ABC: Adaptive Bitrate Algorithm Commander for Multi-Client Video Streaming

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Abstract

With the improvement of live streaming technology, ensuring high QoE and fairness of different ABR algorithm clients sharing the same LAN is becoming a pressing issue. However, aggressive and conservative algorithm will make different bitrate adjustment decisions when they share network resources, which leads to unfairness. In this poster, we proposed a regulation mechanism ABC, adjusting the sensitive parameters such as bandwidth, delay and buffer, to improve the fairness problem and coordinate overall system QoE by 68%.

Background

With the improvement of live streaming technology, more and more conferences and courses are now being broadcasted online, with teachers teaching online and students watching in the same classroom using different clients. In this case, how to ensure the playback quality of multiple video clients sharing the same LAN and the fairness among them becomes a pressing issue.

To satisfy the Quality of Experience(QoE) requirements, including video playback quality, fluency and stability, many solutions based on adaptive bitrate(ABR) have been proposed. They can be broadly classified into the following types, throughput-based[4, 5, 10], buffer-based[3, 9, 8]and Hybrid control strategies[6, 10, 1].

Research gaps

However, in the above multi-participant video course scenario, multiple players deployed with different ABR algorithms will share the same LAN link bandwidth like Figure1(left), and different decision mechanisms will lead them to make different bitrate adjustment decisions, some are too aggressive while others are relatively conservative. This situation can lead to certain unfairness, making a QoE gap between different ABR clients. As shown in Figure1(right), the client deployed with rate-based and MPC tend to select high bitrate earlier compared to the other algorithms, resulting in a more pronounced preemption of network resources.

