Project Details

Jiasi Chen

Lectures: Monday 1:10-2pm in Sproul 2343

TA: Ryan Holt

Lab: Tuesday 7-10pm in Chung 133

http://www.cs.ucr.edu/~rholt002/cs179i_winter17/

Outline

- Virtual reality
- Video streaming
- Download booster
- Proposal

Virtual Reality

Available Platforms

- Google Cardboard
  - $20 cardboard viewer to use any Android phone as a VR display

- Samsung Gear VR
  - Only certain Samsung phones (Galaxy S7, Galaxy S6, Note5)
  - Better motion-tracking, higher resolution screens

- Google Daydream
  - Only certain phones (Google Pixel, Moto Z, ASUS Zenfone, Huawei Mate, ZTE Axon)
  - Bluetooth controller

Available Platforms

- ~~HTC Vive~~
  - Accurate motion tracking with room cameras

- Oculus Rift
  - Xbox controller
  - Oculus Touch controllers

- 360 cameras
  - 6 GoPros on a mount
  - Adobe Premiere Pro and Kolor Autopano

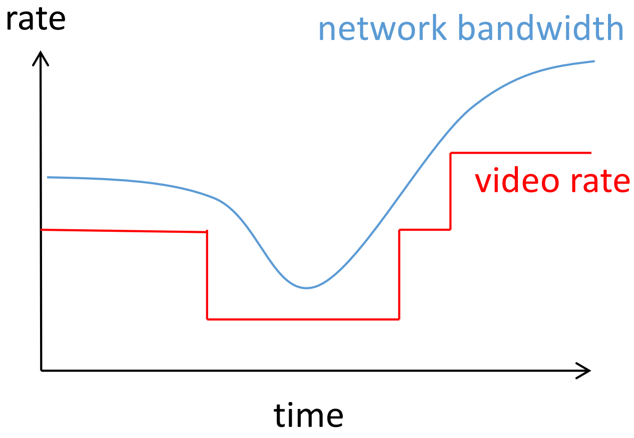
How to Program?

- Unity (GUI + C#) or Android Studio (Java)
- Need appropriate SDK (Oculus, Android, Daydream)

MPEG-DASH Video Streaming

MPEG-DASH Protocol

- MPEG-DASH
  - APP-layer protocol for adapting video quality to network conditions
  - Client-driven: client estimates network conditions and requests appropriate video quality
  - Standard doesn't specify adaptation algorithm, just the communication protocol between client and server



