Paper Review: From Theory to Practice: Improving Bitrate Adaptation in the DASH Reference Player

Author: Kevin Spiteri Ramesh Sitaraman Daniel Sparacio

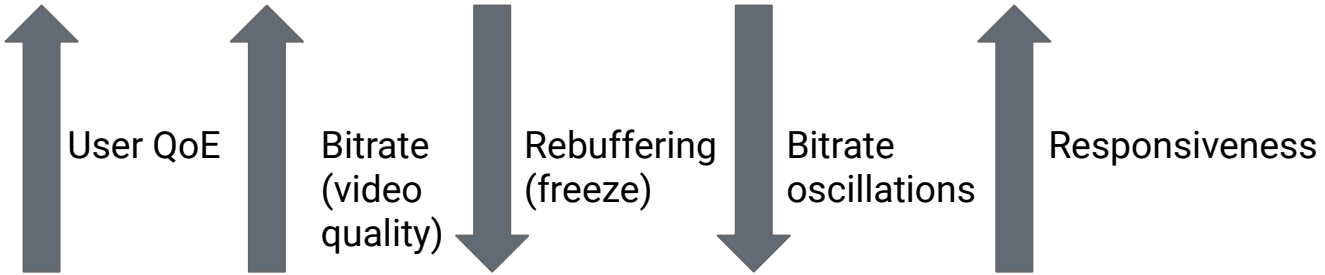
Presenter: Tanzhen Li

Adaptive Video Streaming

ABR

Adaptive Bitrate Algorithm

Modern video streaming uses adaptive bitrate (ABR) algorithms which run inside video players and continually adjust the quality of the video segments that are downloaded and rendered to the user.



Types of ABR Algorithms

- Throughput-based
  - PANDA
- Buffer-based
  - BOLA
- Hybrid
  - DYNAMIC

Adaptive Video Streaming Formats

- Apple HTTP Live Streaming(HLS)
- Microsoft Smooth Streaming
- DASH

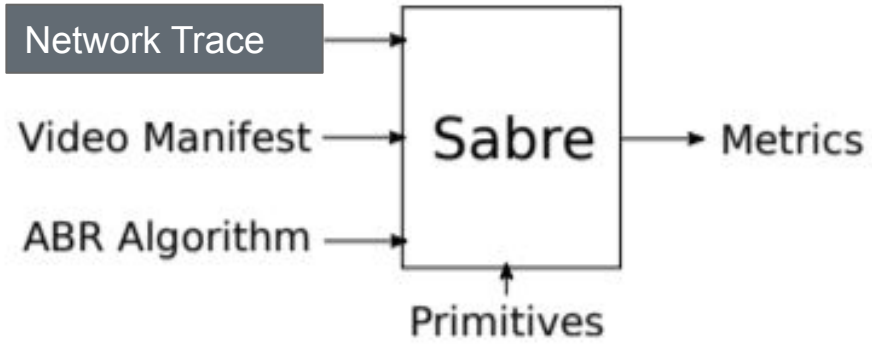
Author’s contributions

- Sabre
  - ABR environment simulation
- ABR algorithms implementation
  - BOLA-E
  - DYNAMIC
  - FAST SWITCHING

Sabre’s Inputs

- Network Trace

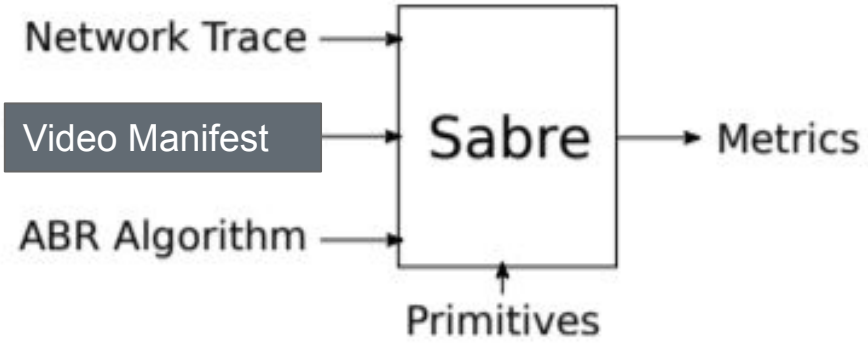
Sequence of records where each record contains the time duration, and network throughput and latency for that duration



