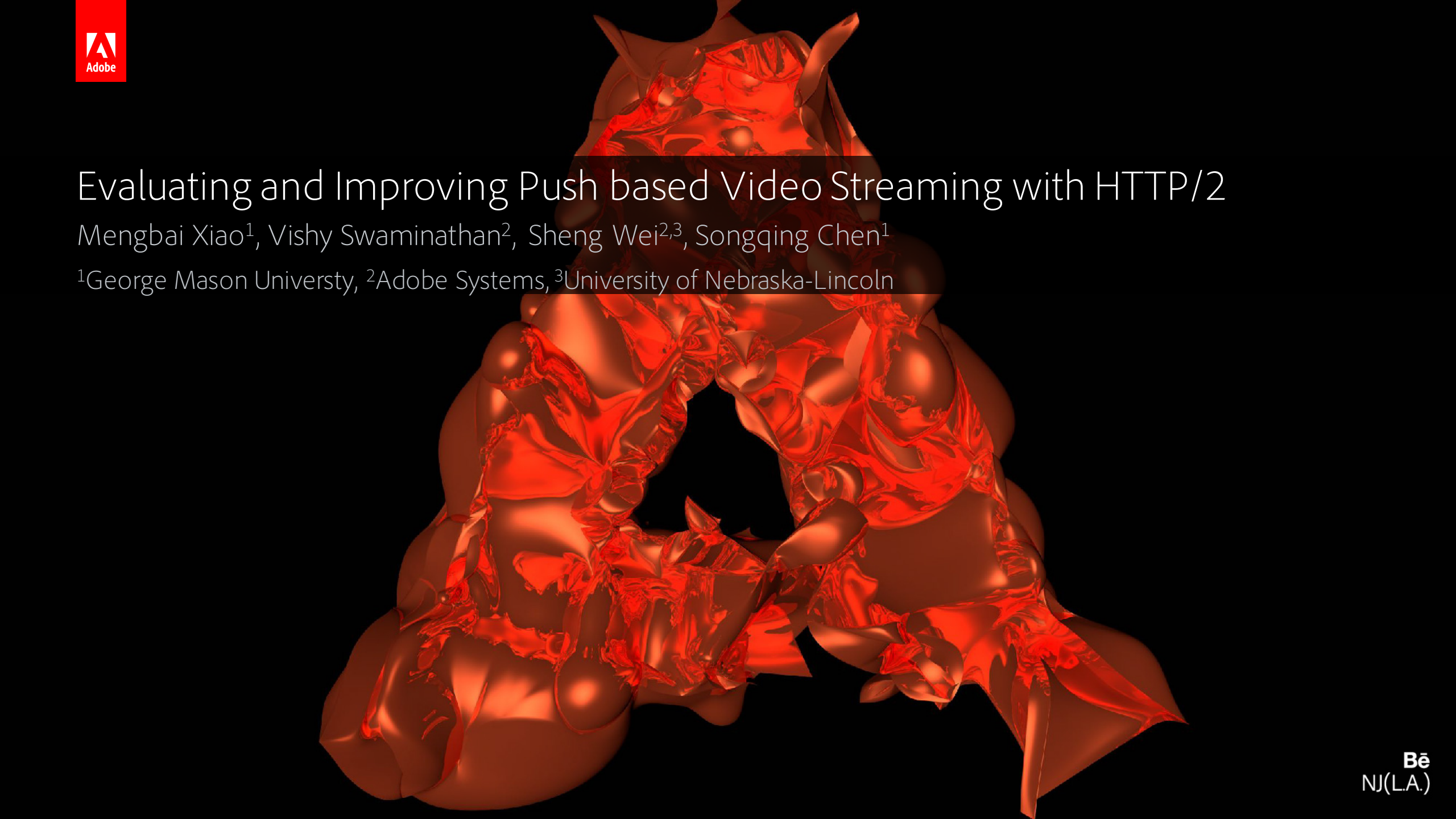

Evaluating and Improving Push based Video Streaming with HTTP/2

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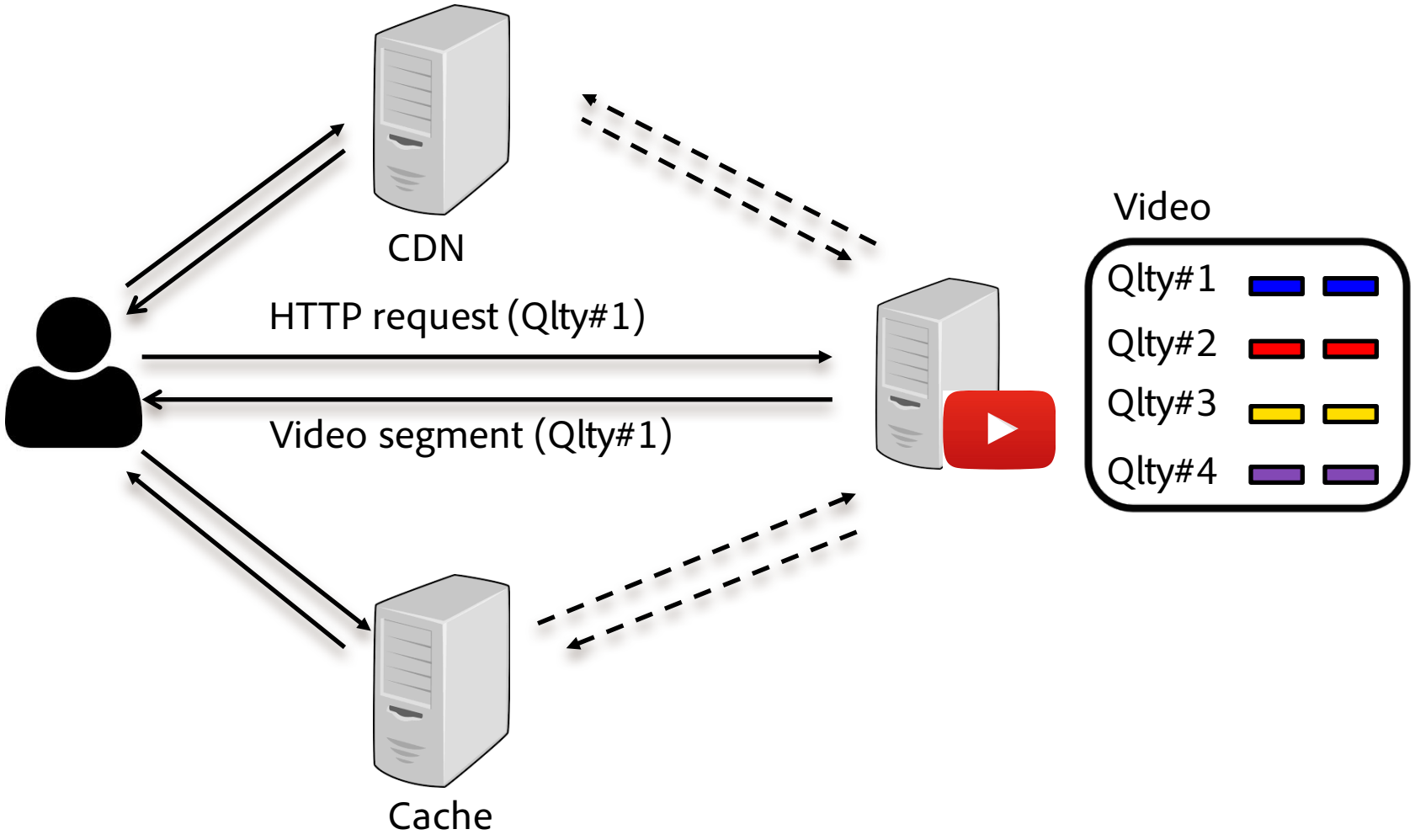
[1]George Mason Universty, [2]Adobe Systems, [3]University of Nebraska-Lincoln