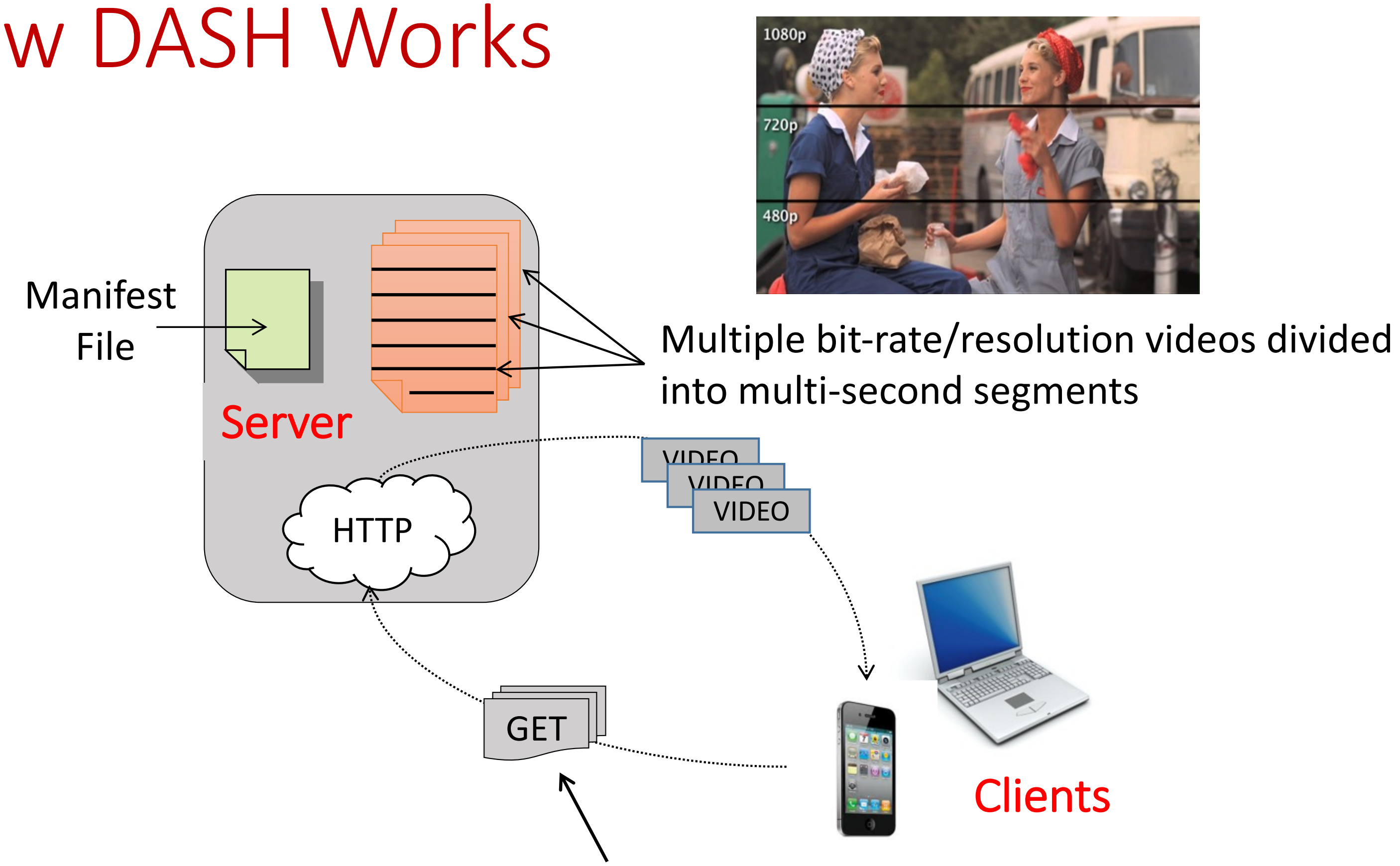
- Who uses it? YouTube NETFLIX hulu

Project Goal

- Current approaches
  - Numerous approaches proposed in research literature and in practice
  - Need a apples-to-apples comparison under common set of test conditions

- Resources
  - MPEG-DASH video player: https://github.com/Dash-Industry-Forum/dash.js/wiki

How DASH Works



Multiple bit-rate/resolution videos divided into multi-second segments

- Clients request a new video segment every ***X*** seconds.
- The bit-rate of the requested segment is based on the average TCP throughput of last ***Y*** segments.

General Video Rate Adaptation Algorithm

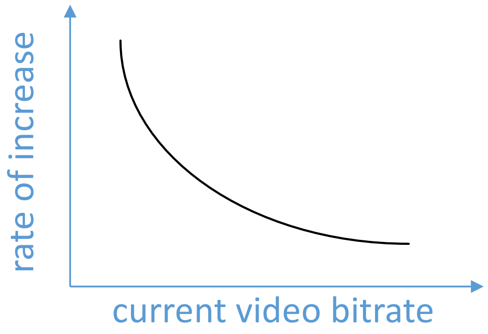
1. Estimate bandwidth
   1. Update bandwidth estimate of ith chunk, B[t]
   2. Based on previous bandwidth estimates B[1], B[2], ..., B[t], predict new bandwidth B[t+1]
2. Make new video rate selection
   1. Pick the new video rate R = f(video bitrate, network bandwidth, buffer size)
   2. t++
3. Go to step 1

Current Approach 1: Bandwidth-based

- Default approach: R[t+1] = max {r : r < B[t+1]}

- Problem: higher bitrates → higher bandwidth estimate → unfair competition between clients
  - Lower overhead for higher bitrates

- R[t+1] = f(previous video bitrate, bandwidth estimate)
  = f(R[t], B[t+1])