Sabre’s Inputs

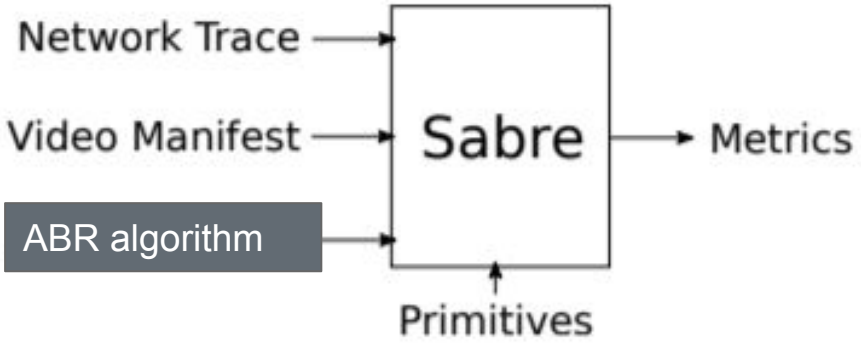
- Video Manifest

A video description that is analogous to the DASH manifest. The video description includes the segment length (in seconds), the encoded bitrates, and a segment size matrix



Sabre's Inputs

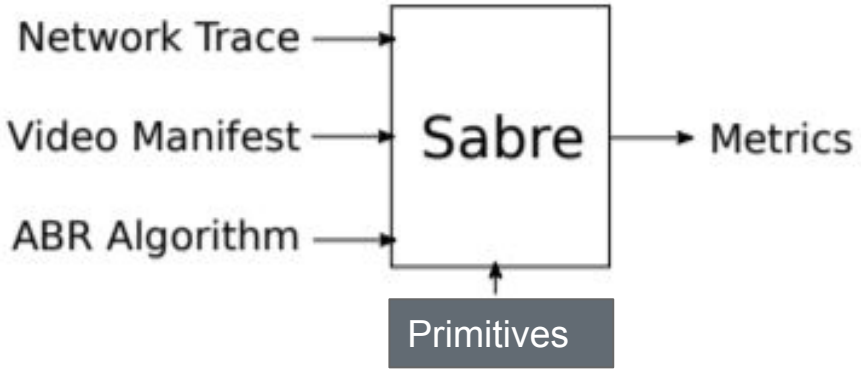
- ABR algorithm:
  - In python module
  - BOLA/PANDA



Sabre's Primitives

The native feasure video player has to help with ABR streaming

History throughput estimation



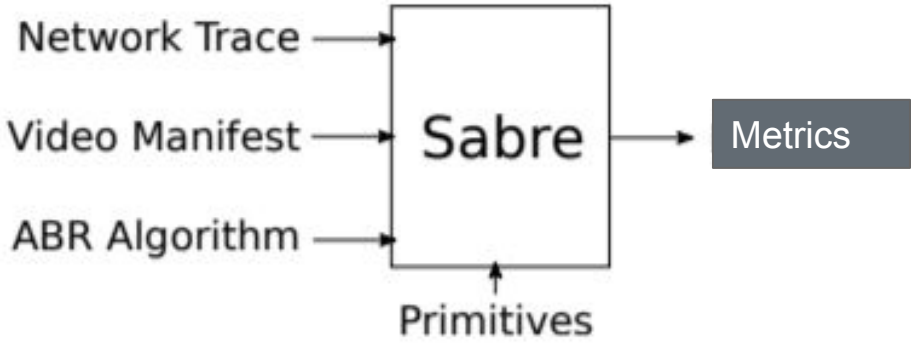
Sabre's Output

- Bitrate
- Download time
- Size of each downloaded segment
- Duration of each rebuffer event
- Each change in bitrate as the segments are played out
- All segment abandonments and replacements