HTTP Streaming

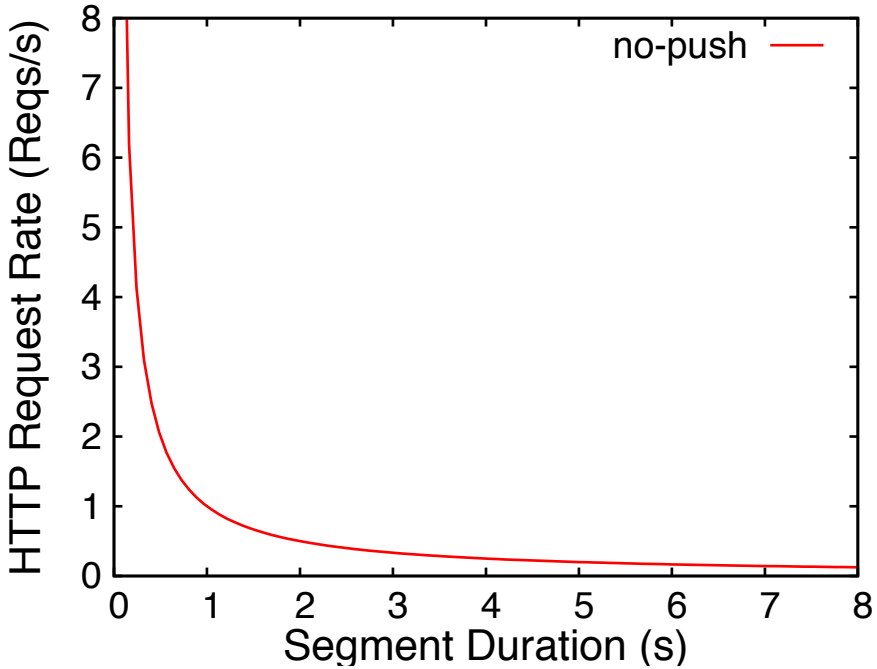
HTTP Streaming



Downgraded Throughput

- HTTP streaming is build upon TCP
  - Sawtooth pattern traffic

- Short segment duration
  - live latency
  - High network adaptability
  - User abandonment behaviors lead to less waste of network resources
  - request explosion



Video Streaming enhanced by HTTP/2

Cable TV Users

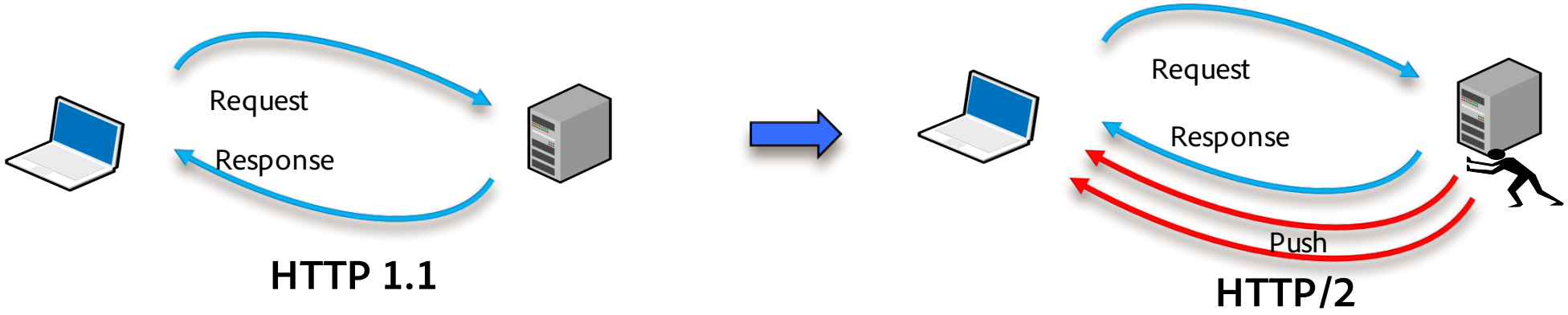
1:0

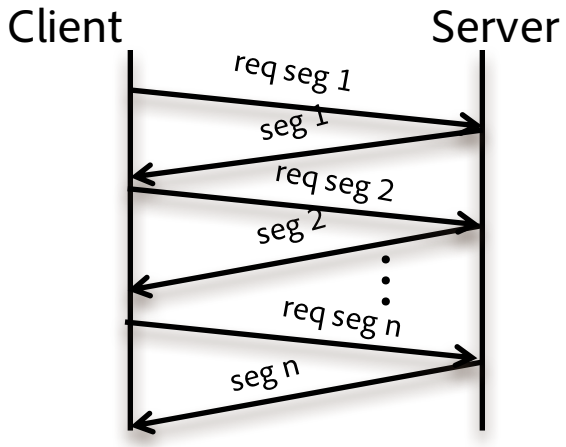
"Goal"