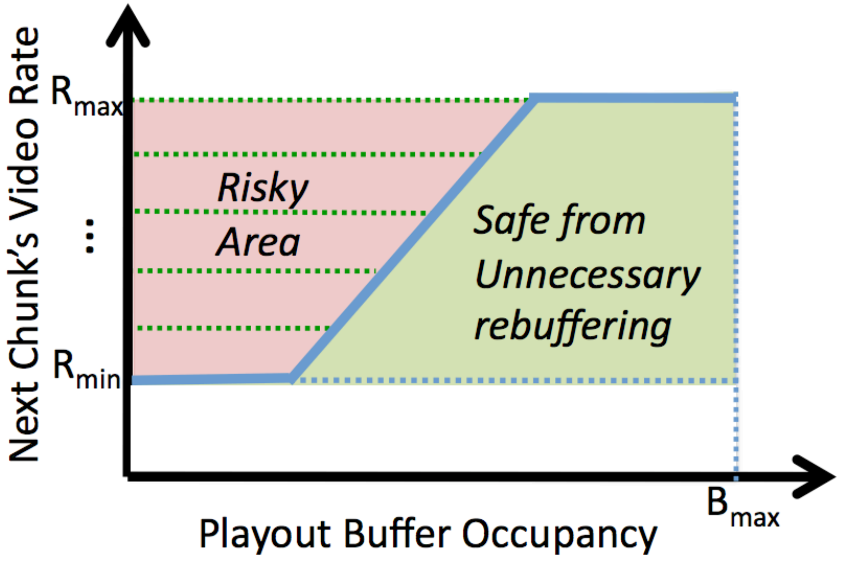


- Compensate by ramping up quickly for lower bitrates, ramping up slowly for higher bitrates

Reference: http://conferences.sigcomm.org/co-next/2012/eproceedings/conext/p97.pdf

Current Approach 2: Buffer-based

- In steady state, R = f(buffer size)



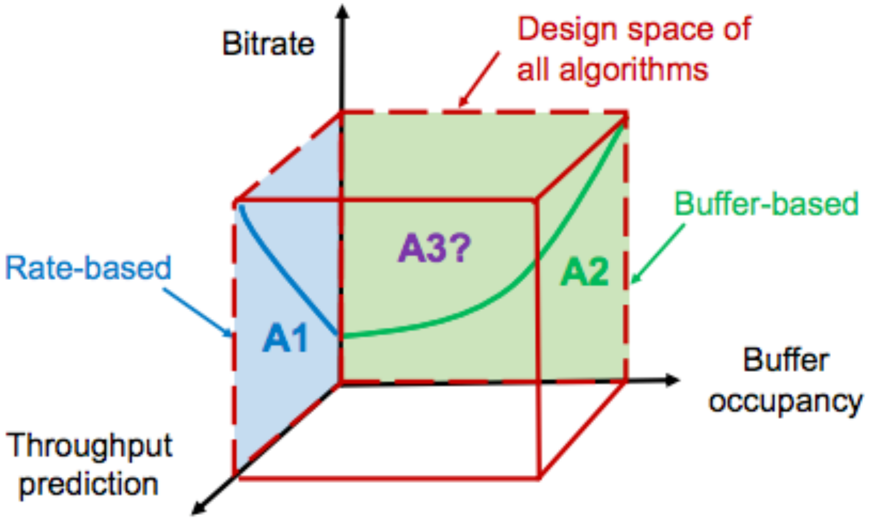
Reference: http://yuba.stanford.edu/~nickm/papers/sigcomm2014-video.pdf

Current Approach 3: Bandwidth + Buffer-based

- Look into the future: make bandwidth predictions for the next N time slots

- R[t+1] = f(previous video bitrate,
  bandwidth estimate, buffer)
  = f(R[t], B[t], …, B[t+N], buffer size)

