mobile devices (e.g., laptop, smartphone, tablet) and advanced video codecs. The newly standardized video codec, the High Efficiency Video Coding (HEVC) [?], allows up to 50% encoding bit rate savings for an equivalent perceptual quality compared to the H.264/MPEG-4 Part 10 (also called H.264/Advanced Video Coding or H.264/AVC) which is enabled in most up to date end user devices. However, the higher compression efficiency leads the compressed

¹This percentage does not include video exchanged through peer-to-peer (P2P) file sharing.

video more sensitive to error/loss. Stephen Wenger shows in [?] that the Peak Signal to Noise Ratio (PSNR) decreases up to several dB when the loss rate is greater than 1%.

A simple solution to tackle the problem of video packet loss is to let the receiver detect the missing packets and ask for their retransmission. This approach is used in TCP-based streaming solutions such as Adobe Flash Player and Microsoft Silverlight. It works fine if the playout delay is large enough (i.e., higher than 3/2 Round Trip Time (RTT)) so that the retransmitted packets arrives before the playout time of the frame it belongs. Unfortunately, the RTT is often too large compared to the delay constrained by the application. In the context of low delay applications, the video decoder has to implement error concealment schemes in order to guess the value of the missing data [?]. To make the error concealment mechanisms effective, the video encoder may implement error resilience schemes such as Flexible Macroblock Ordering (FMO) with a cost of higher encoding bit rate than an encoded video without error resilience.

Another type of error resilience schemes frequently used falls in the family of application layer forward error correction (AL-FEC) and more particularly (n, k) block based erasure codes which generate n encoded packets out of k source packets and allow the recovery of the block if at least k packets among any of n encoded packets are received. The downside of these block-based erasure codes is that it requires complex probing of n and k as it trades off throughput, delay for residual loss rate. Recently, a novel erasure coding approach that prevents such complex configuration has been proposed in [?, ?, ?]. Tetrys [?, ?] that belongs to the class of on-the-fly codes, has the advantage to be systematic². Tetrys uniformly distributes the repairs packets among the data packets and it recovers all the packets within a small delay independent of the RTT. As a result, it has been shown in [?] that Tetrys significantly outperforms the other erasure codes in the context of video transmission. Despite its performance, lost packets that are not recovered on time by Tetrys are considered as lost by the video decoder and these packets will impair the Quality of Experience (QoE).

²An erasure code is said to be systematic if source packets appear unaltered in the encoded output. As a result, some of the received packets are usable even if the decoding fails.