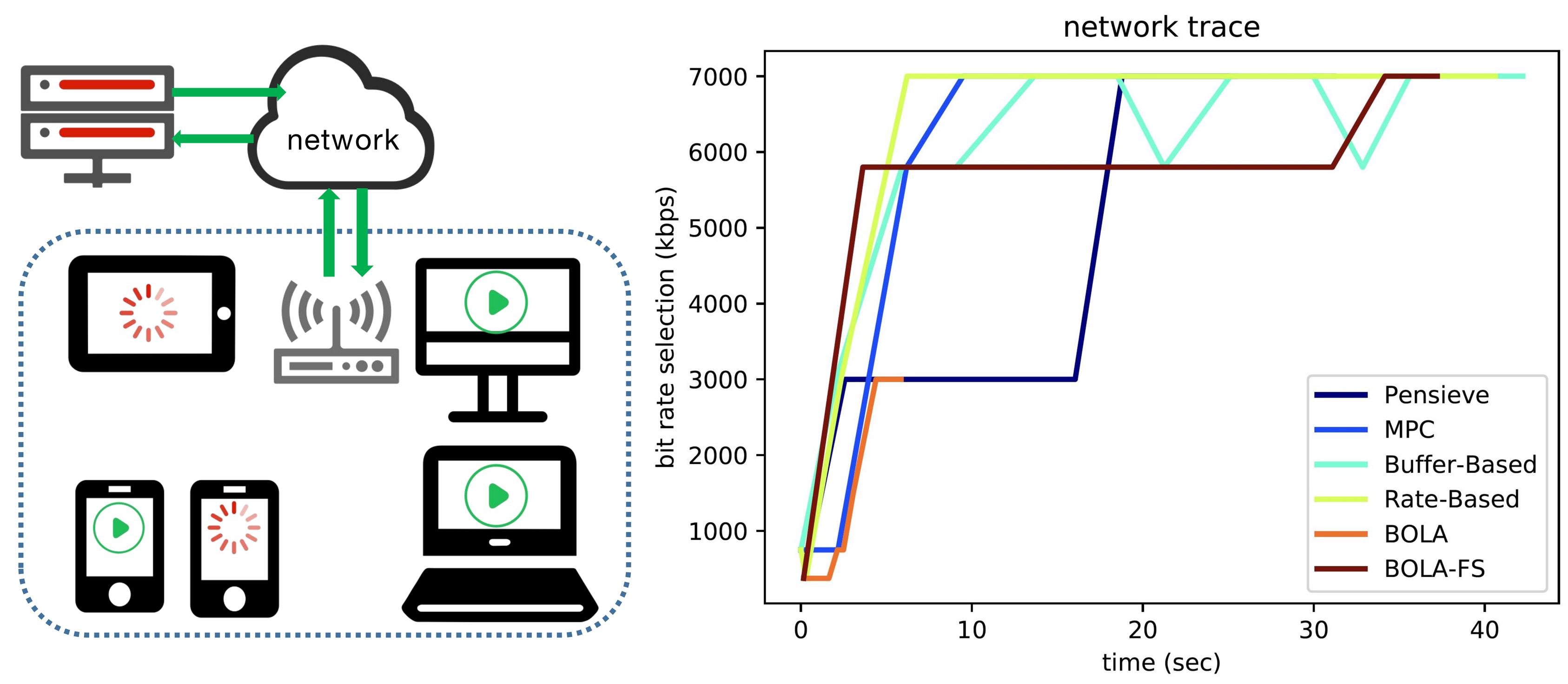

Figure 1. Different ABR coexistence lead to unfairness.

Fairness objectives

- The smaller the difference in QoE_{ABR}, the better.
- The fewer fluctuations, the better.
- The higher the overall QoE_{ABR}, the better.

We use the definition of QoE_{ABR} Maximization Problem in MPC[10], and the overall QoE_{total} is measured by both individual QoE_{ABR} and the convergence factor f_{ABR}. The convergence factor is determined by convergence delay, rebuffering time and the fluctuations times when the network is unstable. N indicates the number of ABR algorithm types and $F()_+$ is a decreasing function that increases as f_{ABR} decreases. The goal of the ABC regulator module is to maximize the QoE_{total}.

$$QoE_{total} = \sum_{n=1}^{N} QoE_{ABR}^{n} + \sum_{n=1}^{N} F(f_{ABR}^{n})_+ \quad (1)$$

System Overview

Figure 2 shows the high-level architecture of system with ABCommander. Multiple video clients located in the same LAN are deployed with different ABR algorithm, client calculates the bitrate level locally and then sends an HTTP request to the server. And the server returns video content and other information for the next bitrate decision. Our ABC module is located between the server and clients, functioning before client makes a decision on the bitrate level of the next video chunk. According to the inherent characteristics of different algorithms and the changes of network conditions, ABC module indirectly controls the decision result of the algorithm by adaptively adjusting the decision parameters of each ABR algorithm.