HTTP Streaming Users

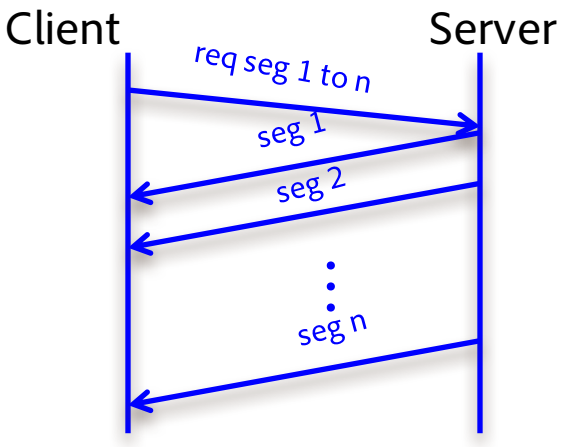
Adobe

K-Push

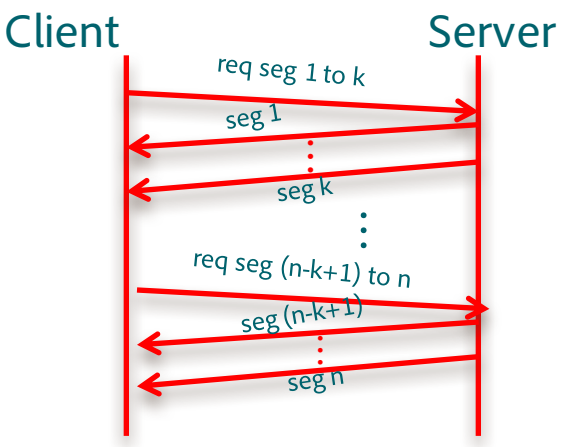




(a) No-Push



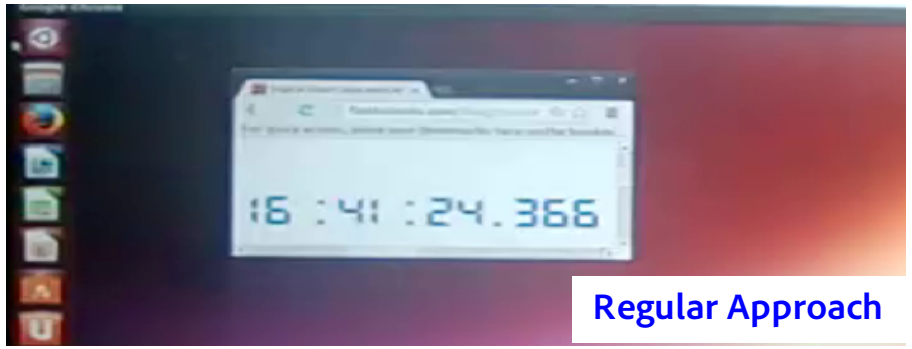
(b) All-Push

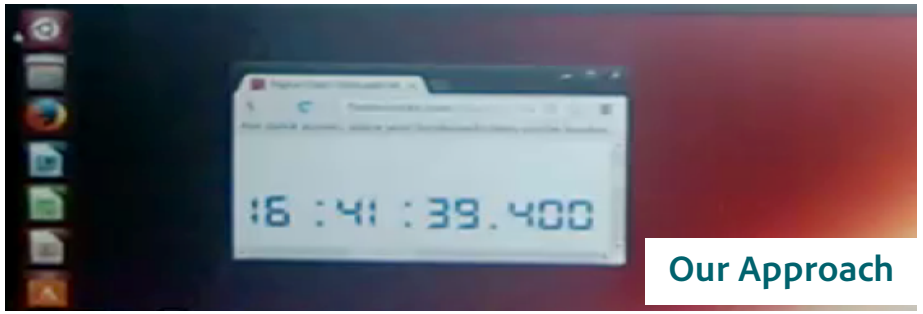


(c) K-Push

Demo

Playback

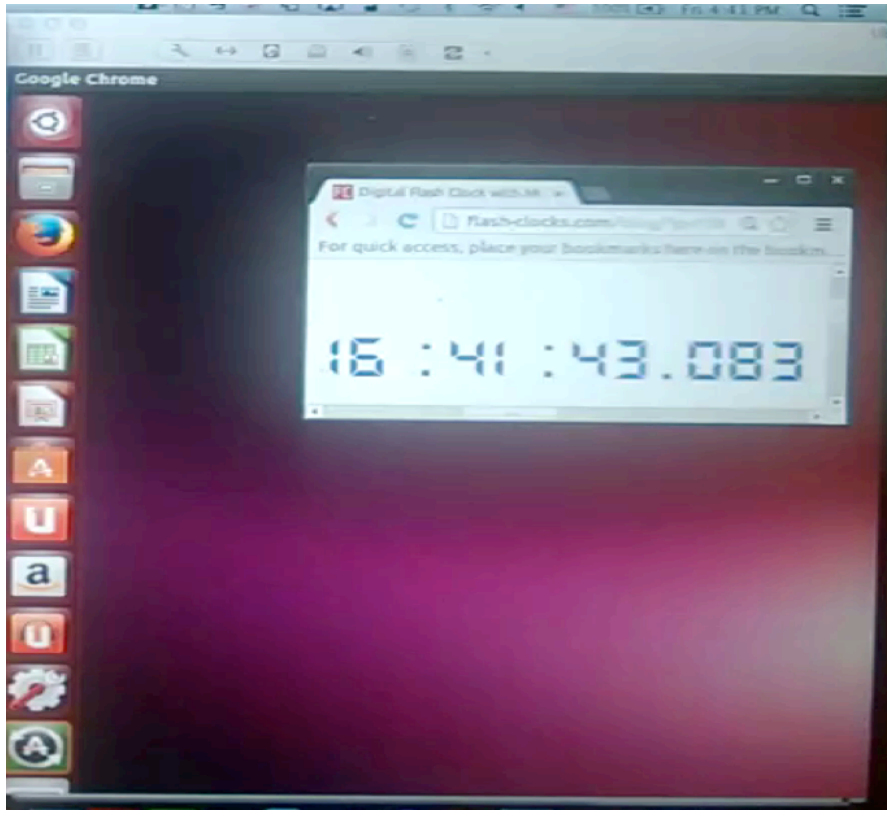




~18.7 sec

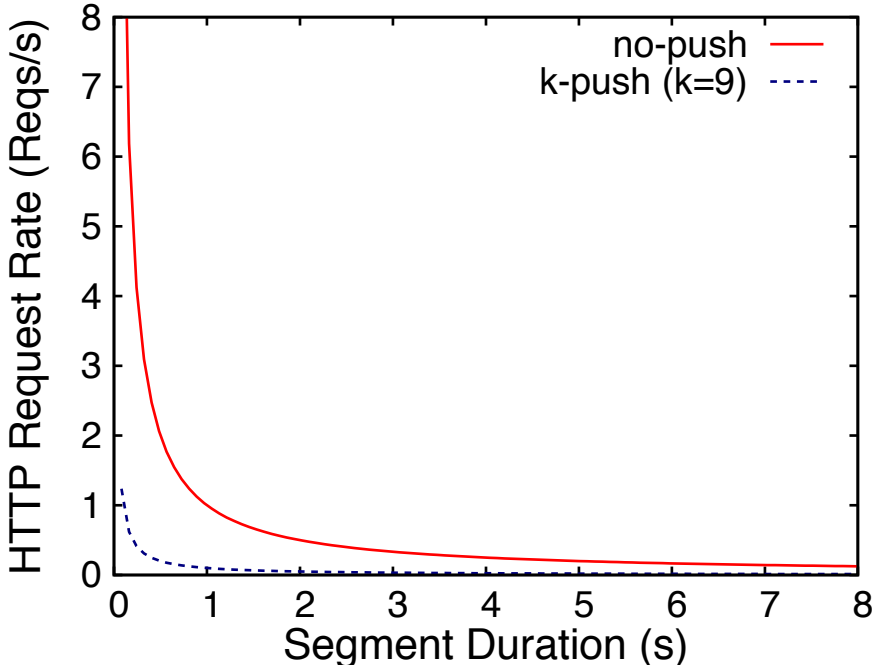
~3.7 sec

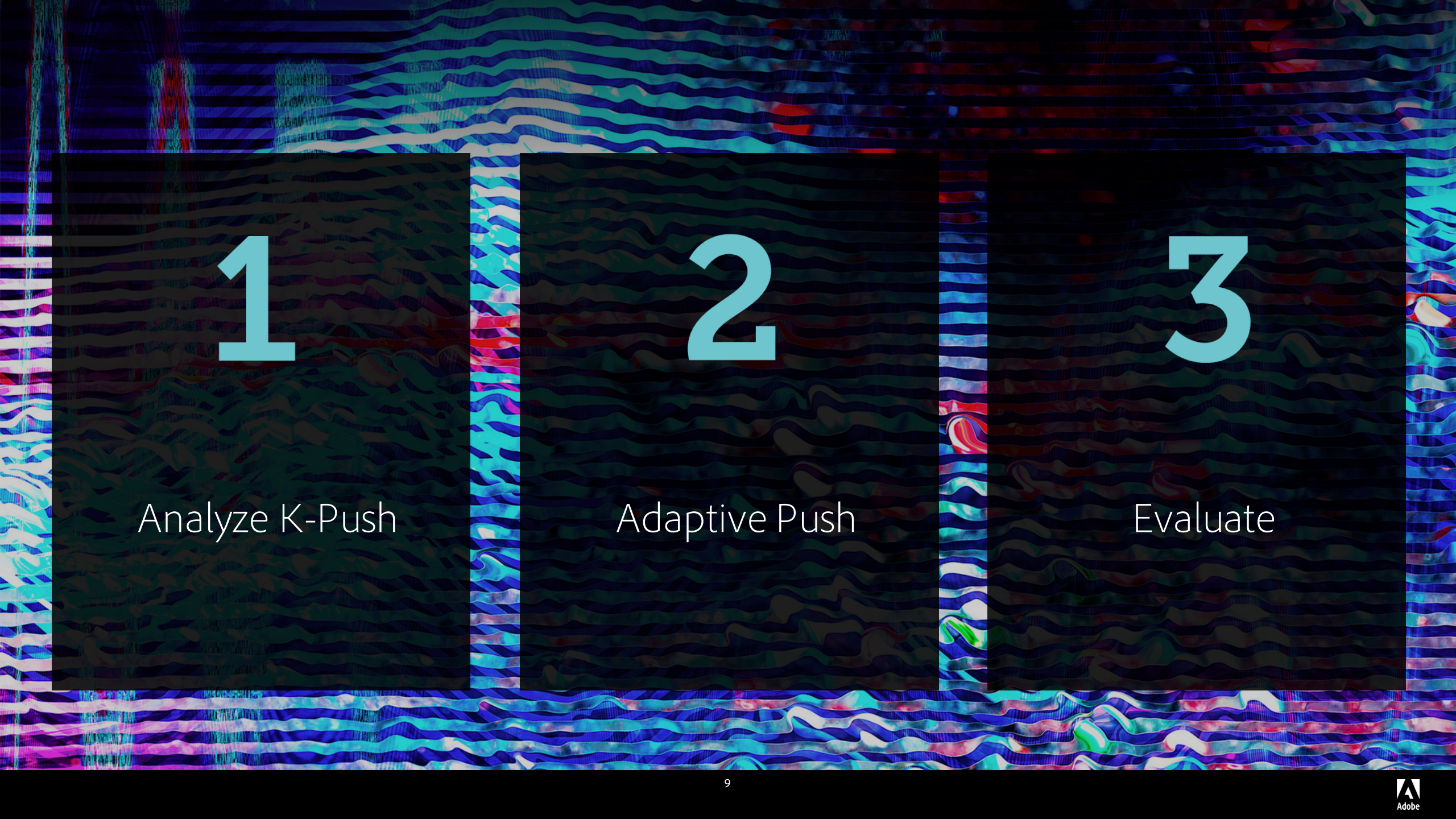
Live Event



Server Push Mechanism and k-push

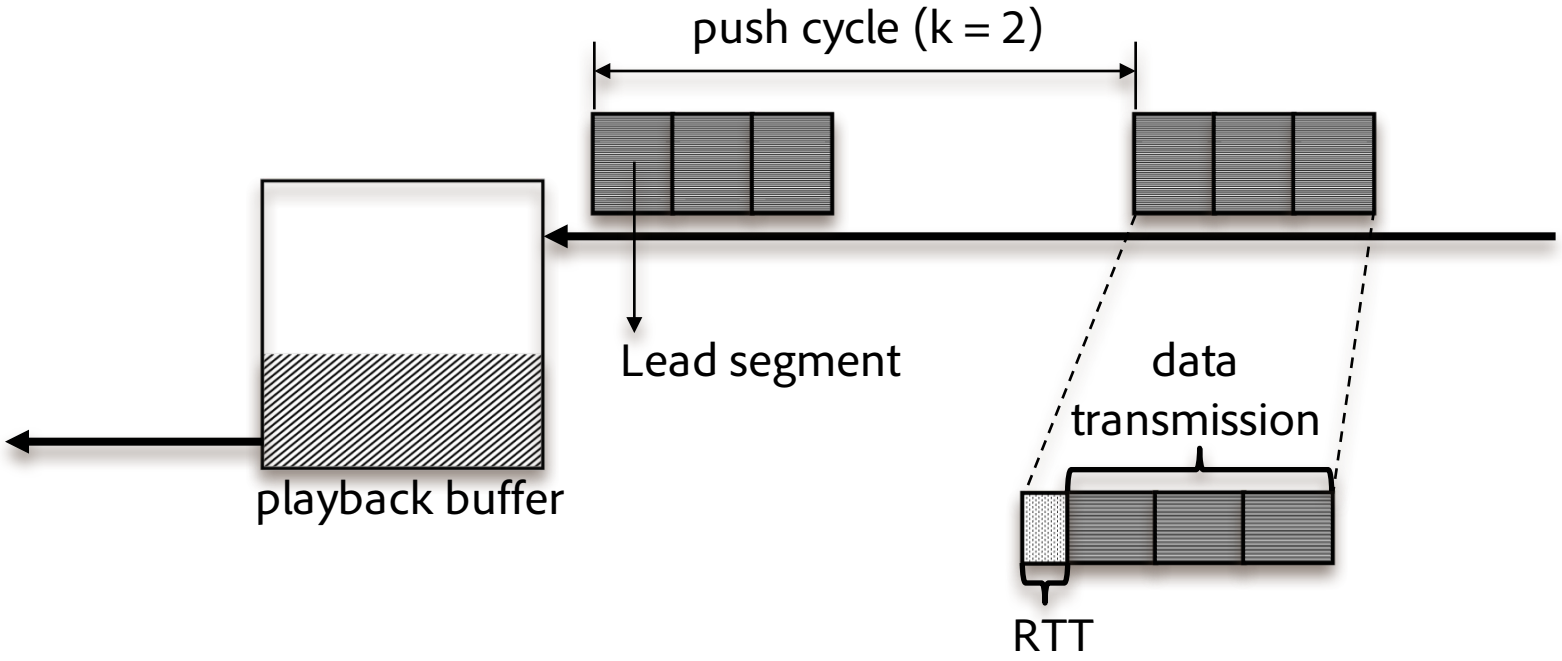
- The server push mechanism is proposed in HTTP/2
  - HTTP servers speculatively push back HTTP responses that the client does not request yet
- K-push is a solution to relieve the request explosion problem
  - One request for k+1 segments
- More practical than the pipeline solution
