

Kinerja Protokol SRT dengan ARQ dan RaptorQ pada Video Streaming di Jaringan Unguaranteed = Performance of the SRT Protocol with ARQ and RaptorQ in Video Streaming Over Unguaranteed Networks

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Abstrak

Layanan video real-time di jaringan unguaranteed yang sering mengalami delay, jitter, dan kehilangan paket. Penelitian ini melakukan simulasi protokol SRT yang dilengkapi mekanisme error handling gabungan antara selective repeat ARQ dan RaptorQ FEC, untuk mengevaluasi performa pada skenario random loss dengan loss rate bervariasi dan burst loss dengan variasi probabilitas transisi Good ke Bad dan Bad ke Good. Metode simulasi dilakukan di MATLAB menggunakan model Bernoulli untuk random loss dan model Markov dua-state Gilbert-Elliott untuk burst loss. Efektivitas dinilai dari metrik kapabilitas pemulihan paket (effective recovery rate dan residual loss rate), kinerja streaming (latency, jitter, dan overhead bandwidth), serta effective frame rate. Hasil simulasi menunjukkan bahwa strategi gabungan berhasil mempertahankan nilai recovery di atas 95 persen dan residual loss di bawah 1 persen hingga loss rate 20 persen. Latency rata-rata berkisar antara 27 ms hingga 76 ms, jitter antara 4 ms hingga 21 ms, dan overhead bandwidth di bawah 20 persen pada kondisi loss moderat. Effective frame rate stabil di sekitar 30 FPS, mengungguli metode ARQ murni dan RaptorQ tunggal. Temuan ini menegaskan bahwa integrasi ARQ selektif dan RaptorQ FEC pada protokol SRT meningkatkan ketahanan terhadap degradasi jaringan dan menjaga kualitas streaming video real-time.

.....Real-time video services over unguaranteed networks often experience delay, jitter, and packet loss. This study simulates the SRT protocol equipped with a combined error handling mechanism of selective repeat ARQ and RaptorQ FEC to evaluate performance under random loss scenarios with varying loss rates and burst loss scenarios with variations in Good-to-Bad and Bad-to-Good transition probabilities. The simulation method is implemented in MATLAB using a Bernoulli model for random loss and a two-state Gilbert-Elliott Markov model for burst loss. Effectiveness is assessed by packet recovery capability metrics (effective recovery rate and residual loss rate), streaming performance (latency, jitter, and overhead bandwidth), and effective frame rate. Simulation results show that the combined strategy maintains recovery values above 95 percent and residual loss below 1 percent up to a 20 percent loss rate. Average latency ranges from 27 ms to 76 ms, jitter from 4 ms to 21 ms, and overhead bandwidth remains below 20 percent under moderate loss conditions. Effective frame rate remains stable at around 30 FPS, outperforming pure ARQ and standalone RaptorQ methods. These findings confirm that integrating selective repeat ARQ and RaptorQ FEC into the SRT protocol enhances resilience to network degradation and preserves real-time video streaming quality.