Optimising DASH over AQM-enabled Gateways using intra-chunk parallel retrieval (chunklets)

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Outline

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Introduction

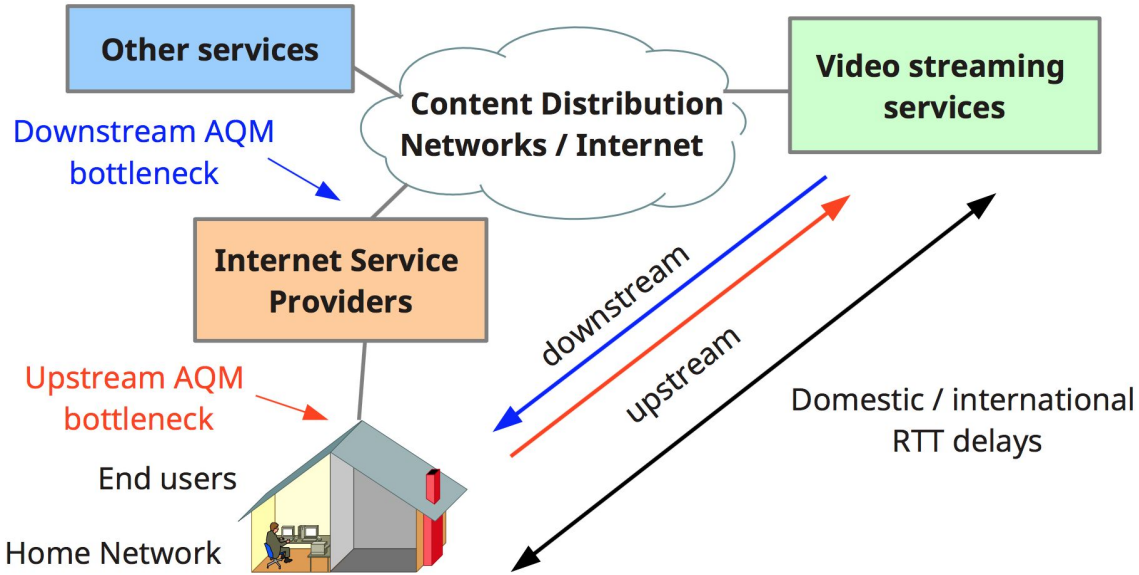
- Dynamic Adaptive Streaming over HTTP (DASH) is a recent standard for live and on-demand video streaming services
- Active Queue Management (AQM) schemes are being progressively deployed either at the ISP-end or home gateway to counter bufferbloat
- DASH adapt the video quality to match the network capacity by requesting multi-rate video by using a single TCP connection
- They propose a system using intra-chunk parallel connections (chunklets) to accelerate the DASH content transfer when bottlenecks implement AQMs
- Chunklet: different parts of a video chunk when DASH using multiple concurrent TCP connections in parallel

Related work

- DASH
  - In DASH streaming systems, video is encoded into multiple versions at different bitrates (quality)
  - Then each encoded video is segmented into small video segments (chunks), each containing a few seconds of video
- AQMs
  - It aims to keep queuing delays low, such as PIE and FQ-CoDel
  - PIE: it operates on single queue and keep queuing delays low by dropping packets when queuing delays exceed a target delay 15ms
  - FQ-CoDel: it isolates traffic flows into sub-queues (by default is 1024) then serves each sub-queue with a Deficit Round Robin (DRR) scheduler (by dropping packets every periodical time when queuing delay exceed 5ms)

