

SARA: Segment Aware Rate Adaptation for DASH Video Services

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Overview

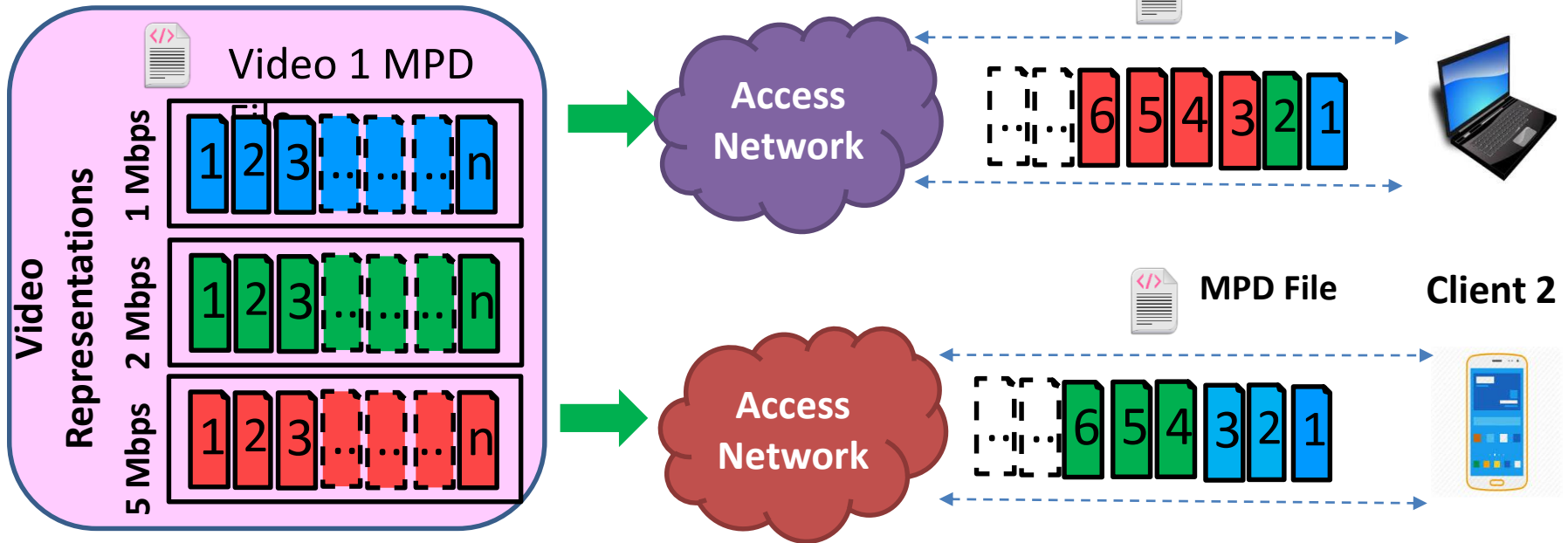
- Introduction
- DASH Overview
- Related Work & Motivation
- Segment Aware Rate Adaptation Algorithm
- Experiment Setup & Evaluation
- Demo

Introduction

- HTTP Video streaming is the most popular service over the Internet
- In North America, Netflix and YouTube accounted for 43% of the peak hour download traffic in 2014.
- Advantages of HTTP based video streaming:
 - Reuse of existing web architecture
 - NAT/Firewall transversal
- DASH improves QoE by adapting the bitrate based on network conditions

DASH Overview

Web Server



Related Work

- ABR Algorithms: Determine the bitrate for the next segment
- ABR algorithms of 3 popular video streaming services (Netflix, HULU, OSMF player) were found to have limitations [1]
 - Too slow to converge
 - Too many bitrate switching events
 - Just not good enough QoE
- Categories of current ABR algorithms
 - Throughput Based [2][3][4]
 - Buffer Occupancy Based [5]

[1] S. Akhshabi, A. C. Begen, and C. Dovrolis, “An experimental evaluation of rate-adaptation algorithms in adaptive streaming over HTTP,” in Proc. of the ACM conf. on Multimedia systems, 2011.

[2] C. Liu, I. Bouazizi, and M. Gabbouj, “Rate adaptation for adaptive HTTP streaming,” in Proc. of the 2nd ACM conf. on Multimedia systems, 2011.