Important Metrics

- Rebuffer ratio
- Average bitrate
- Average bitrate oscillation

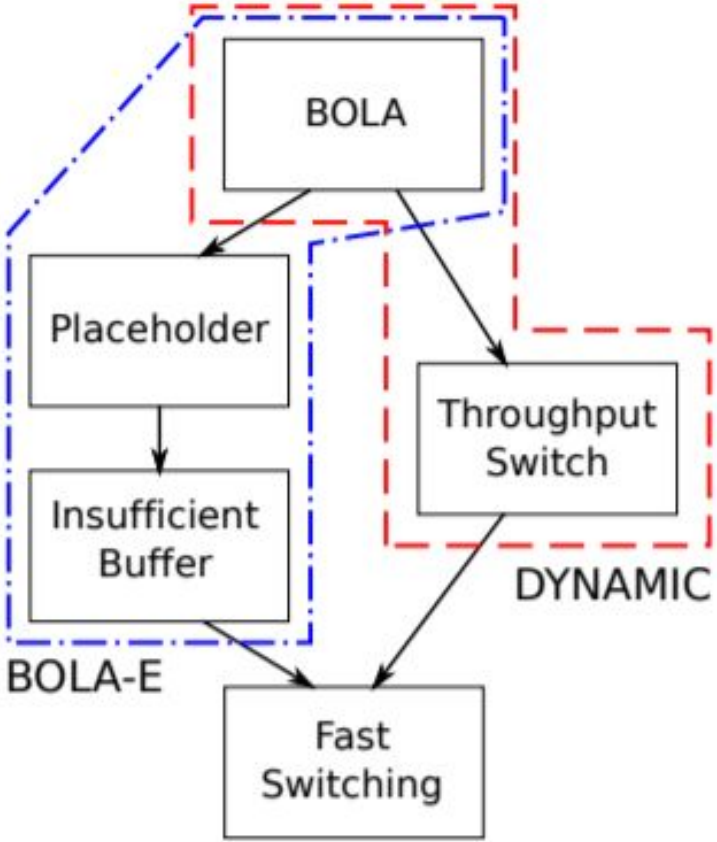
$$\frac{1}{N-1}\sum_{i=1}^{N-1}\left|\text{bitrate}(i)-\text{bitrate}(i+1)\right|$$



Sabre is open source!

https://github.com/UMass-LIDS/sabre

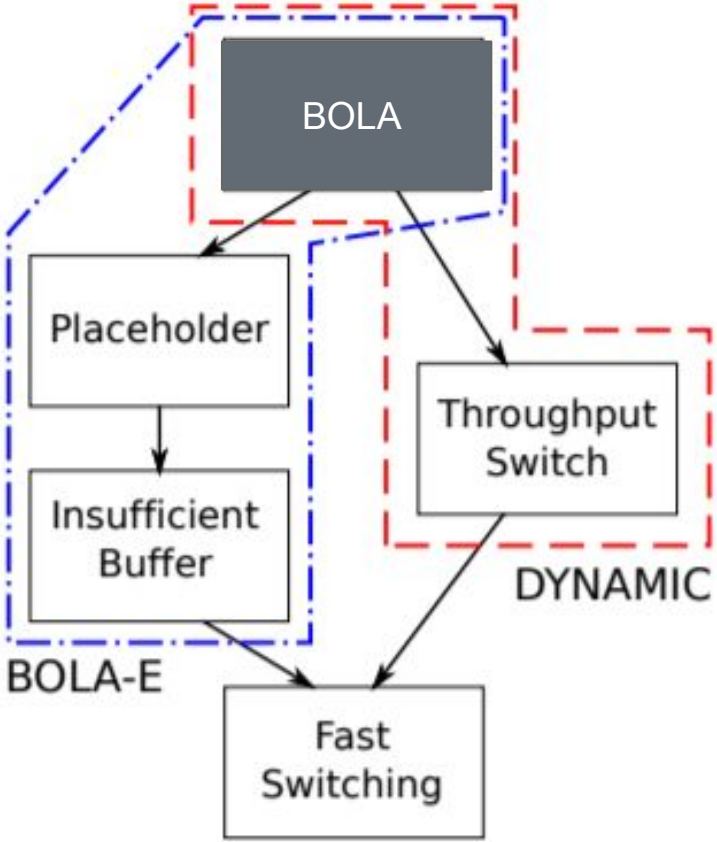
The design and production implementation of ABR algorithms for DASH



BOLA:

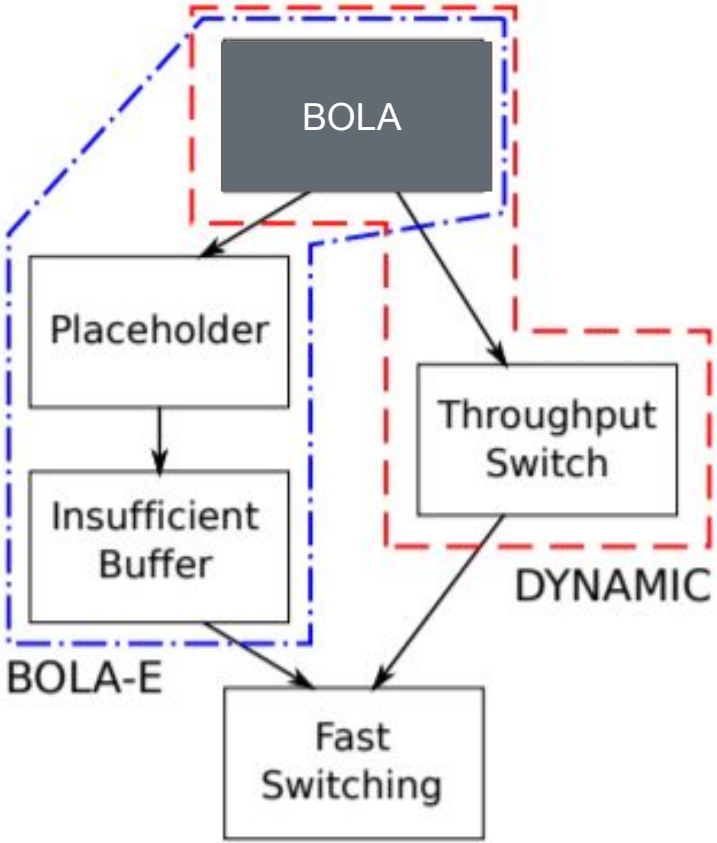
Utilizes Lyapunov optimal control to make ABR decisions based on buffer levels to maximize an arbitrary utility function that combines the two key QoE metrics of video bitrate and rebuffering.

BOLA: Near-optimal bitrate adaptation for online videos



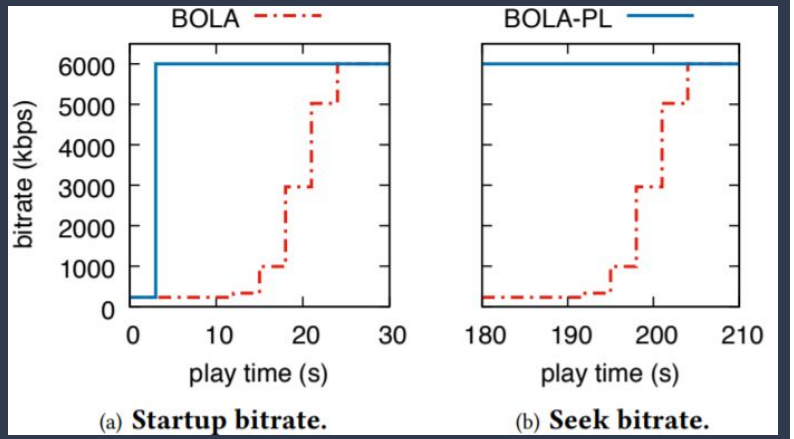
BOLA's Drawbacks

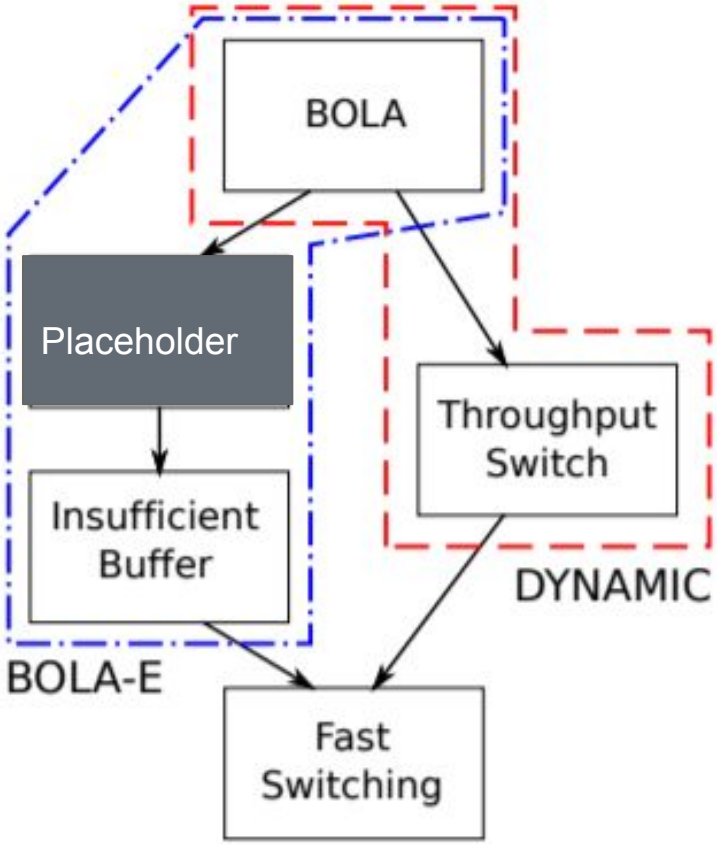
- Not responsive to user events:startup and seeking
  - Low Buffer Level
- Not well-performed for low buffer capacity situations: live stream
  - Low Buffer Capacity