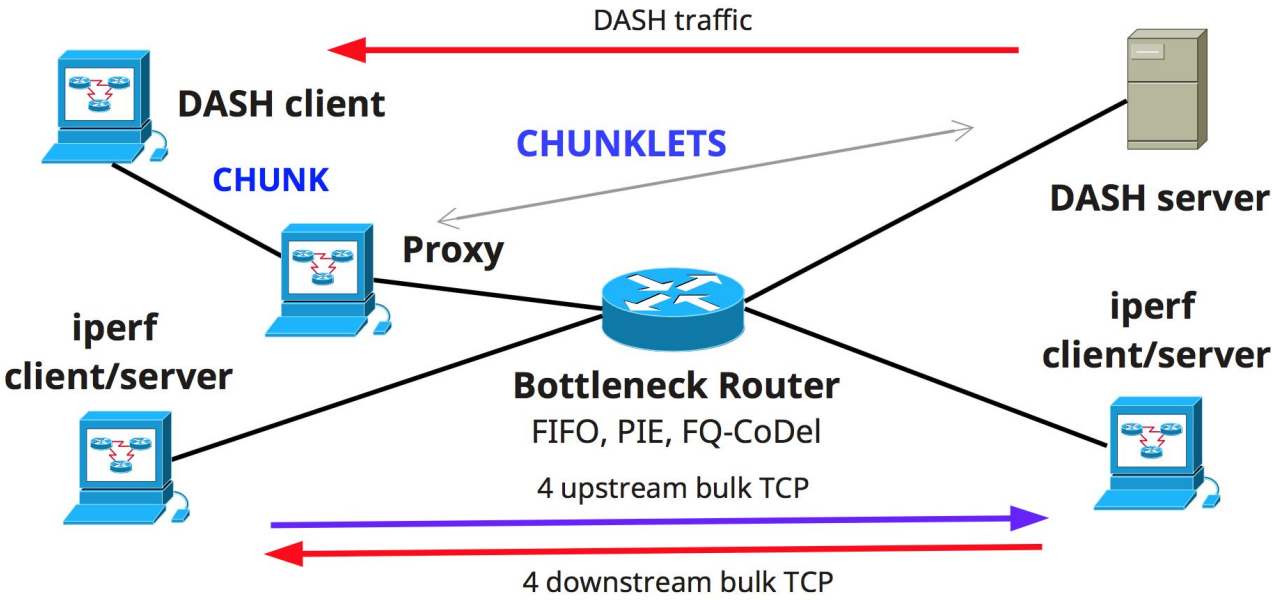
Use scenario

- A home network that is connected to local or international video streaming services and other Internet-based services
- AQMs replace traditional FIFO home gateways in modern



Experiment

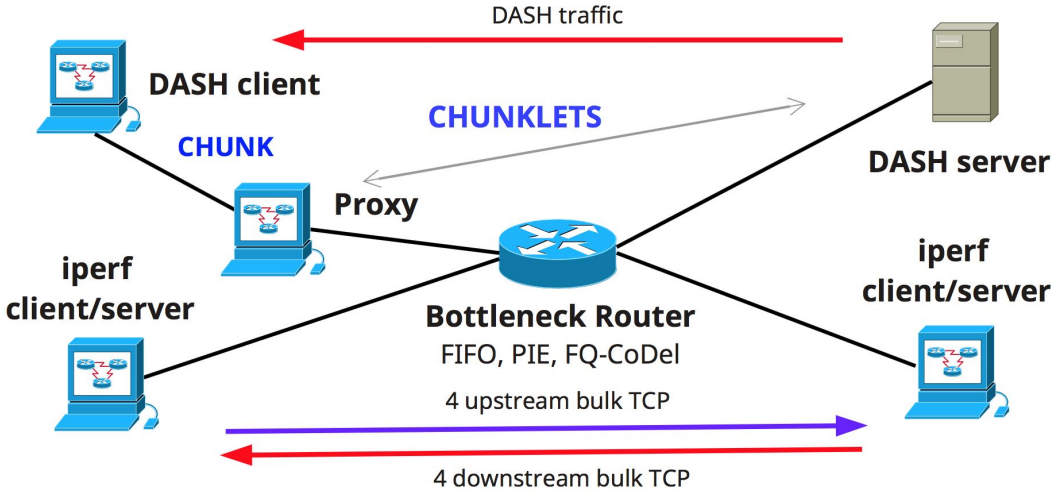
- Experiment testbed built based on TEACUP [1] software, a system for automated TCP testbed experiments



[1] http://caia.swin.edu.au/reports/150529A/

Experiment (cont.)