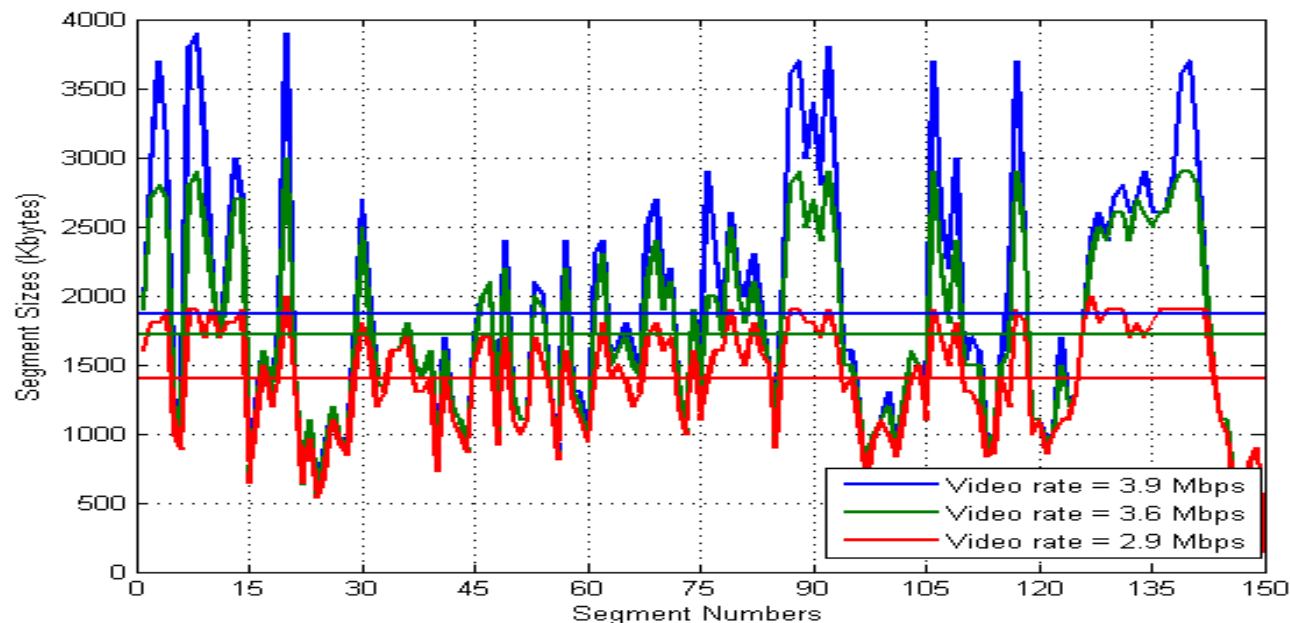
[3] K. Miller, E. Quacchio, G. Gennari, and A. Wolisz, “Adaptation algorithm for adaptive streaming over HTTP,” in *Packet Video Workshop (PV), 2012 19th International*.

[4] J. Jiang, V. Sekar, and H. Zhang, “Improving fairness, efficiency, and stability in HTTP-based adaptive video streaming with FESTIVE,” in *Proc. of the 8th Emerging networking experiments and technologies*, 2012.