Placeholder

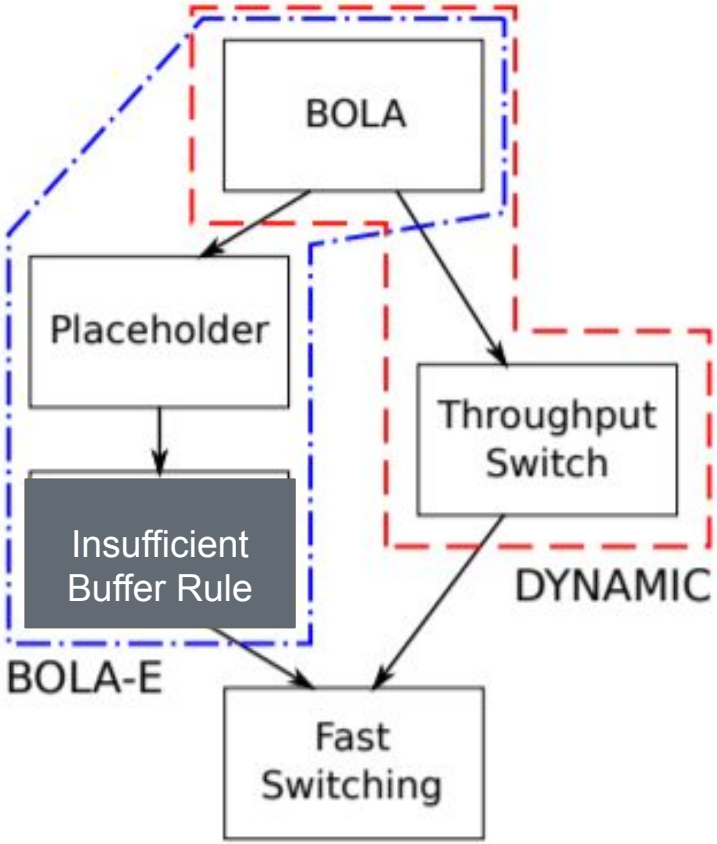
- Solving Low Buffer Level problem
- Inserting virtual video segments to the buffer to fake a larger buffer