  - Less requests are delivered via network and are processed on servers
  - The knowledge of future segment URLs are not required





K-push Model

- K-push description
  - A push cycle consists of a HTTP request and k+1 HTTP responses
  - The lead segment of a push cycle is the first segment transmitted
    - Lead segment implies the bit rate level selected for the push cycle



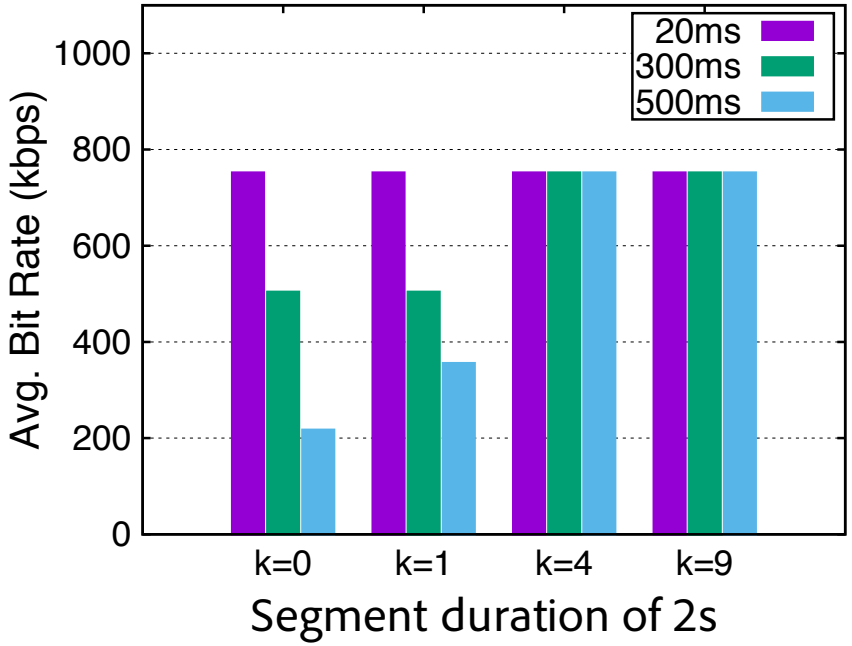
Verification

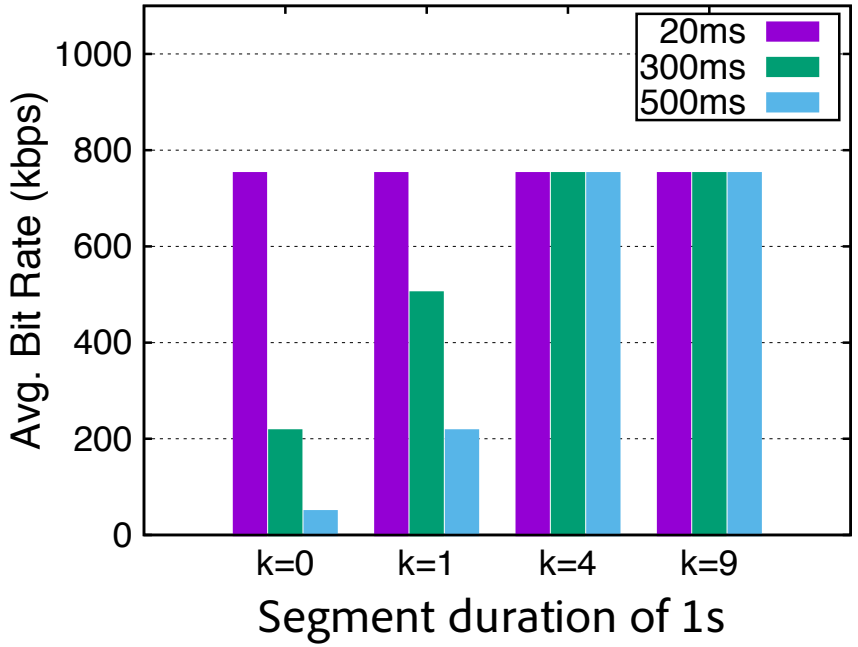
- Experimental parameters
  - Video length: 120s
  - Video qualities: 49 kbps, 217 kbps, 504 kbps,752 kbps
  - Number of segments pushed: 0, 1, 4, 9
  - Bandwidth: 200 kbps, 560 kbps, 880 kbps
  - Round trip time: 20 milliseconds, 300 milliseconds, 500 milliseconds