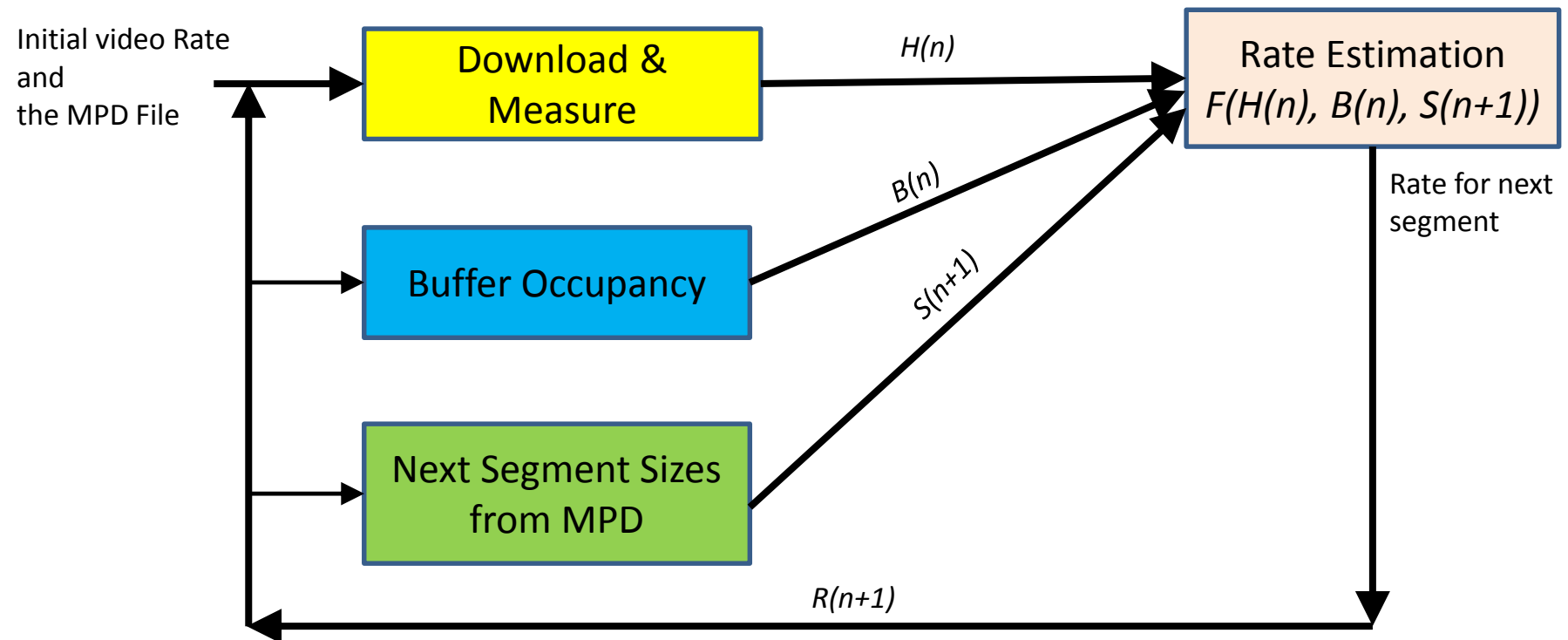
[5] T.-Y. Huang, R. Johari, N. McKeown, M. Trunnell, and M. Watson, “A buffer-based approach to rate adaptation: Evidence from a large video streaming service,” in Proc. of the ACM SIGCOMM, 2014.

Motivation

- To improve the QoE of DASH
 - Video Quality,
 - bitrate switching,
 - convergence
- Current algorithms assume the segment sizes are constant (average segment size)
- The size of the HTTP objects affects the throughput



Rate Adaptation Model



SARA: Segment Aware Rate Adaptation

- Enhanced MPD File
 - List the individual segment sizes during the pre-processing stage
- Throughput Estimation: Weighted Harmonic Mean

$$H_n = \frac{\sum_{i=1}^n \omega_i}{\sum_{i=1}^n \frac{\omega_i}{d_i}}$$

- Smart Segment Fetch Times

$$T_{n+1} = \frac{\omega_{n+1}^i}{H_n}, \quad i \in \text{List of bitrates}$$

- Buffer Occupancy

SARA: Buffer Mapping

Buffer Map Thresholds

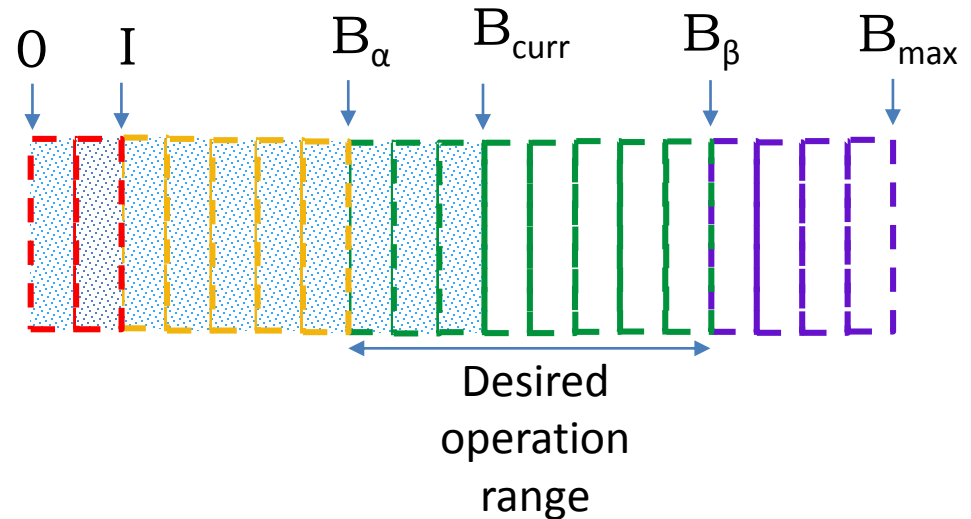
1. Fast Start ($0 < B_{curr} \leq I$)