- Bottleneck Router: a FreeBSD's dummynet/ipfw to provide FIFO, PIE and FQ-CoDel queue management schemes
- DASH server: a lighttpd version 1.4.35 web server
- DASH client: dash.js version 2.4.17
- Proxy server: 64-bit FreeBSD



Performance metrics

TABLE I
REPRESENTATION RATES AVAILABLE IN 2-SEC DATASET

Resolution	Encoding Level	Representation Rates
320x240	1 - 3	46, 89, 131kbps
480x360	4 - 8	178, 222, 263, 334, 396kbps
854x480	9 - 10	533, 595kbps
1280x720	11 - 14	0.8, 1.0, 1.2, 1.5Mbps
1920x1080	15 - 20	2.1, 2.5, 3.1, 3.5, 3.8, 4.2Mbps

- Representation Rate (RR): video sequences encoded at different bitrates
- Smoothed Achieved Rate (SA): the average of the achieved rate from the last three chunks
- Instability index: calculate the weighted sum of the number of RR

$$\frac{\sum_{d=0}^{k-1} |b_{x,t-d} - b_{x,t-d-1}|.w(d)}{\sum_{d=1}^{k} b_{x,t-d}.w(d)}$$

  - video chunks k = 10
  - w(d) = k − d
  - b(x,t) is the encoding level retrieved at time t

Result & analysis

- It shows SA increases for all FIFO, PIE and FQ-CoDel as N increase
- N < 6, PIE has wider spread in both SA and RR
- N > 6, FQ-CoDel has wider spread

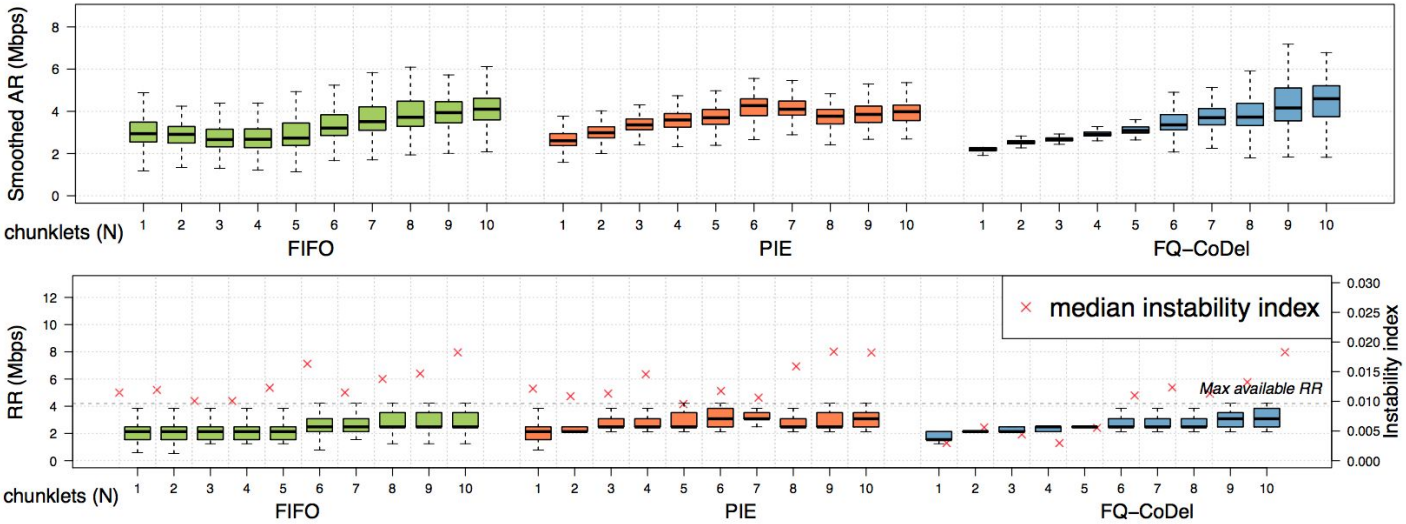


Fig. 6. Smoothed AR, RR and instability index *vs N* for FIFO, PIE and FQ-CoDel @ {12/1Mbps, 20ms RTT} path, 4 downstream elastic flows

Result & analysis (cont.)