- The bandwidth is carefully capped to make quality switch reflect the streaming throughput

Experimental Results

- Request overhead is caused by two dimensions
  - Request number
  - Round trip time



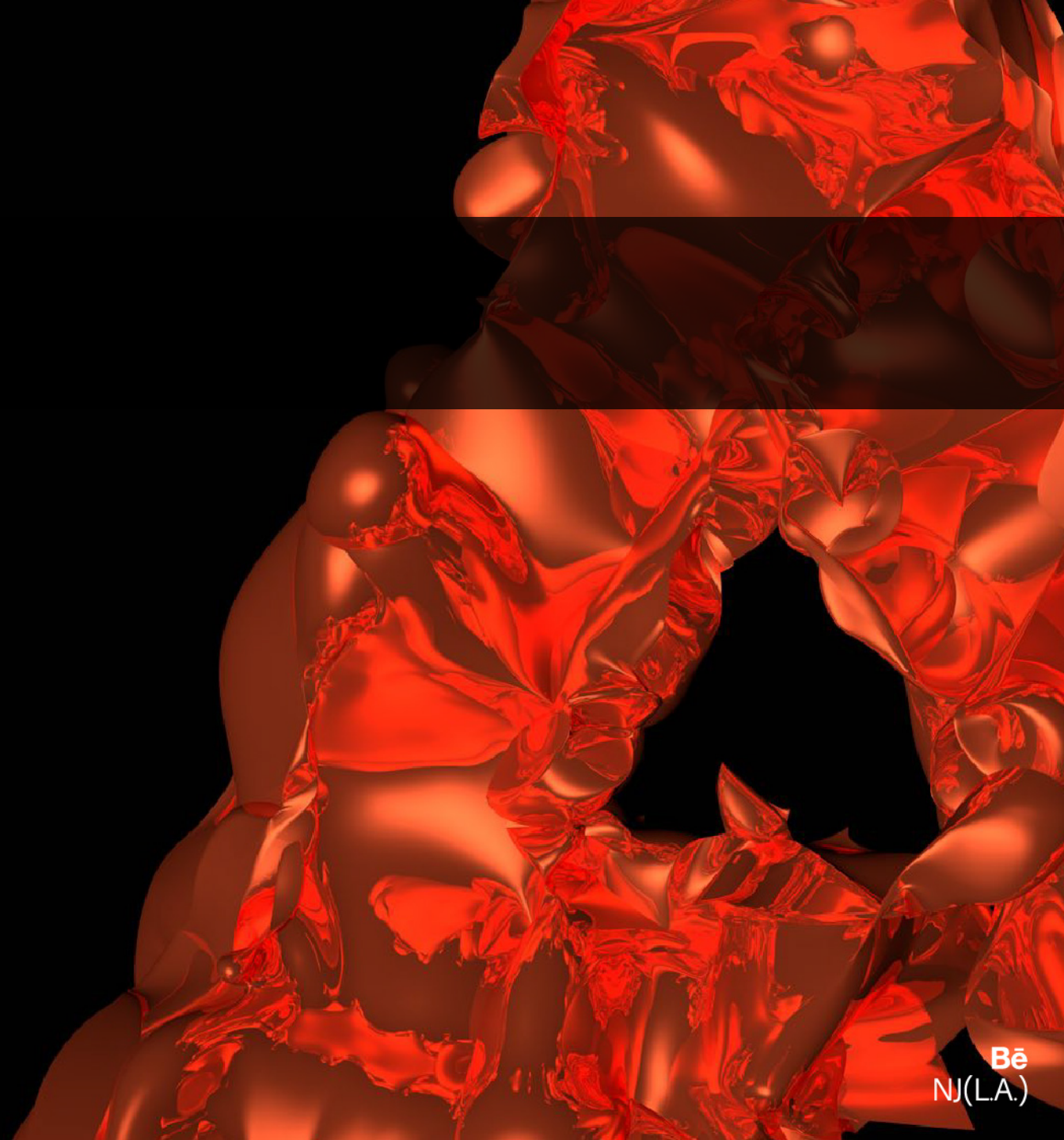


- Playback bandwidth is defined as the effective bandwidth to deliver video payload
  - Increasing k substantially improves the playback bandwidth

Beyond Playback Bandwidth

- Diminishing marginal returns with the increasing number of segments pushed
- Network adaptability is not improved with reduced segment duration
- Over-push problem
  - User may decide not to continue watching a video after checking the first few seconds

Adaptive Push



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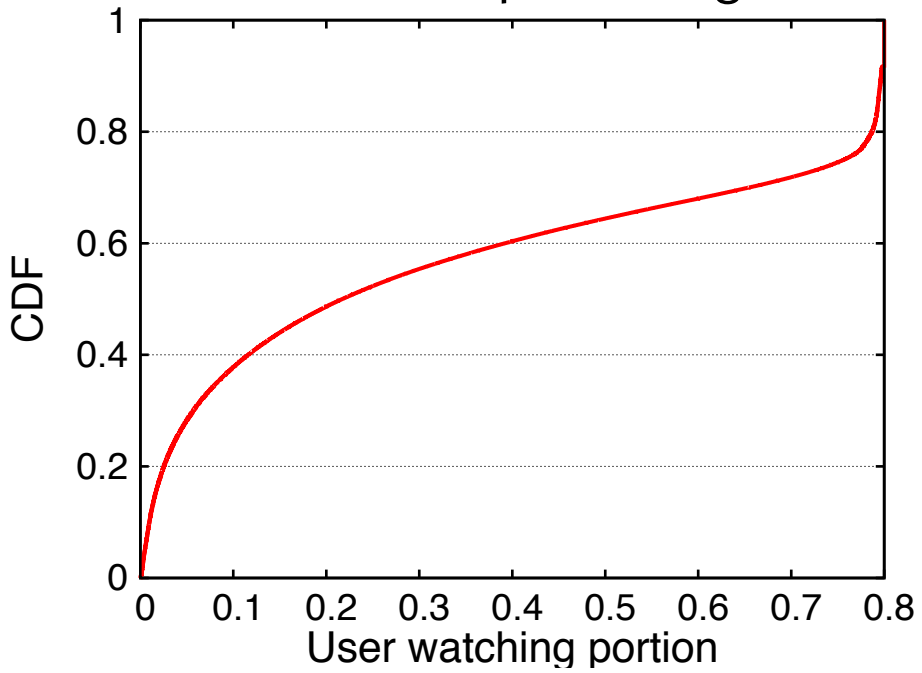
Adaptive-push Design

- Adaptive-push features dynamically scaling the number of segments pushed in a video session

- A small k is selected for the first push cycle to alleviate over-push problem
  - A number of users stop watching the videos after checking the first few seconds



Adaptive-push Design (Cont.)

- The number of segments pushed is increased in various rates
  - When k is small, a high increment rate is preferred to improve the playback bandwidth
  - When k is large, a low increment rate or non-increment is more appropriate due to the diminishing playback bandwidth improvement

- The number of segments pushed is constraint by current buffer status
  - Long buffer length more efficiently absorbs network fluctuations