- Select the minimum bitrate to minimize playback start time

2. Additive Increase ($I < B_{curr} \leq B_{\alpha}$)

3. Aggressive Switching ($B_{\alpha} < B_{curr} \leq B_{\beta}$)

4. Delayed Download ($B_{\beta} < B_{curr}$)



SARA: Algorithm

Algorithm 1: Segment Aware Rate Adaptation Algorithm

Data:

\mathbb{R} : Set of available bitrates $\{r^{min}, \dots, r^i, \dots, r^{max}\}$

$I, B_\alpha, B_\beta, B_{max}$: Buffer constants (number of segments)

Input:

n : Segment number of the most recent download

r^{curr} : Bitrate of the most recently downloaded segment

B_{curr} : Current buffer occupancy in seconds

$W_{n+1} = \{w_{n+1}^{min}, \dots, w_{n+1}^i, \dots, w_{n+1}^{max}\}$ The sizes of the segments for bitrates $\{r^{min}, \dots, r^m, \dots, r^{max}\}$

respectively

H_n : Weighted Harmonic mean download rate for the first n segments

Initialization:

if $B_{curr} \leq I$ // Fast Start

then

| $l_{n+1} = r^{min}$

SARA: Algorithm (contd..)

else

```
if  $(\frac{w_{n+1}^{curr}}{H_n}) > B_{curr} - I$  then
   $l_{n+1} =$ 
   $\max\{r^i | r^i \in \mathbb{R}, \frac{w_{n+1}^i}{H_n} \leq B_{curr} - I, i \leq curr\};$ 
   $\delta = 0;$ 
else if  $B_{curr} \leq B_\alpha$  // Additive Increase
then
  if  $\frac{w_{n+1}^{curr+1}}{H_n} < B_{curr} - I$  then
     $l_{n+1} = r^{curr} \uparrow$  // increase by one
    level
  else
     $l_{n+1} = r^{curr};$ 
   $\delta = 0;$ 
```

```
else if  $B_{curr} \leq B_\beta$  // Aggressive Switching
then
   $l_{n+1} =$ 
   $\max\{r^i | r^i \in \mathbb{R}, \frac{w_{n+1}^i}{H_n} \leq B_{curr} - I, i \geq curr\};$ 
   $\delta = 0;$ 
else if  $B_{curr} > B_\beta$  // Delayed Download
then
   $l_{n+1} =$ 
   $\max\{r^i | r^i \in \mathbb{R}, \frac{w_{n+1}^i}{H_n} \leq B_{curr} - B_\alpha, i \geq curr\};$ 
   $\delta = B_{curr} - B_\beta$ 
else
   $l_{n+1} = r^{curr};$ 
   $\delta = 0$ 
```

Result:

l_{n+1} : the bitrate of the next segment to be downloaded

δ : The wait time before downloading the next segment

Setup & Evaluation

- **Astream**

- Python based emulated DASH client

- Rate Adaptation Modules:

- Throughput Based (tba)

- Buffer Based (bba)

- SARA

- Available on Github: <http://github.com/pari685/AStream>

- **Evaluation Scenarios**

- Limited Bandwidth

- Short Interruptions

- Long Interruptions

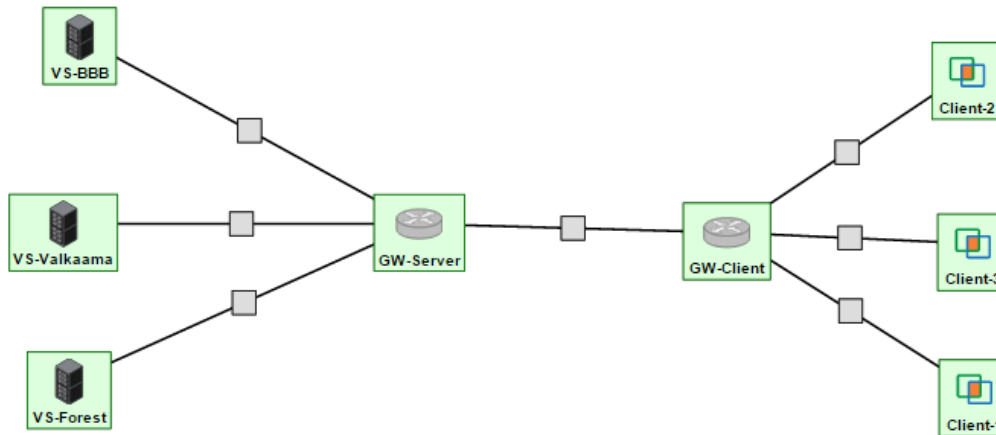
- For more details please refer to

P. Juluri, V. Tamarapalli, and D. Medhi, “SARA: Segment Aware Rate Adaptation algorithm for Dynamic Adaptive Streaming over HTTP,” in ICC QoE-FI Workshop, June, 2015

GENI Topology

Resources on UMKC InstaGENI are ready.

