Empowering Video Players in Cellular: ML-enabled Throughput Prediction

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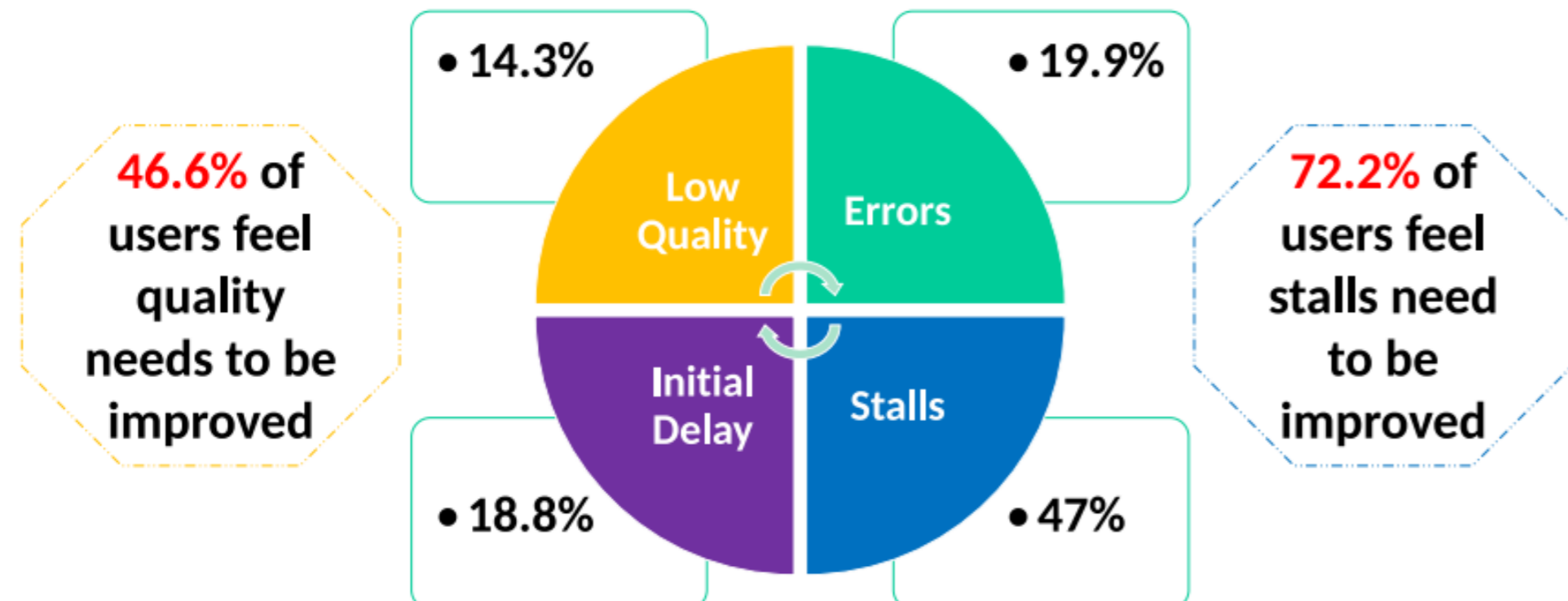
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Introduction

- Video is almost 58% of the total downstream volume of traffic on the internet

- YouTube accounts for 35% of worldwide mobile traffic

Most annoying problems when streaming a video

- 14.3% Low Quality
- 19.9% Errors
- 18.8% Initial Delay
- 47% Stalls

46.6% of users feel quality needs to be improved

**72.2%** of users feel stalls need to be improved

Challenges

- Data rate in cellular networks may fluctuate by an order of magnitude over a span of a few seconds

- As a result, video streaming players struggle to adapt to sudden changes, leading to **low quality** and increased **re-buffering events**

Motivation

- Most of video quality adaptation algorithms rely on bandwidth estimate calculated using one of the standard smoothing techniques (arithmetic, harmonic or EWMA)

