Trickle: Rate Limiting Video Streaming

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Video Streaming

TCP

Just-in-time video delivery

Ustreamer

Application pacing
Video Streaming

Startup phase

Throttling phase

Token bucket

64kB

Sequence offset (bytes)

Target streaming rate

= 125% video encoding rate

Time (sec)
The Problem: Burstiness is **Bad** for TCP

Not specific to YouTube videos.

Netflix sends bursts as large as 2MB.

Main contribution:

*A simple and generic technique to implement just-in-time video delivery by smoothly rate-limiting TCP transfers.*
Trickle To Rate Limit TCP

- Dynamic upper bound on TCP’s congestion window.
- Periodically computed based on RTT and target rate (R).
  
  \[ R = 50 \text{ pkts/sec (600Kbps)} \quad \text{RTT} = 200 \text{ ms} \]
  
  \[ \text{max\textunderscore cwnd} = 50 \text{ (pkts/sec)} \times 0.2 \text{ (sec)} = 10 \text{ pkts} \]

- Only server side changes for easy deployment.
- Not a special mechanism tailored only for YouTube.
Demo*

Smooth

Bursty

Trickle

Ustreamer

* http://www.cs.utoronto.ca/~monia/tcptrickle.html
Experiments

Two data centers: India and Europe.
15 days in Fall 2011, total of 23 million videos.

4-way experiment:
(1) Baseline1: application pacing with 64kB blocks,
(2) Baseline2: application pacing with 64kB blocks,
(3) Trickle,
(4) shrunk-block: application pacing with 16kB blocks.
Experiments Methodology

Western Europe/India data center

(1) Baseline1
(2) Baseline2
(3) Trickle
(4) shrunk-block

Same number of flows, flow sizes, flow completion times.

Video ID
IP/Port
Bytes sent
Retransmission rate
RTT
Transmission time
Goodput
Target rate

Users
Experiments: Packet Losses

Trickle reduces the average retransmission rate by 43%.
Trickle reduces the average RTT by 28%.
Conclusions

• Trickle rate limits TCP by dynamically setting the maximum congestion window size.

• Minimal sender-side changes, fast deployment.

• Generally applicable to rate limit other kinds of streaming.