[View Rspec](#)



Sample LabWiki Output

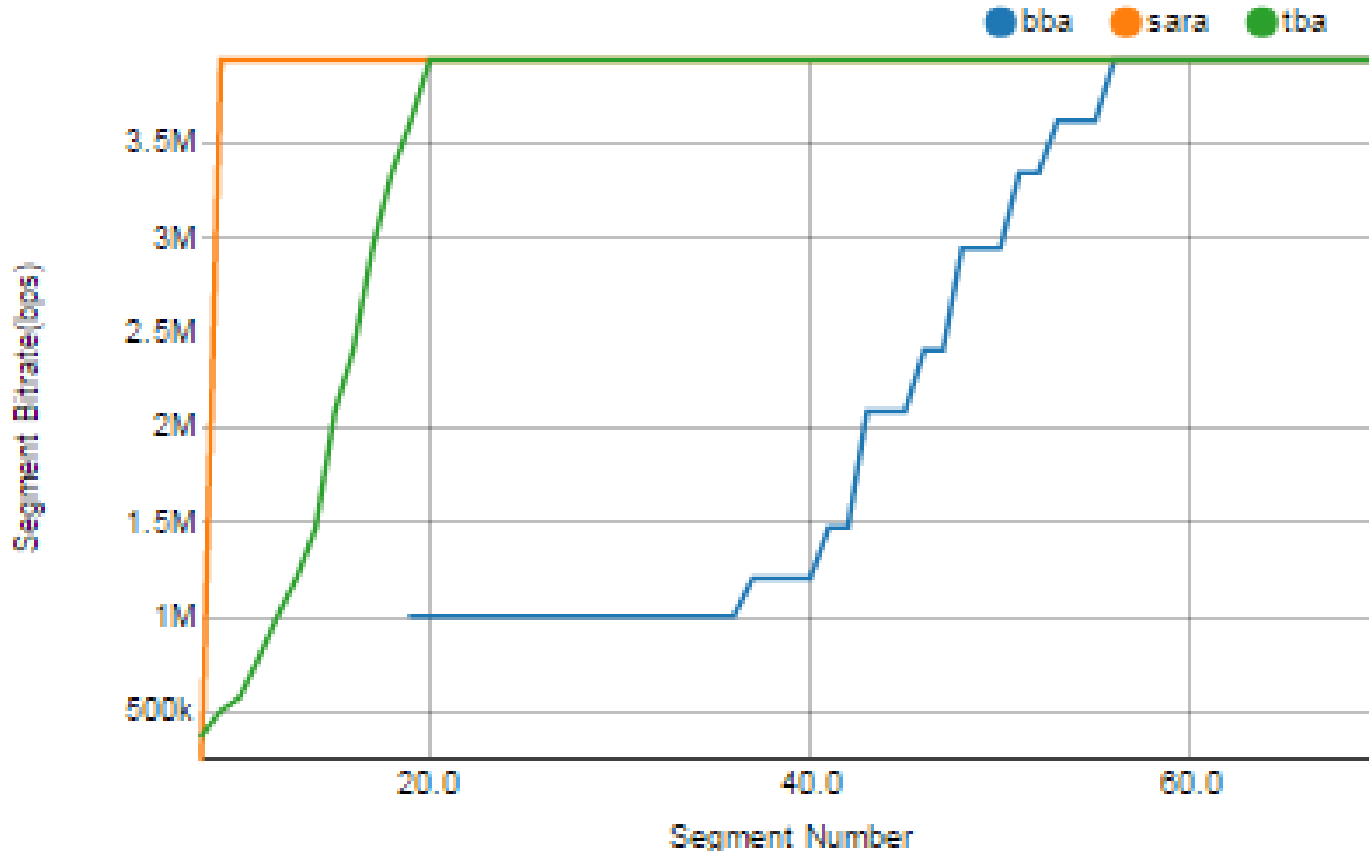


Figure: Segment Bitrates

Thanks!
Questions or Comments?