- **Idea:** Improve accuracy of **estimator** by leveraging additional information about channel characteristics (SNR, CQI...)
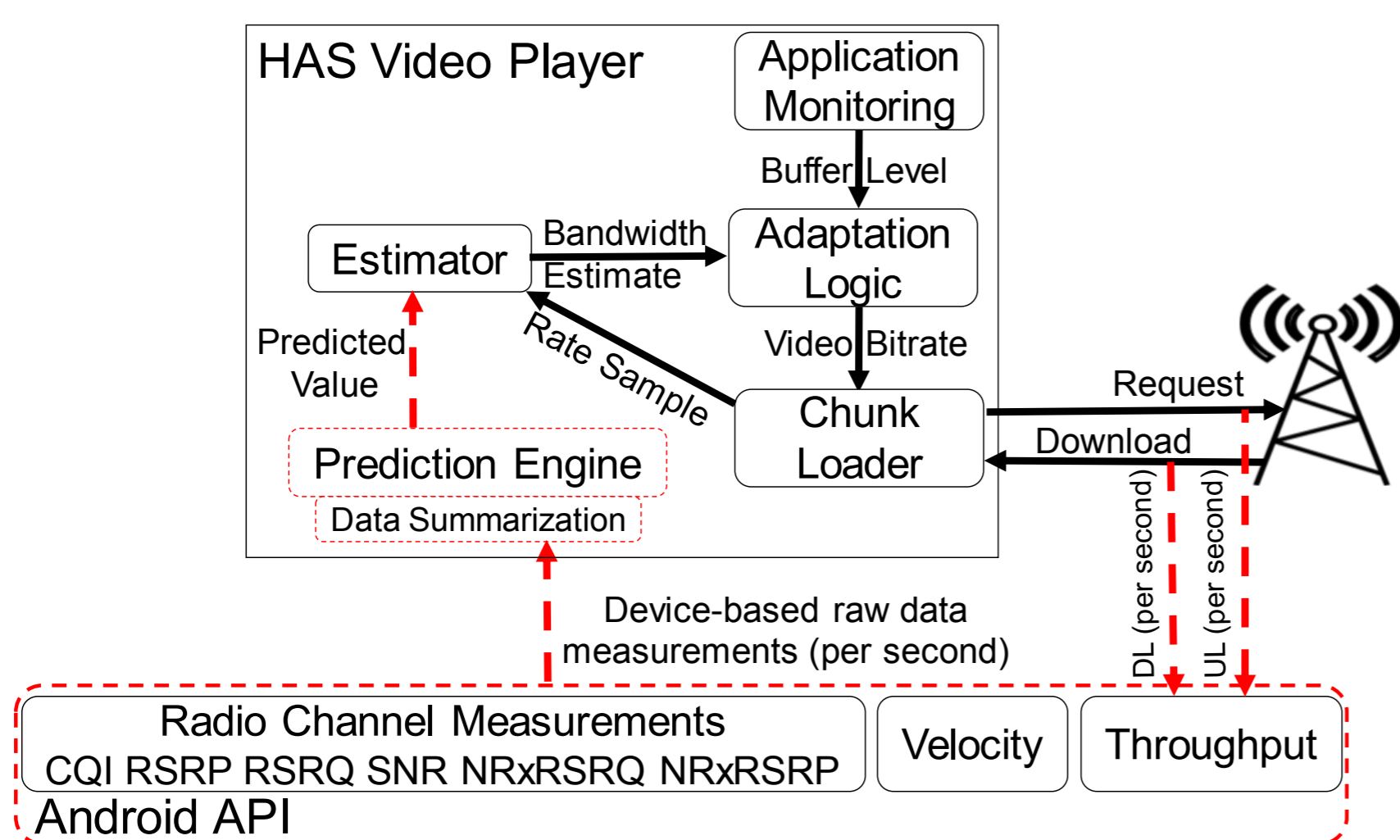

- Use a Machine Learning approach to predict future throughput values

Throughput Prediction via ML

- **What does a streaming algorithm need?** - predicted average throughput for the decision for next streaming quality (in addition to buffer application state...)