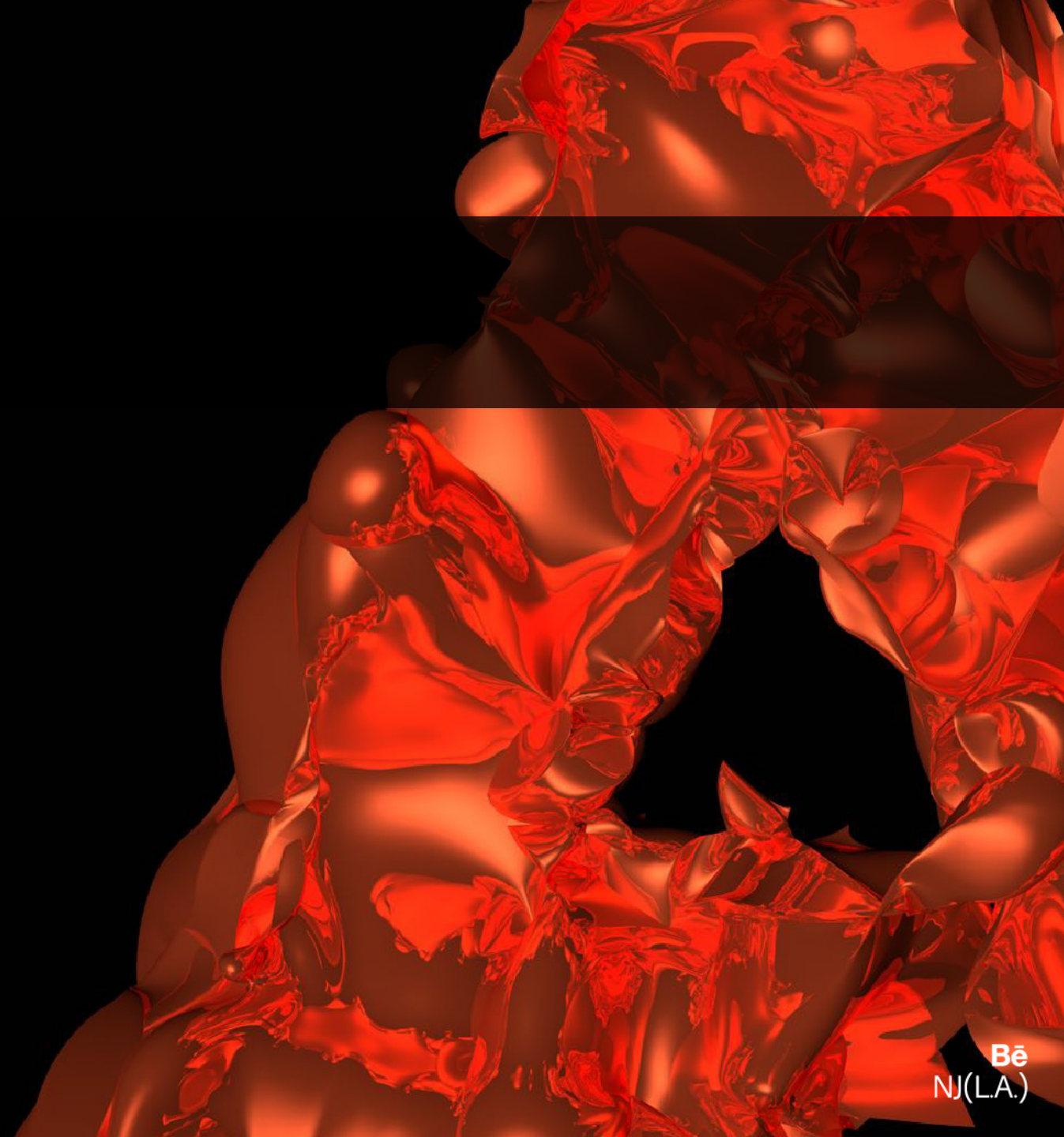
$$(k+1)(\frac{bD}{B}-D)<L$$

Implementation

- The push directive is carried in the HTTP request header
  - PushDirective: k

- Jetty HTTP/2 server
  - Jetty project
- Video player: dash.js
  - Dynamically determined k
- tc is used to manipulate bandwidth and RTT

Evaluation



Evaluation

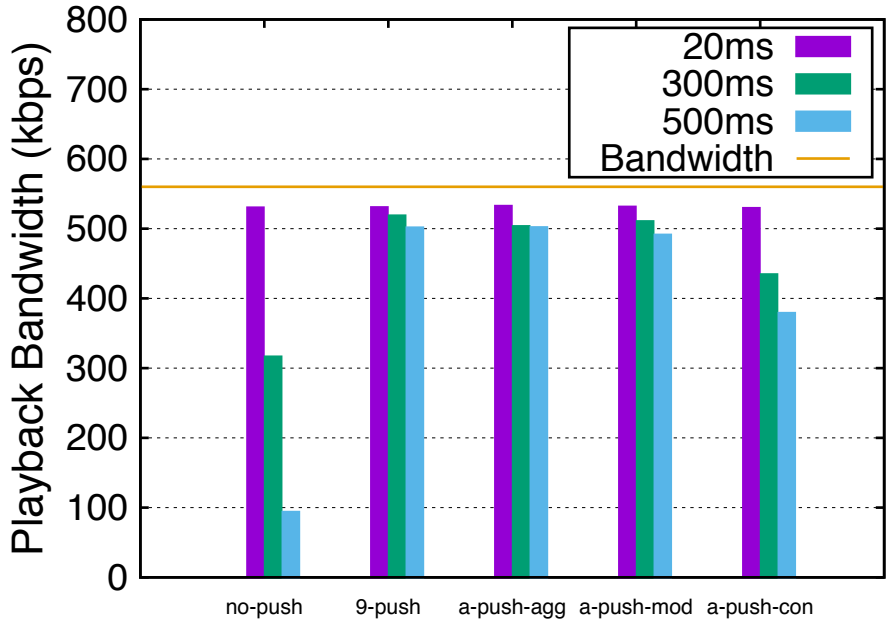
- Same experimental parameters as those in k-push analysis

- Additional adaptive-push schemes
  - Aggressive/moderate/conservative bandwidth prediction (880/415/49 kbps)
  - Two increment rates: 2k, k+1
    - Increment rate is decreased if the playback bandwidth improvement is detected less than 10%
    - Increment of k is stopped if the playback bandwidth improvement is detected less than 2%

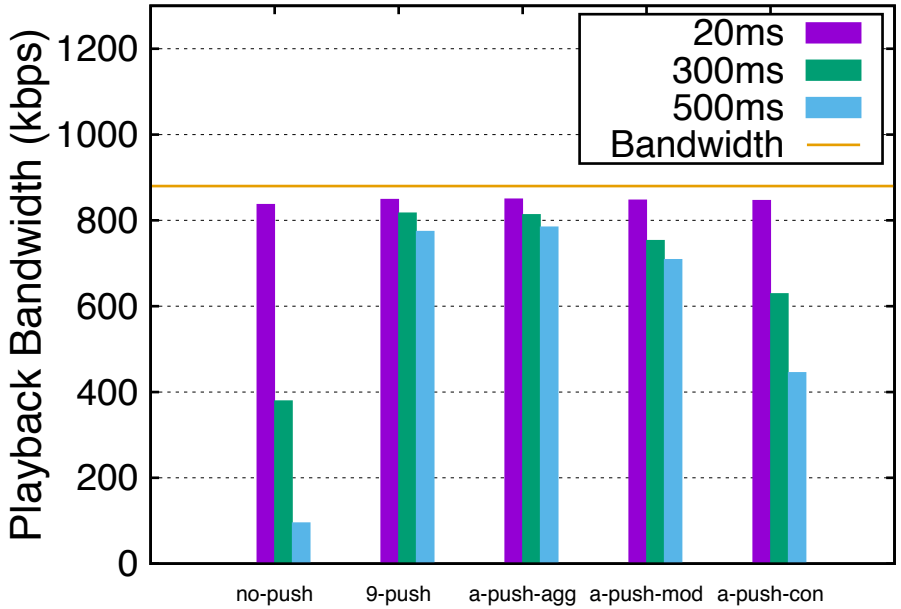
- Evaluate playback bandwidth, network adaptability, and over-pushed content

Playback Bandwidth

- Progressive download the experimental video
  - Playback bandwidth is derived by dividing the overall downloaded segment size by the time consumed



