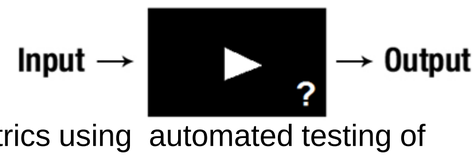
AdViSE: Adaptive Video Streaming Evaluation Framework for the Automated Testing of Media Players

Anatoliy **Zabrovskiy**, Evgeny **Kuzmin**, Evgeny **Petrov**, Petrozavodsk State University, {z_anatoliy, kuzmin, johnp}@petrsu.ru
Christian **Timmerer**, Alpen-Adria-Universität Klagenfurt / Bitmovin Inc., christian.timmerer@itec.uni-klu.ac.at
Christopher **Mueller**, Bitmovin Inc., christopher.mueller@bitmovin.com

Motivation

Current situation

- Adaptive video streaming over HTTP is becoming more and more **the primary technology** for video delivery in the open internet
- Nowadays, there exists a large number of different players/algorithms
- New versions of players are released in a short period
- Most of the players and their rate adaptation algorithms work as a **black box**
- There is no **public, reliable information** about the performance of adaptive media players



Research Goals/Questions

- Study and quantify the quality parameters and metrics using automated testing of media players
- Research and compare the media players behavior under various network scenarios
- Research QoE metrics for the adaptive video streaming

Adaptive HTML5 Players

Bitmovin Player, dash.js, Flow Player, HAS Player, JW Player, Radiant MP, Shaka Player, VideoJS Player

Context conditions

The context conditions can be categorized into several areas:

- **Access network**: wired, WiFi, mobile 3G/4G/5G;
- **Network architecture/paradigm**: content delivery network (CDN), software-defined networking (SDN), information-centric networking (ICN);
- **Client device**: desktop, laptop, mobile, TV, set top box, virtual reality (VR)/head-mounted display (HMD);
- **Client device condition/state**: in motion, fixed;
- **Server infrastructure**: single server, direct stream from Internet of Multimedia Things (IoMT) device;
- **Content characteristics**: live or video on-demand, segment size (e.g., 2s, 4s, 6s or 9s), number of representations (bitrates, resolutions, languages), video codec, content profile.

One change in the context condition might have a **big impact** on the player behavior

Web Management Interface

Functions

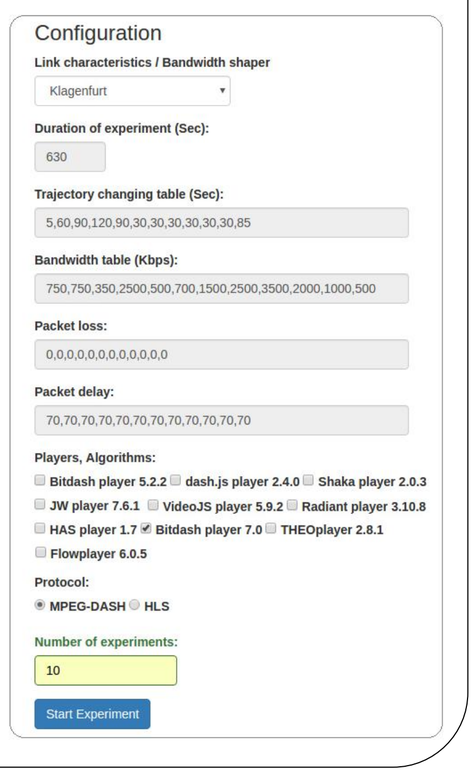
- Configuring and conducting the experiments
- Presenting the player with real-time information about the currently conducted experiment and its parameters

Customizable items and parameters

- Management of network emulation profiles including the configuration of **bandwidth trajectory**, **packet loss**, and **packet delay**
- Specification of the **number of runs** of an experiment
- Selection of the **adaptive media player** and the **adaptive streaming protocol** (MPEG-DASH or HLS).