- **Methodology** - use historical data (past throughput, channel information) to train ML algorithm (Random Forest)

- **How to represent history of each metric?**

  - *Quantile* approach: estimate unknown distribution of historical data by percentiles

  - *Raw* approach: use samples directly as input

Results

- **Accuracy metrics** - ratio of the difference between actual and predicted throughput and actual throughput (ARE)
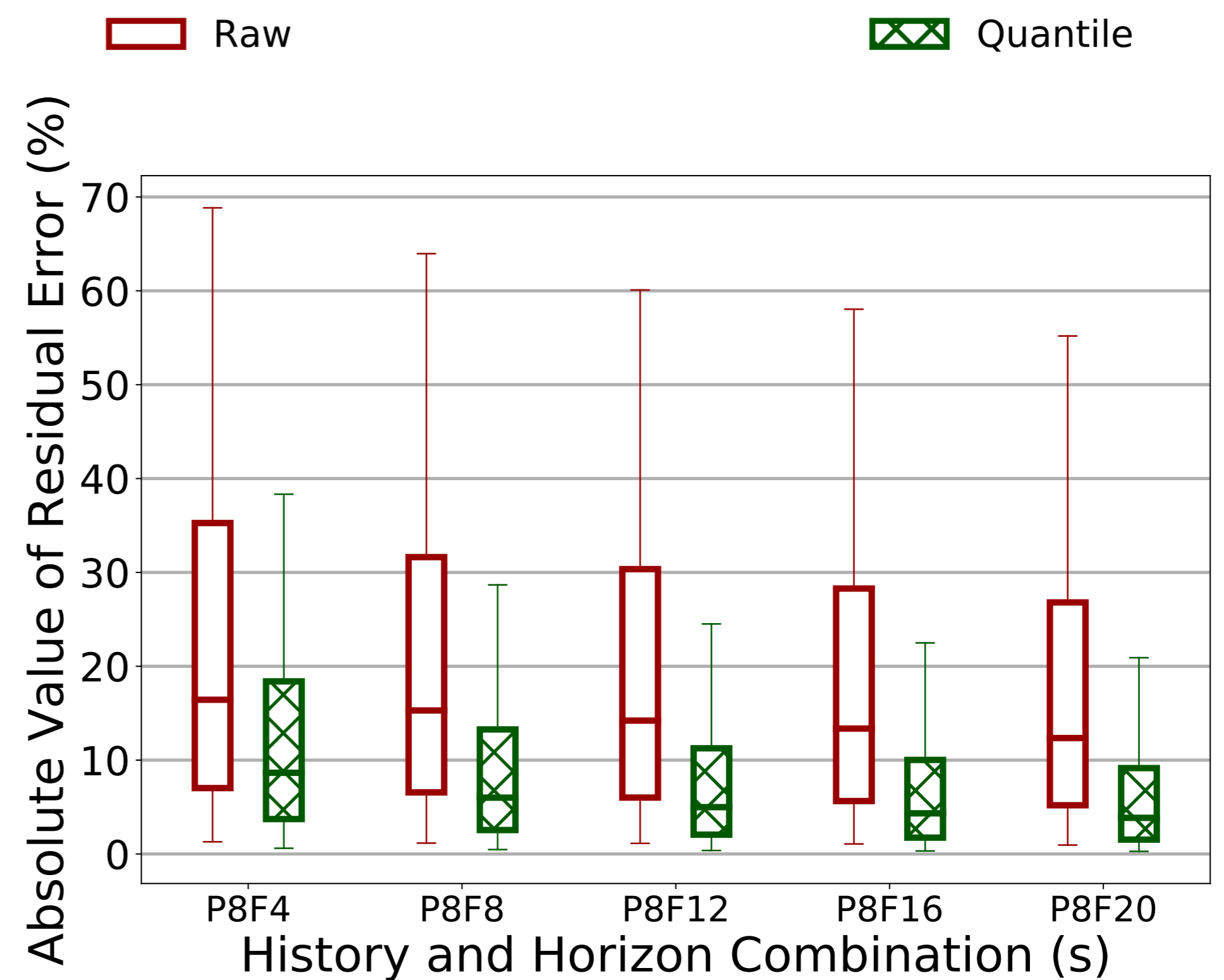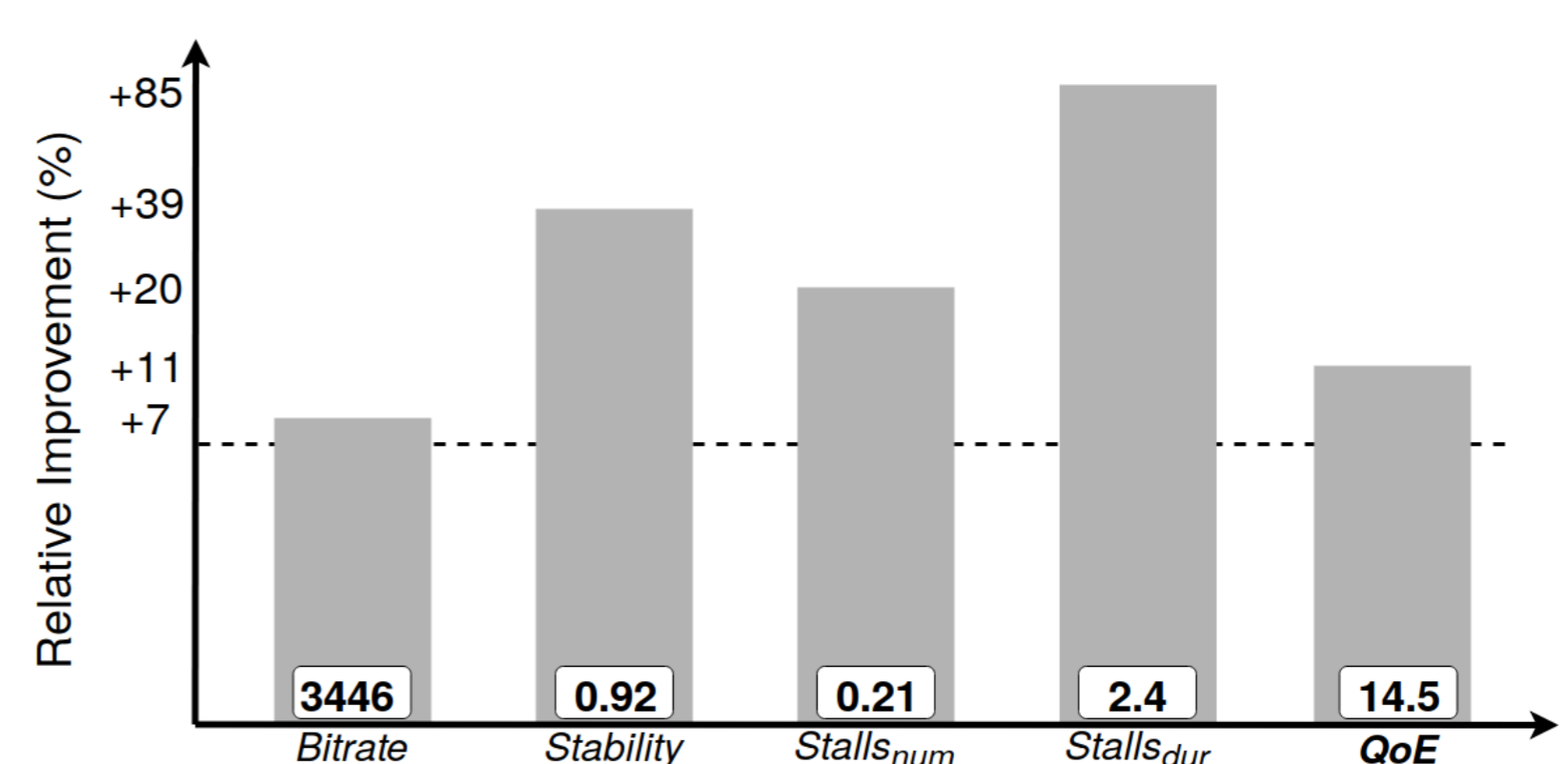