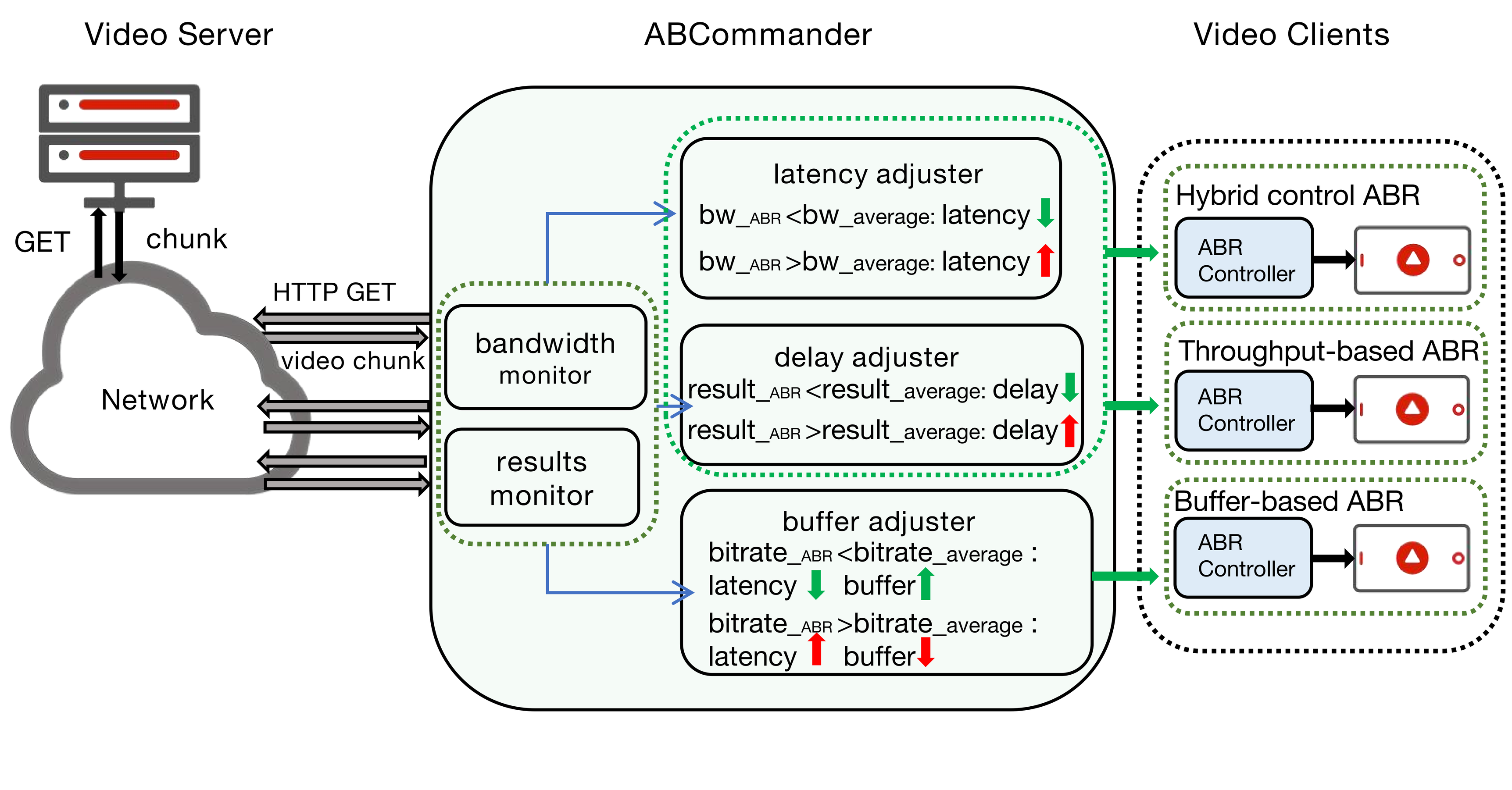

Figure 2. System architecture.

Study methodology

ABC will continuously monitor all ABR clients during video playback, and if "unfairness" is detected, it will choose the regulation mode according to the ABR type: for ABR algorithms sensitive to comprehensive parameters, the parameters will be regulated to appropriate values according to the pre-stored "regulation control table". For bandwidth-sensitive or buffer-sensitive ABRs, the corresponding parameters are adjusted to the appropriate values according to the bandwidth regulator or buffer regulator. After updating the original parameters, continue to send them to the ABR video client.