Result page

- Providing a list of conducted experiments
- Generating graphs of the results
- Providing various metrics of the conducted experiments
- Exporting the raw values for a further offline analysis



Quality parameters and metrics

- Download video bitrate (or selected video quality);
- Video buffer length (or video buffer level);
- Video startup time;
- Stalls (or buffer underruns);
- Number of quality switches.
- Unstability and inefficiency;
- Average video bitrate;
- **QoE metrics:** ***QoE$_{Maki}$***, which takes into account the number of stalls, total stalling time; ***QoE$_{Mok}$*** which depends on video start-up time, stalling frequency and average duration of a stalling event.

$$\text{Instability} = \frac{\sum_{d=0}^{k-1} |b_{t-d} - b_{t-d-1}|}{\sum_{d=1}^{k} b_{t-d}}$$

$$\text{Inefficiency} = \frac{1}{N} \cdot \sum_{t} \frac{|b_{i,t} - W_{i,t}|}{W_{i,t}}$$

- N – the number of measurements
- $W_{i,t}$ - network bandwidth
- $b_{i,t}$ - selected video bitrate

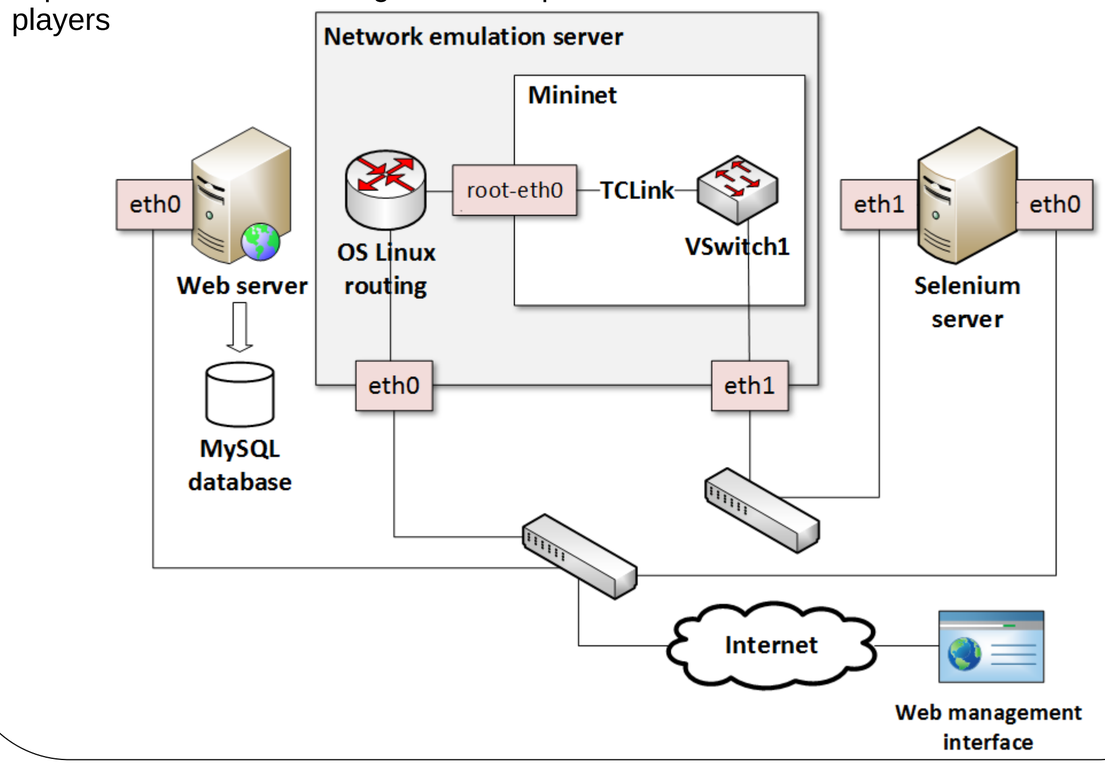
Adaptive Video Streaming Evaluation Framework

AdViSE

- Powerful tools to both researchers and practitioners which enable easy and rapid testing of new media player solutions and rate adaptation algorithms under a variety of context conditions

System Architecture

- **Web server** with standard HTTP hosting the segmented **video content** and **MySQL database**
- **Network emulation server** with customized Mininet
- **Selenium server** for running adaptive media players on various platforms.
- **Web management interface** for conducting the experiments and running the adaptive media players