560 kbps actual bandwidth

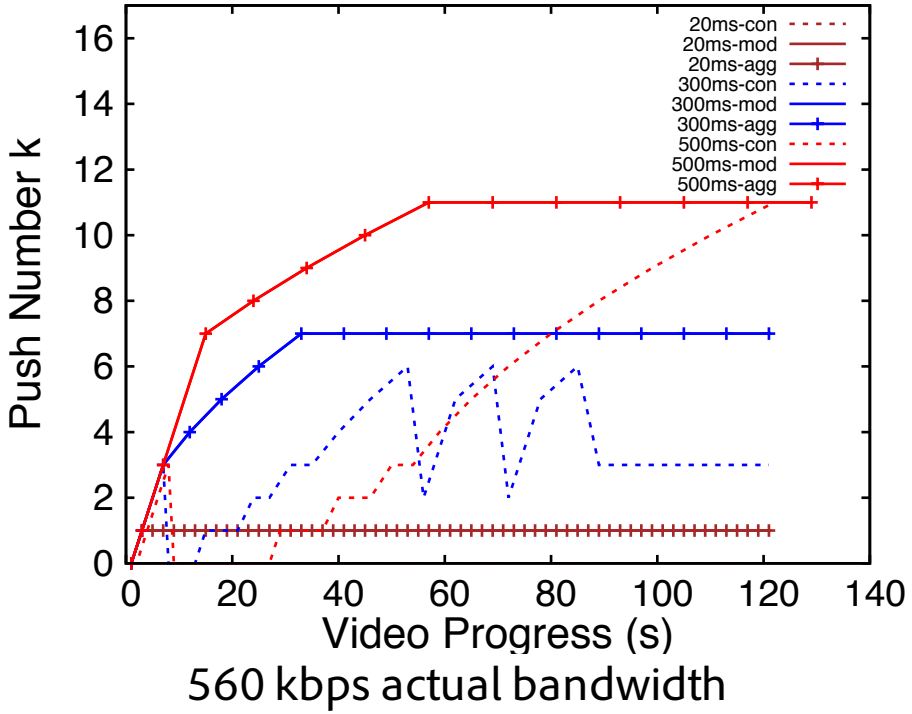


880 kbps actual bandwidth

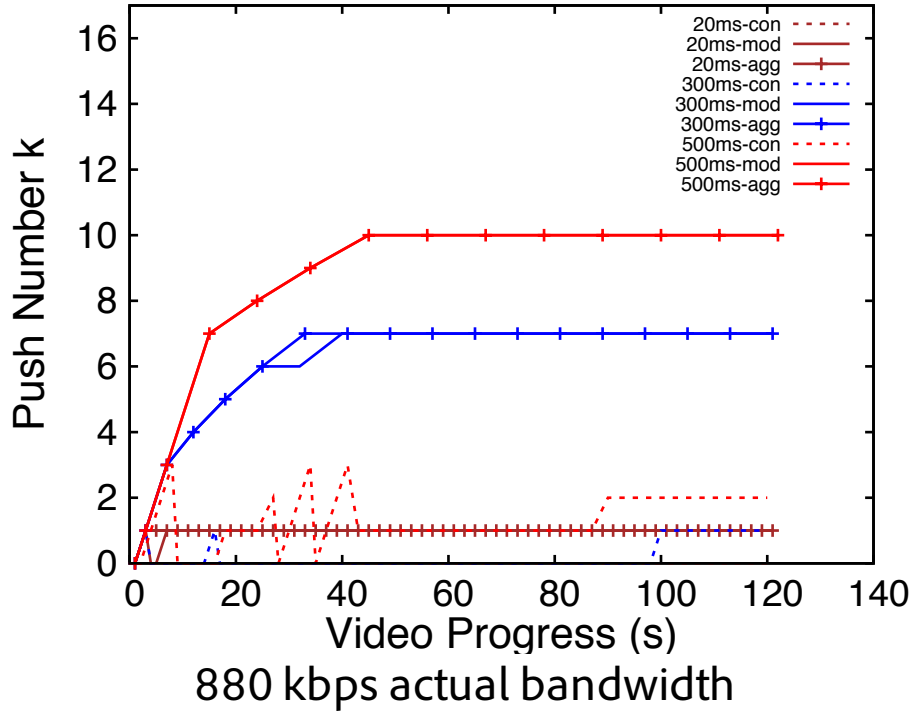
- Adaptive-push outperforms regular HTTP/1.1 streaming, approaching k-push

K Variation

- Two increment rates are observed in the figures
- K is always low if small RTT is observed, which means little playback bandwidth improvement when increasing k
- Fluctuations occur when a large k is desired but the buffer length is low



560 kbps actual bandwidth



880 kbps actual bandwidth

Network Adaptability

- Experimental parameters
  - Length: 5 minutes
  - buffer length: 30 seconds
  - Network condition varies every 30 seconds
    - Bandwidth: 480 kbps, 640 kbps, 800 kbps
    - RTT: 20 ms, 300 ms, 500 ms

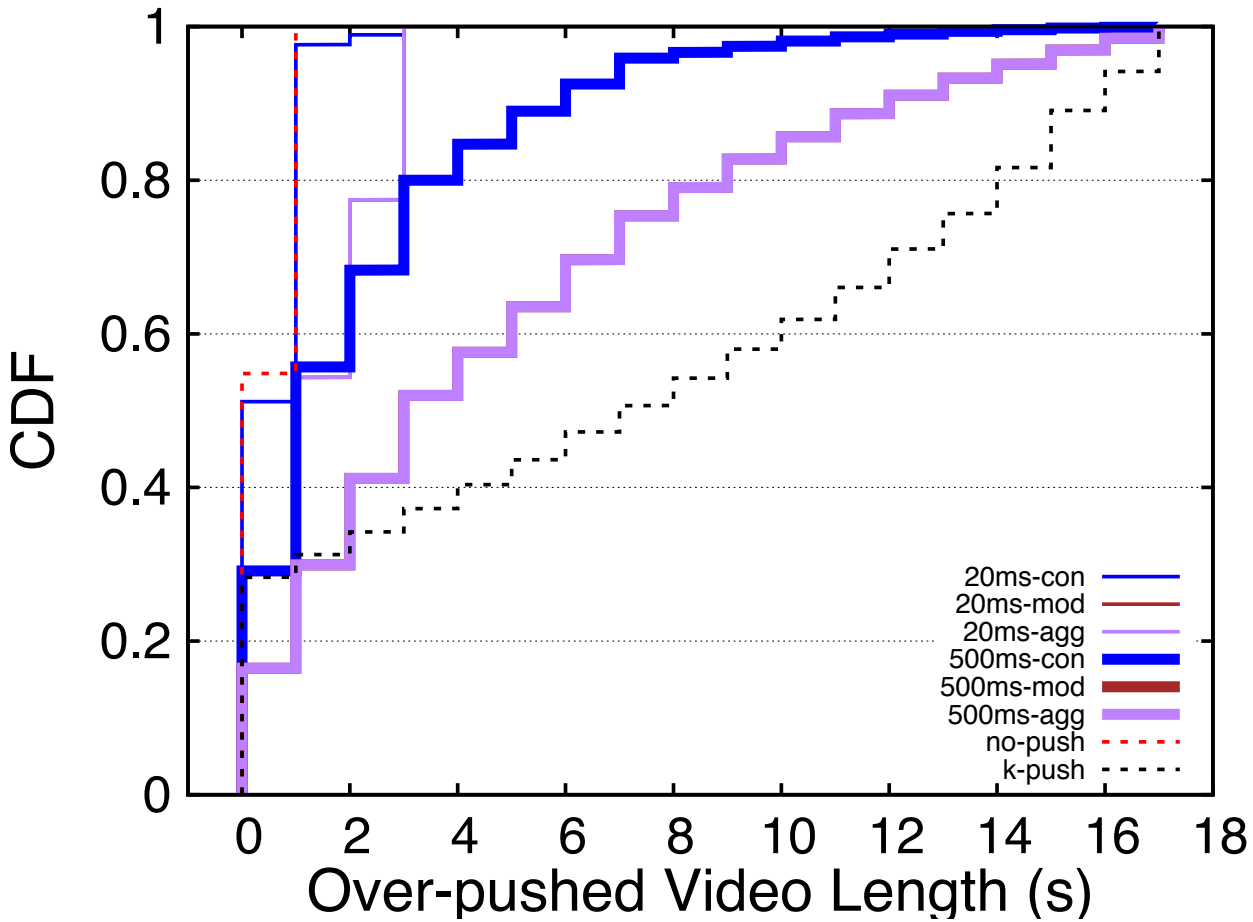
Results

	Buffer Length (s)	
	E	δ
no-push	29.08	1.69
9-push	16.46	10.34
a-push-con	23.55	7.90