- FIFO performs the worst
- PIE & FQ-CoDel allow low-rate ACK streams to traverse the upstream bottleneck and adjust DASH sufficiently

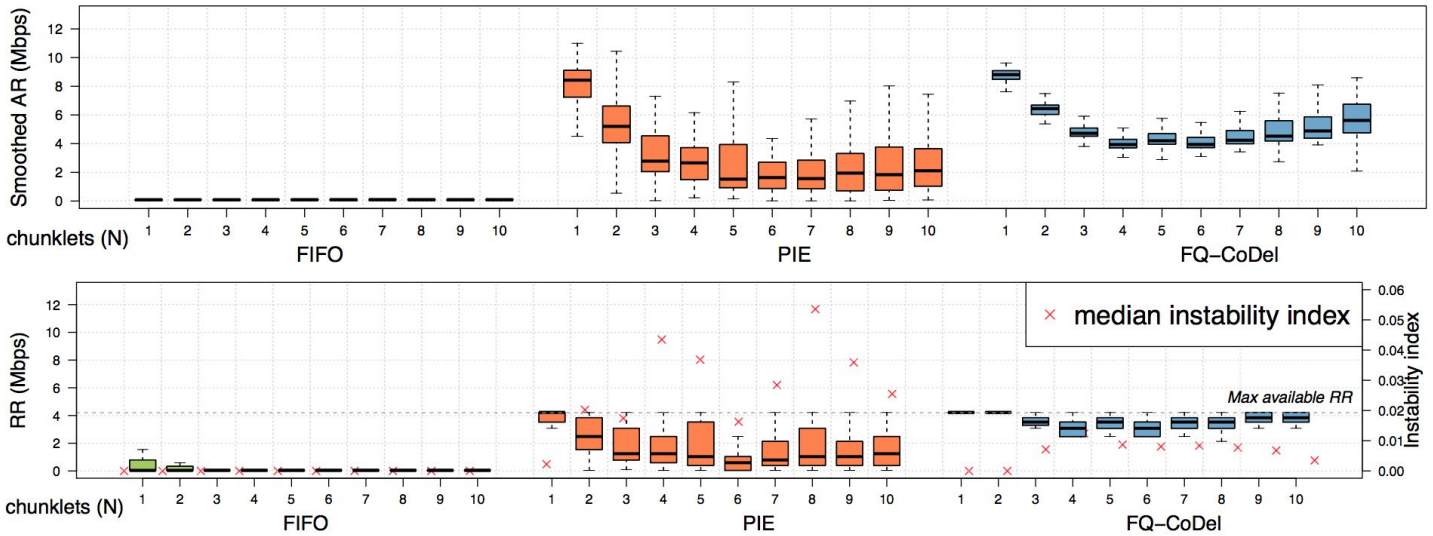


Fig. 9. Smoothed AR, RR and instability index *vs N* for FIFO, PIE and FQ-CoDel @ {12/1Mbps, 20ms RTT} path, 4 upstream bulk TCP flows

Conclusion

- Optimise DASH performance over AQM schemes by using parallel TCP connection and DASH chunklets
- With downstream or upstream TCP flows, it can provide better performance over AQMs than regular DASH over FIFO

- Experiment? or not? (not sure)
- Instability index or SA cannot be used to determine the QoE of DASH video content
- Is chunklet efficient? Due to the overhead of chunklet, N HTTP headers are required to transmit N chunklets

Q & A