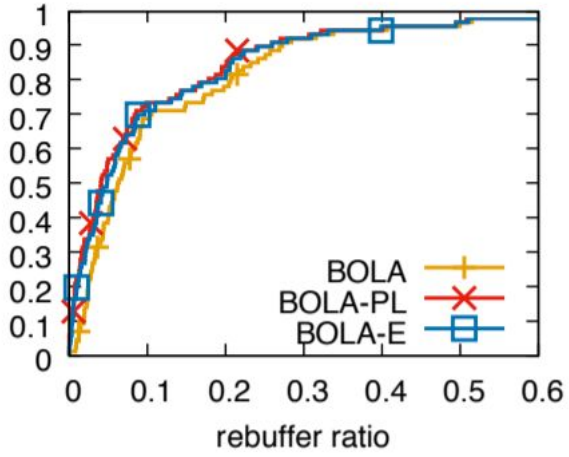


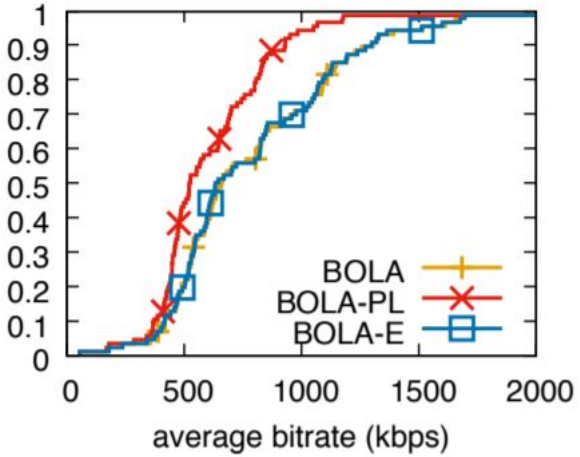
Insufficient Buffer Rule

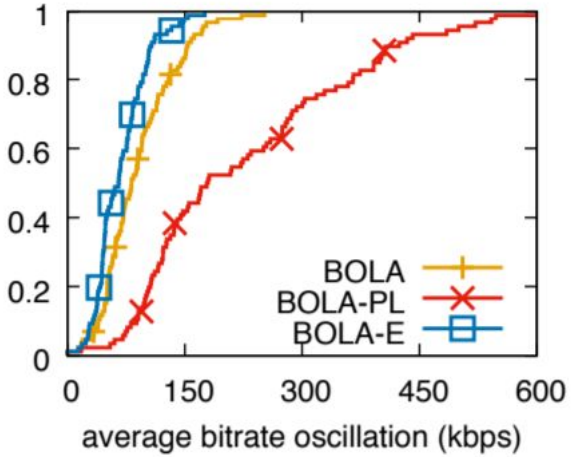
- Solving Low Buffer capacity problem
- Inserting virtual video segments to the buffer to fake a larger capacity buffer while limiting the actual video segments to be the same small capacity