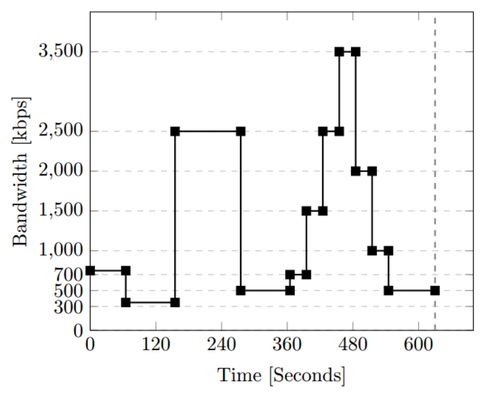


Experiments

Original video file characteristics

- Resolution: 3840x2160 (4K)
- Duration: 634 sec.
- Average bitrate: 7498 kbps

Bandwidth trajectory scheme

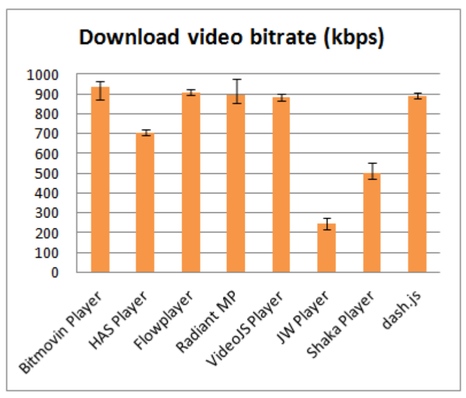


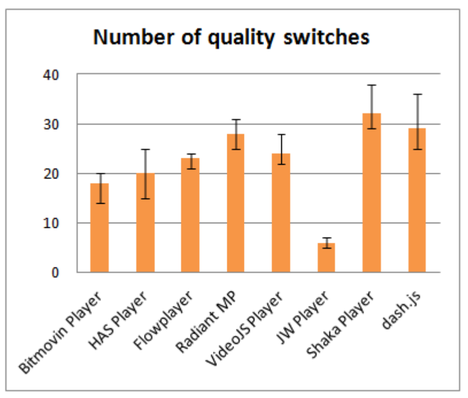
Representations of Amazon Prime Video

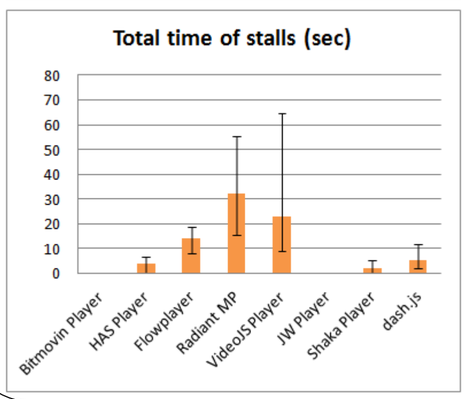
Number	Bitrate (kbps)	Resolution
1	100	400x224
2	150	400x224
3	200	512x288
4	300	512x288
5	500	512x288
6	800	640x360
7	1200	704x396
8	1800	704x396
9	2400	720x404
10	2500	720x404
11	2995	960x540
12	3000	1280x720
13	4500	1280x720
14	8000	1920x1080

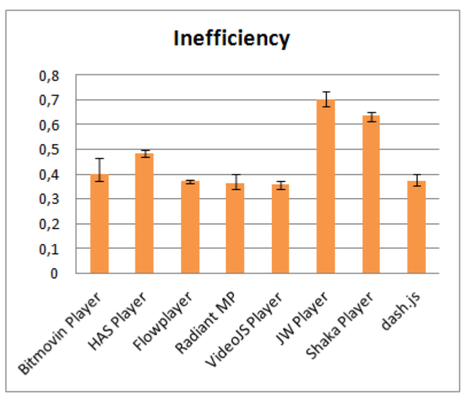
Results

Each experiment has been conducted five times and the average is presented here









Experiments details

- In total**, 80 experiments**
- Duration of each experiment **630 sec**.
- **Total duration** of experiments is **14 hours**