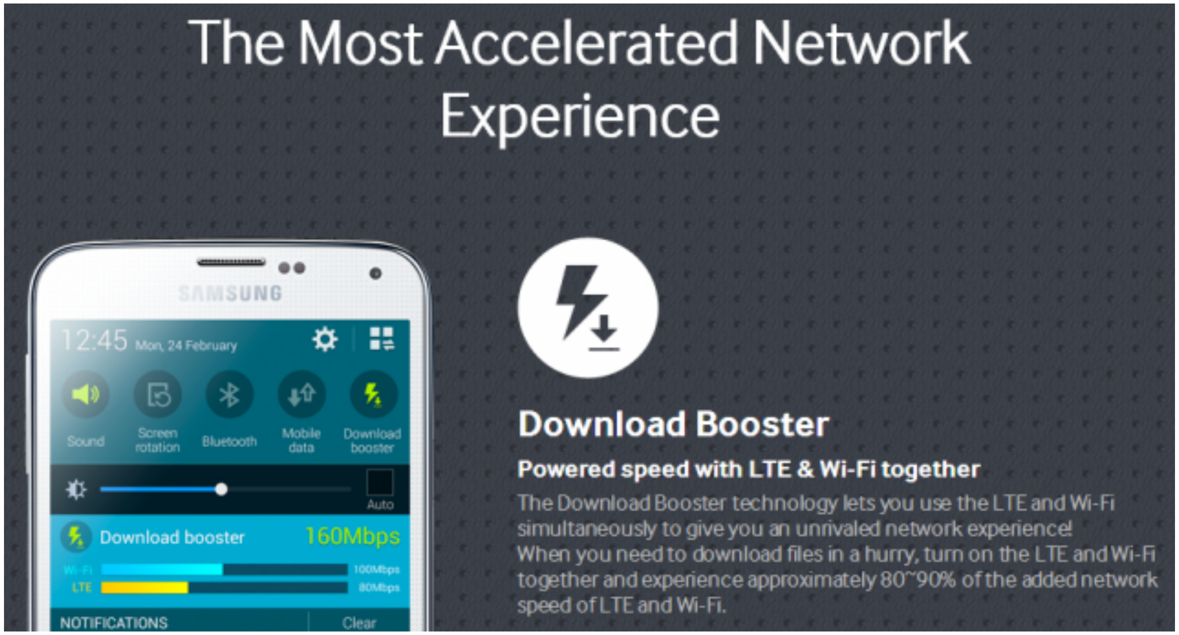
- Markov decision process with online table lookup
  - Multi-criterion objective



Reference: http://conferences.sigcomm.org/sigcomm/2015/pdf/papers/p325.pdf

Download Booster

Download Booster



The Most Accelerated Network Experience

Download Booster

Powered speed with LTE & Wi-Fi together

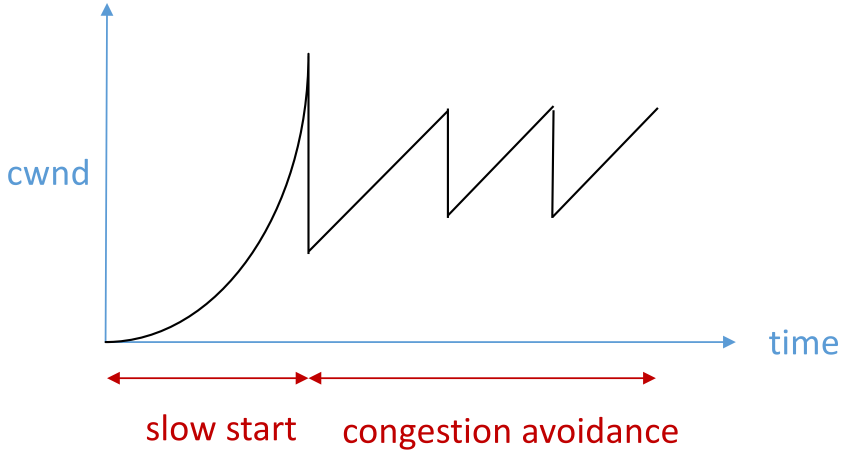
The Download Booster technology lets you use the LTE and Wi-Fi simultaneously to give you an unrivaled network experience! When you need to download files in a hurry, turn on the LTE and Wi-Fi together and experience approximately 80~90% of the added network speed of LTE and Wi-Fi.

- Want to speed up downloads of large files by using multiple interfaces simultaneously (e.g., WiFi, 4G, Ethernet)
- Samsung introduced Download Booster, but it got blocked by major carriers
- Multipath-TCP is another major standardization effort to enable multiple networks

Review of TCP Throughput

- Control transmission rate by setting windowsize
  - Window size = min {cwnd, rwnd}
  - cwnd = congestion window (set by sender)
  - rwnd = receive window (set by receiver)