Video Player with TP - Controlled Experiment
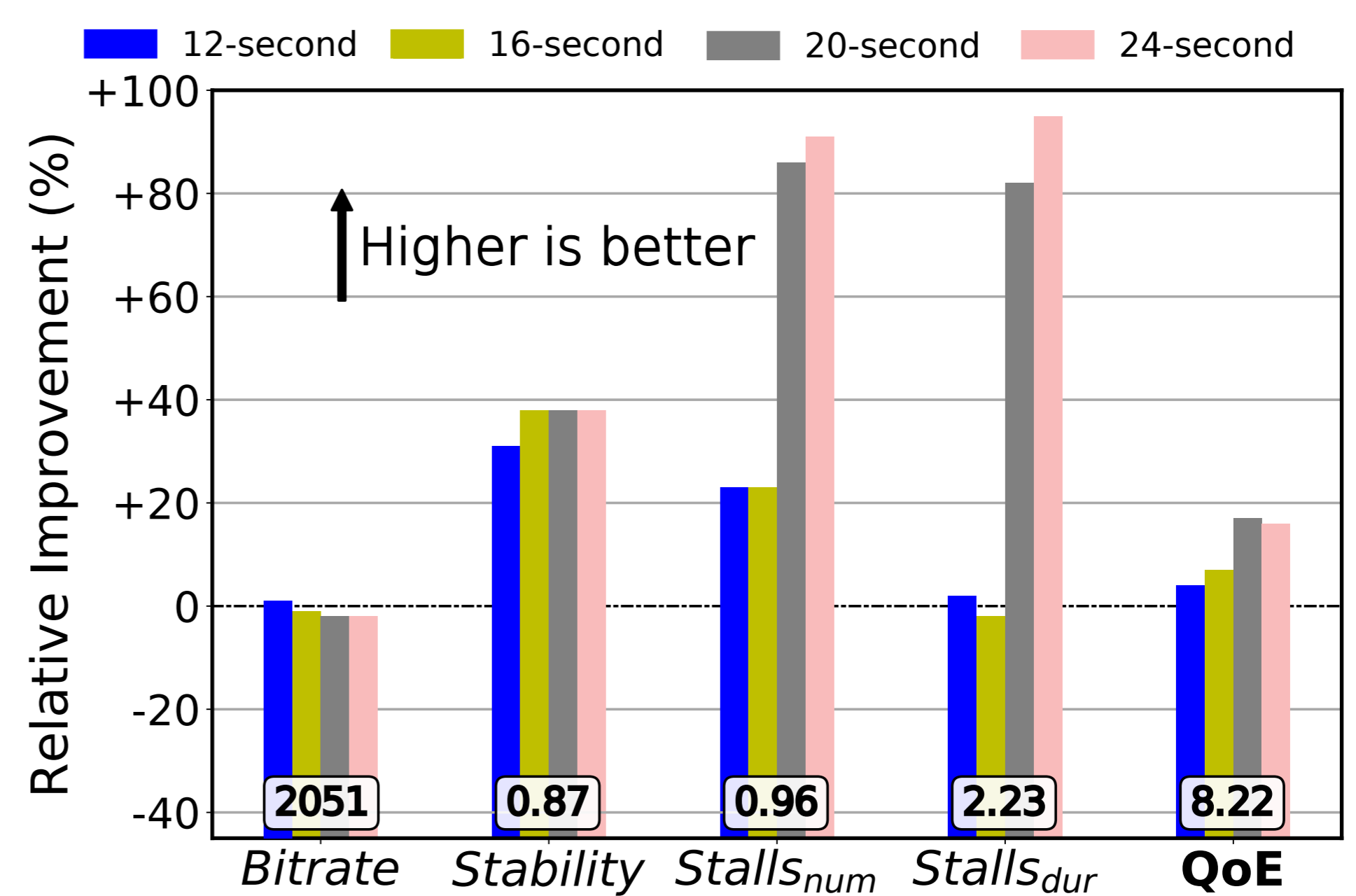
- Prediction enables all algorithms to reduce/eliminate stalls, improve switching stability and average stability

Real Time Prediction

- Prediction engine implemented in a real device as a part of ExoPlayer

- Prediction improves all QoE metrics