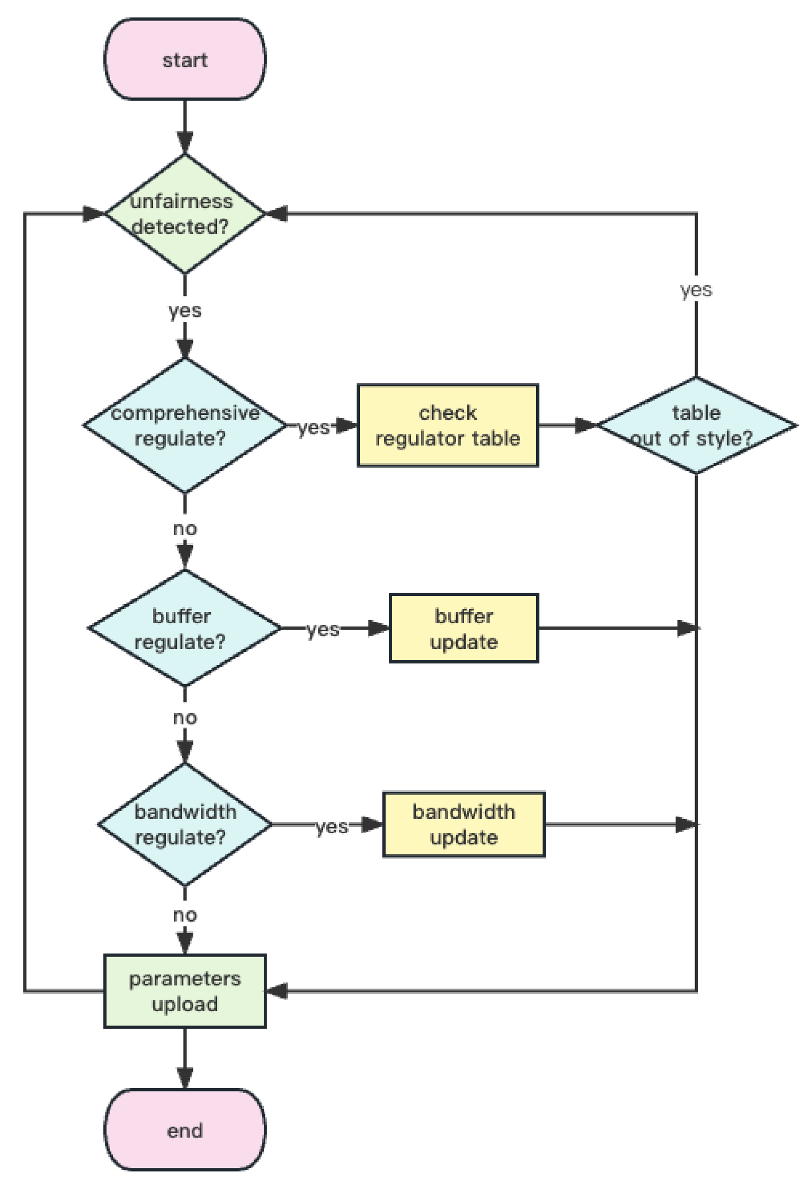

Figure 3. ABCommander regulation process

Preliminary results

Datasets. Our experiments utilized two different video configurations: "EnvivioDash3"[6] in real world experiments and "BBB" in simulated experiments.The network traces including 3G and 4G are provided by datasets[2, 7].

Results. Figure4 shows the QoE_{total} of the system was improved by 68% with the regulation of the ABC module. In addition, the rebuffering time and fluctuation times were reduced, which improves the fairness. The findings show the reduction of algorithmic instability and poor video fluency and overall video quality improvement in the system, and these satisfy the pursuit of fairness objectives.

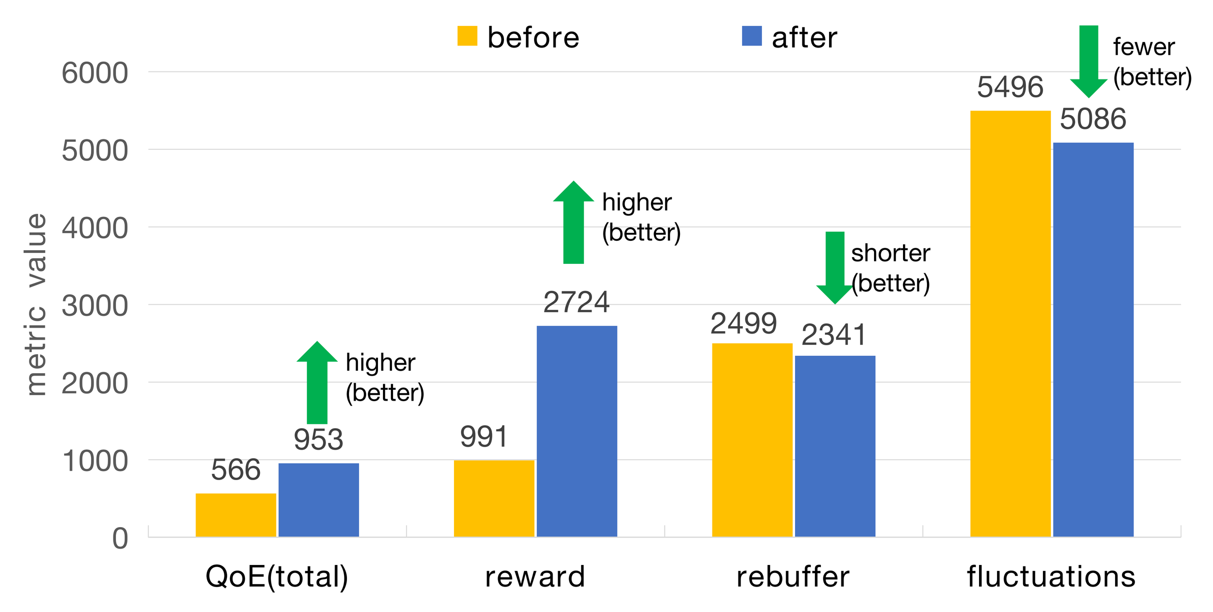

Figure 4. System performance comparison before and after ABC, reward refers to the single ABR's QoE.

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