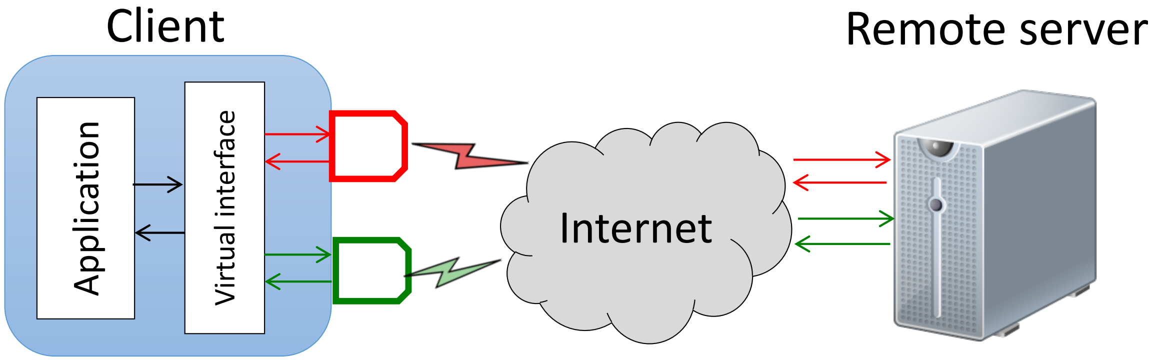
- Scheduler (multiple networks only)
  - If # of pkts to send < window size, which pipe should I send the pkts on?



TCP congestion avoidance:

```
If ACK received:
        cwnd ← cwnd + 1/cwnd
If loss:
        cwnd ← cwnd/2
```

Transport and Application Layer Approaches



Transport layer: multipath-TCP

- MPTCP congestion control + (default, round robin) scheduler
- Corse-grained scheduler control (operate on packets)

Application layer: HTTP proxy

- TCP congestion control + your scheduler
- Fine-grained scheduler control (operate on bytes)

Multipath-TCP

- Congestion control
  - Separate congestion window for each subflow *r*

MPTCP default [1]

If ACK received:

$$\text{cwnd}_r \leftarrow \text{cwnd}_r + \frac{\max_i \left\{ \frac{cwnd_i}{RTT_i^2} \right\}}{\left(\sum_i cwnd_i / RTT_i\right)^2}$$

If loss:

cwnd ← cwnd/2

Pareto-optimal [2]

If ACK received:

$$\text{cwnd}_r \leftarrow \text{cwnd}_r + \frac{cwnd_r / RTT_r^2}{\left(\sum_i cwnd_i / RTT_i\right)^2} + \frac{a_r}{cwnd_r}$$

If loss:

cwnd ← cwnd/2

- Scheduler
  - Default: Send packets on the pipe with the lowest RTT
  - Round-robin: May leave space open in congestion window

[1] https://www.eecs.berkeley.edu/~sylvia/cs268-2014/papers/mptcp.pdf

[2] http://conferences.sigcomm.org/co-next/2012/eproceedings/conext/p1.pdf

HTTP Proxy

- Congestion control
  - Standard TCP congestion control on each pipe

```
If ACK received:
            cwnd ← cwnd + 1/cwnd
If loss:
            cwnd ← cwnd/2
```

- Scheduler
  - How to schedule packets onto each pipe? Your design!
  - E.g., schedule packets proportional to estimated bandwidth

Example Projects from Previous Years

- Convert first-person-shooter video game on PC to display in VR
- “Zombie tag” app using NFC on phones
- Website for synchronized video watching on YouTube

Proposal

- 1-page summary and plan of your project
  - Due next Monday
  - Worth 10% of your grade
  - Feel free to come to office hours on Thursday 2-4pm

- Sections
  - Executive summary
  - Comparison against what others have done
    - e.g., startups, research papers, commercial products
  - Target features
    - Milestone 0 (oral progress update mid-quarter)
    - Milestone 1
  - Methodology (e.g., tools, programming languages)
  - Evaluation (e.g., testbed, metrics)

Proposal

- Make sure to address
  - What makes your project interesting? Does it fulfil some unmet need? Who is it useful for?
  - At least one figure showing system design/architecture
- If you’re choosing an existing project (MPEG-DASH or MPTCP)
  - Read the references, compare them, and discuss what you expect to find/improve
- If you’re choosing your own project
  - Why should someone invest in your “startup”?
- Written feedback given 1 week later

Coming Up…

- Lab this week
  - Work on your proposal

- To do by next Monday (1/30)
  - Submit proposal via iLearn by 1:10pm (one per group)