Benchmark of placeholder/Insufficient Buffer Rule

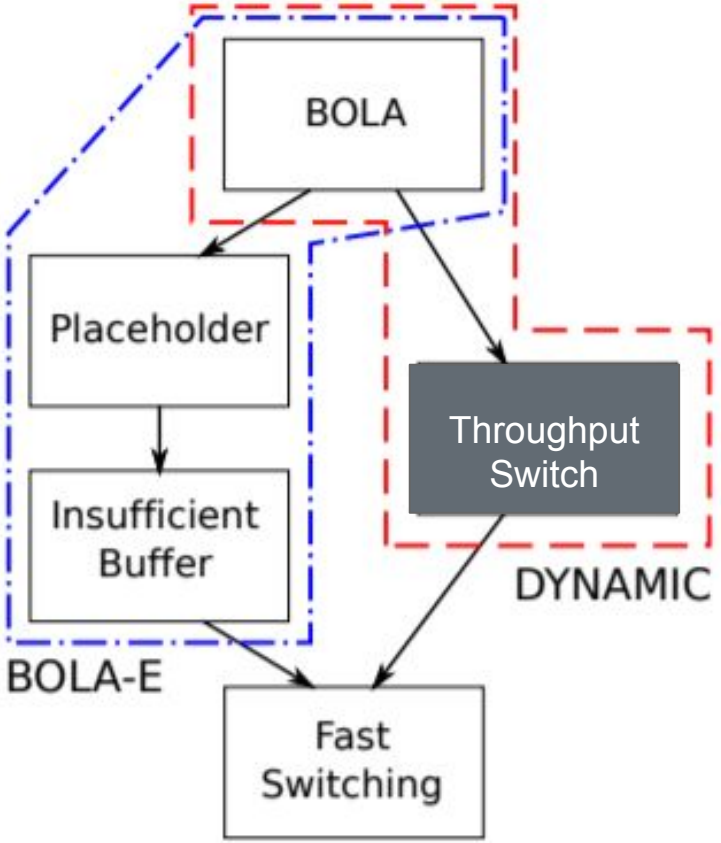




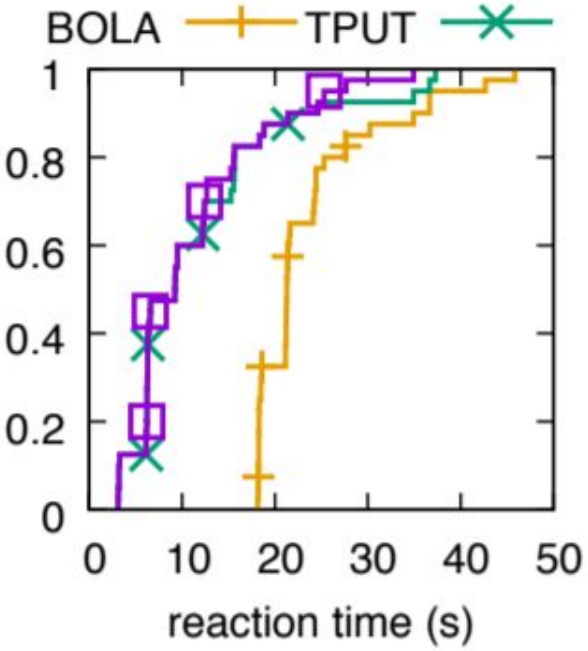


DYNAMIC

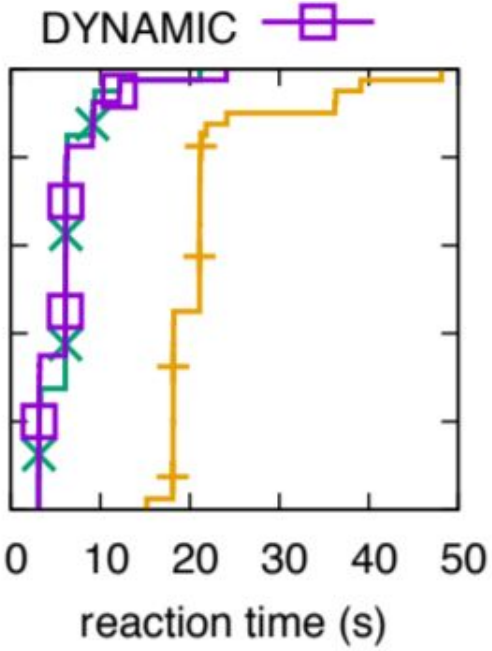
- Solving Low Buffer capacity and Low Buffer Level problem
- Setting buffer level as the trigger to switch between throughput based mode and BOLA
- The default version for DASH



Benchmark of DYNAMIC



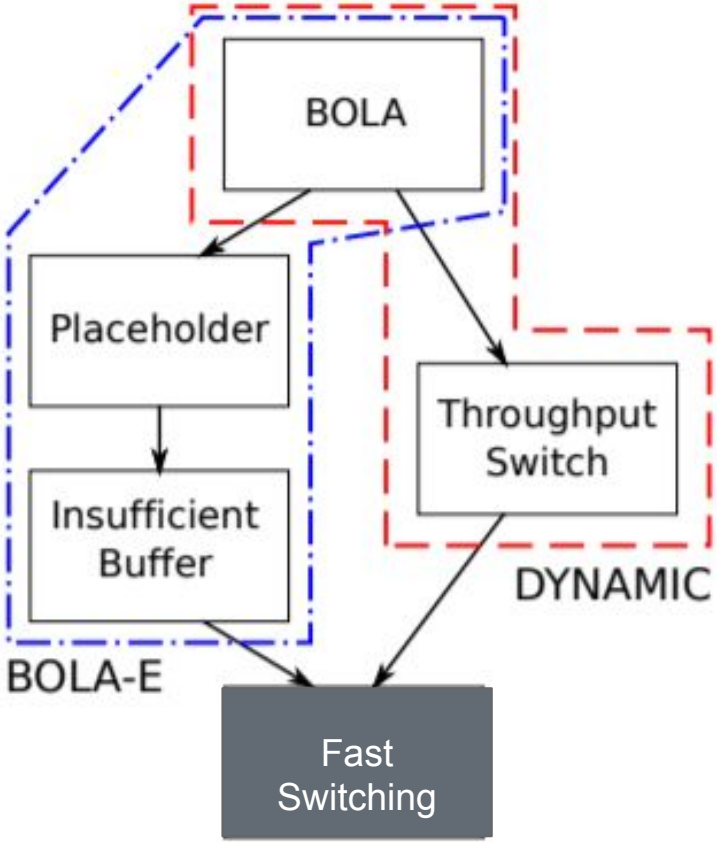
(a) **Startup reaction time.**



(b) **Seek reaction time.**

Fast Switching

- A segment replacement algorithm
- Improves larger buffer's responsiveness to sudden network event by replacing segments already in the buffer
- Works alongside any ABR selection algorithm



Conclusion

PROS:

- Provided a clear analysis of the current state of adaptive streaming
- Provided a well-performed algorithm model that solves multiple problems
- Provided an easy to use simulation software

CONS:

- The benchmark process is not detailed very well
- The validity of the simulation software is not stated

Questions to discuss