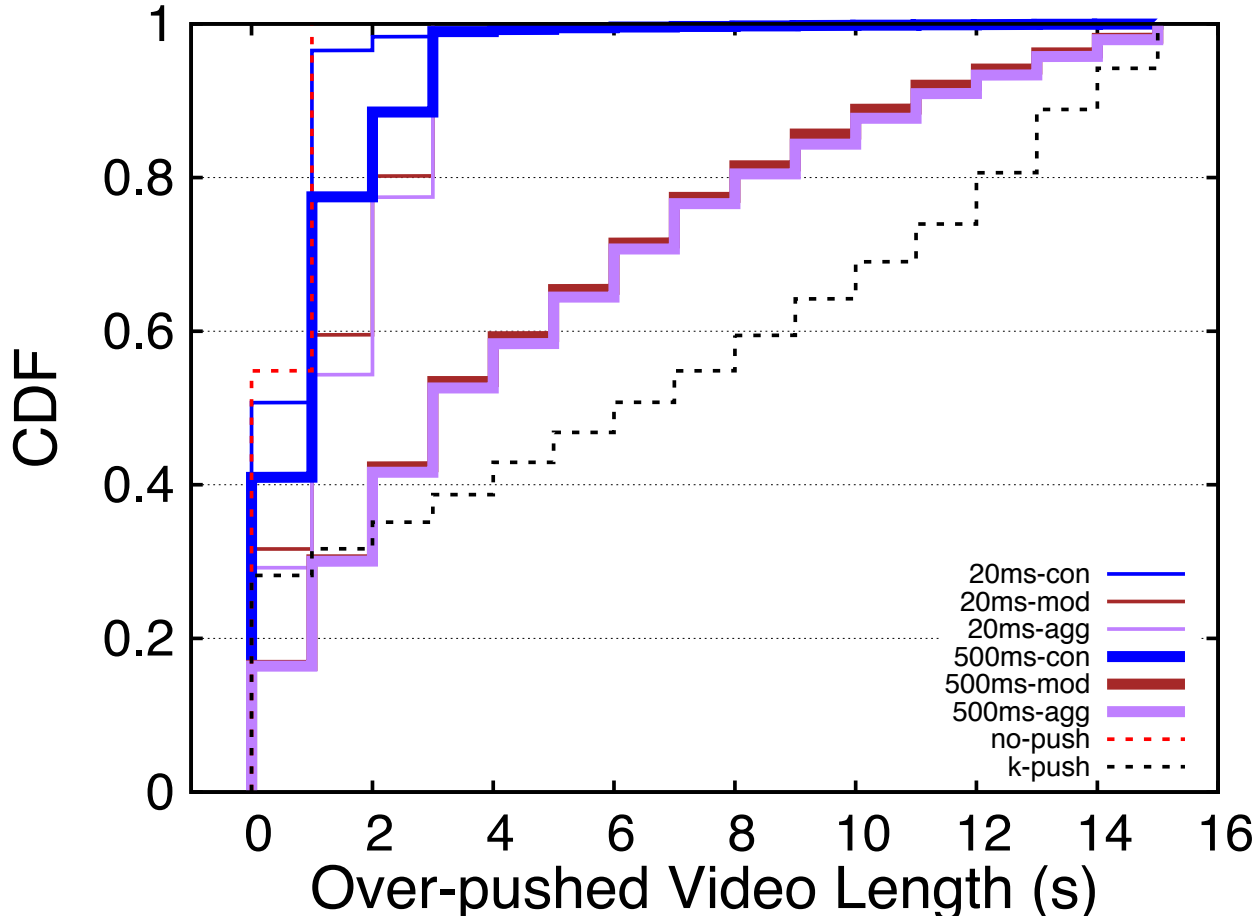
Over-pushed Simulation

- Apple HLS trace collected at client side from Vuclip
  - 07/15/2015 ~ 08/31/2015
  - ~ 12 million video sessions
- Simulator implemented in perl
  - Requests are sent only if previous downloaded segments are watched
  - Requested bitrate is determined by the measured playback bandwidth of last push cycle

Over-pushed Content



540 kbps actual bandwidth



880 kbps actual bandwidth

1

Evaluated K-Push

diminishing returns, network adaptability, and the over-push problem

2

Adaptive Push

Dynamic Scaling of Number of Segments Pushed

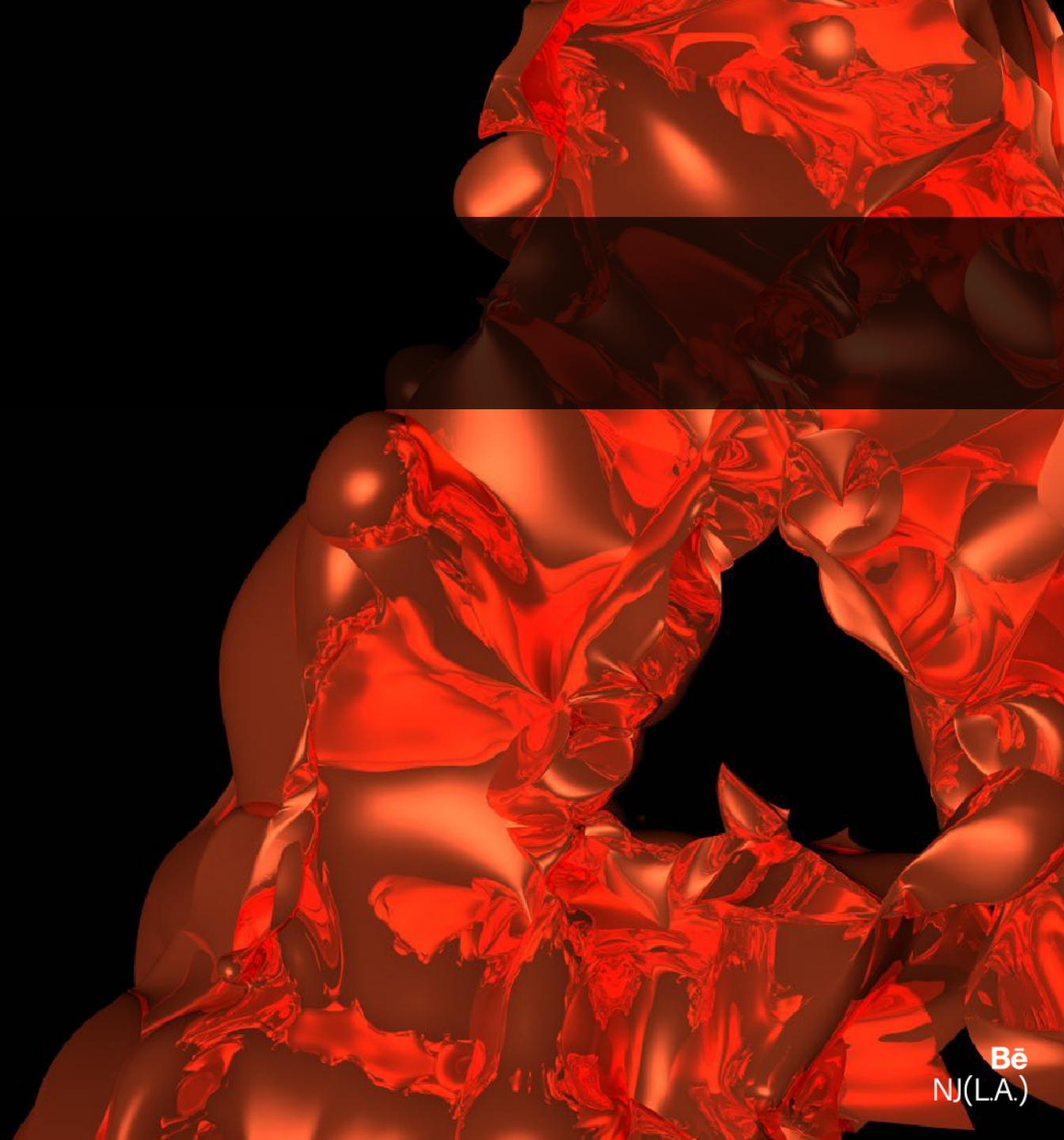
3

Evaluated adaptive push

Good Trade off between K-push and HTTP 1.1

Conclusion

Questions ?



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