

# Rate-Distortion Optimized Streaming with Multiple Deadlines and Proxy Servers for Low Latency Applications

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## Project Goals

In a streaming media system, a server transmits packetized media over the network to a client. The network is typically lossy and can be modeled as an independent time-invariant packet erasure channel with random delays. Moreover, real-time applications and data dependencies constrain the packets to arrive at the client within a specific window of time. Using these assumptions, Chou et al introduced in [1] an iterative descent algorithm to find a packet transmission policy that is rate-distortion optimized. At discrete transmission opportunities, using past observations, the Lagrangian cost,  $J(\mathbf{p}) = D(\mathbf{p}) + \lambda R(\mathbf{p})$ , is minimized over the range of different transmission policy vectors.  $D(\mathbf{p})$  is the expected distortion, and  $R(\mathbf{p})$  is the expected rate for the policy vector  $\mathbf{p}$ . While the number of transmission policies is exponential in the number of packets considered for transmission, it can be shown that this problem can be reduced to a computationally less complex one, where the Lagrangian involves the error probability and the expected number of transmissions for individual media.

In [2], this framework is applied to the scenario where a proxy server at the junction of the backbone network and the last hop to the client acts as an intermediary that caches packets from the server before transferring them to the client. In [3], in order to take advantage of accelerated retroactive decoding (ARD), multiple deadlines are considered for each packet. The extensions in both [2] and [3] can result in significant improvement in the rate-distortion performance of the streaming system over the original model.

Our project considers the case of rate-distortion optimized streaming using multiple deadlines combined with proxy servers. First, we will adapt the algorithm to this scenario. The algorithm will then be simulated using different parameters, such as the rate of packet-loss on each channel and the end-to-end latency, and the rate-PSNR curve will be generated. We expect our system to perform better when compared to the systems in [1], [2], and [3].

## References

- [1] P. A. Chou and Z. Miao, "Rate-Distortion Optimized Streaming of Packetized Media," Microsoft Research. Technical Report. MSR-TR-2001-35, February 2001.
- [2] J. Chakareski, P. A. Chou, and B. Girod, "Computing rate-distortion optimized policies for hybrid receiver/sender driven streaming of multimedia," *Proc. Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 2002. *Invited Paper*.
- [3] M. Kalman, P. Ramanathan, and B. Girod, "Rate-Distortion Optimized Streaming with Multiple Deadlines," *Proc. IEEE International Conference on Image Processing, ICIP-2003*, Barcelona, Spain, Sept. 2003.