Introduction to Computer Networks

Streaming Media (§7.4.3)

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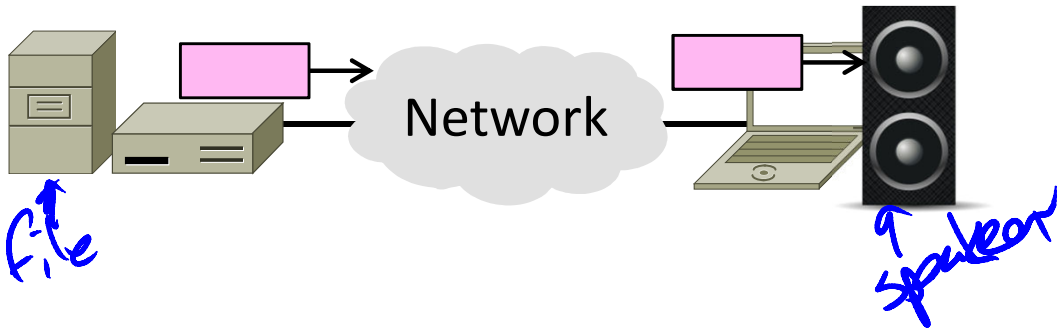
Topic

- Playback of media over the network
  - Using the best effort Internet
  - Coursera, YouTube, Netflix, etc.
  - Huge usage!

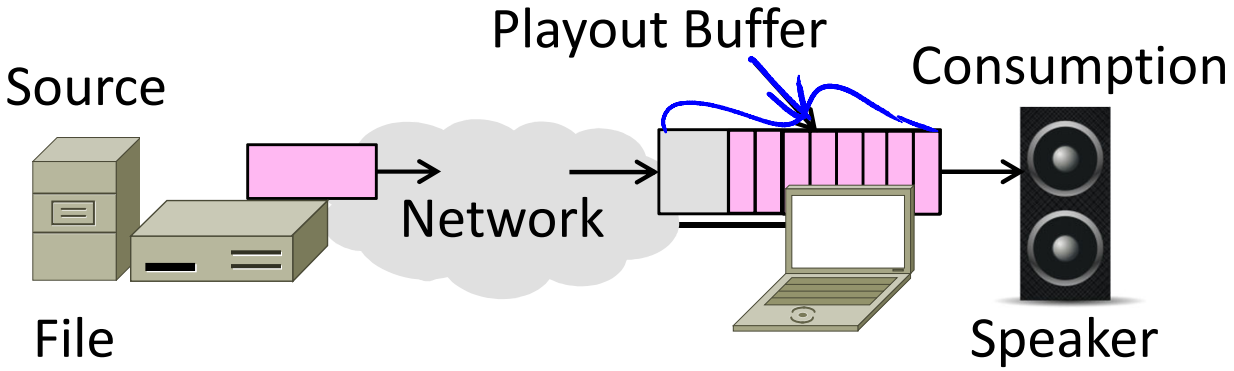
Streamed vs. Interactive Media

- Streamed is less demanding case:
  - Only a single direction to consider
  - Low delay not essential; affects startup but not interactivity
  - Still need to handle bandwidth, jitter



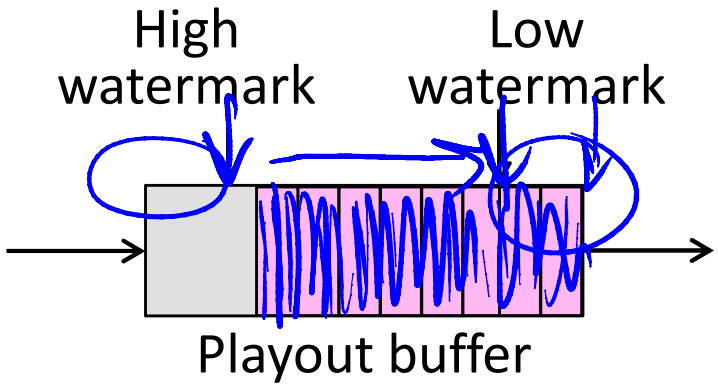
Handling Jitter

- As before, buffer media at receiver until ready for playout time
  - Smooth out variable network delay



Handling Jitter (2)

- Use HIGH and LOW watermarks to control source over/underfill
  - Start pulling media at low level
  - Stop pulling media at high level



Handling Bandwidth

- Send file in one of multiple encodings
  - Higher quality encodings require more bandwidth
  - Select best encoding given available bandwidth

Higher quality
More bandwidth

(JPEG example)

Lower quality
Less bandwidth

15:1

23:1

46:1

144:1

By Toytoy, CC-BY-SA-3.0, from Wikimedia Commons

Streaming over TCP or UDP?

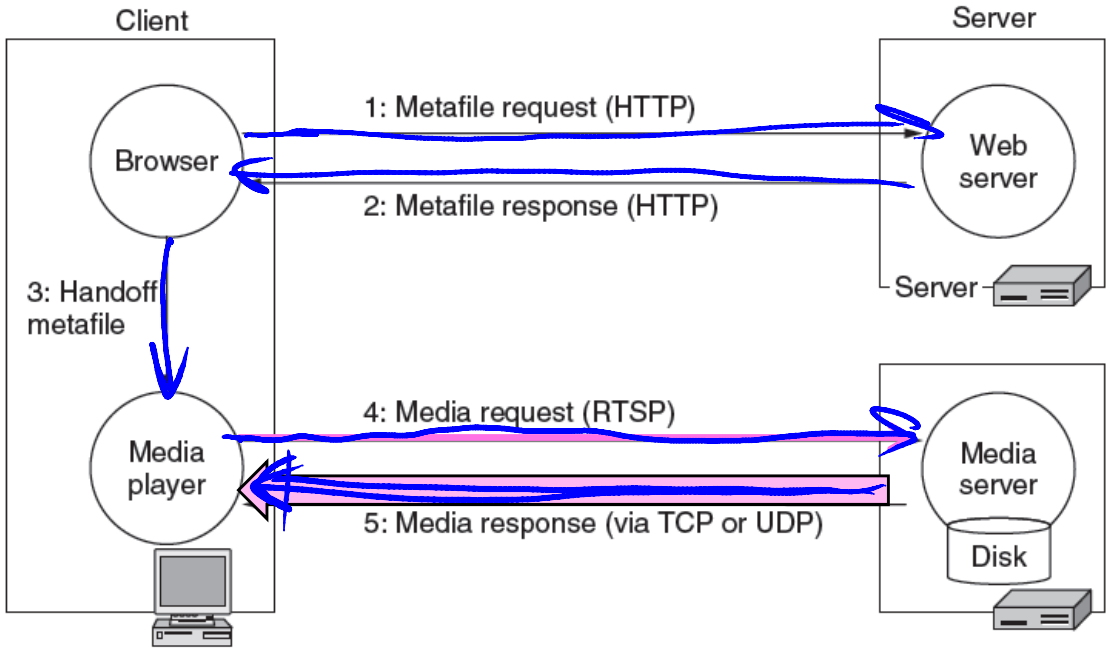
- UDP minimizes message delay for interactive, real-time sessions
- TCP is typically used for streaming
  - Low delay is not essential; startup
  - Loss recovery simplifies presentation
  - HTTP/TCP passes through firewalls

Components of Streaming Media

- Session consists of several parts:
  - Signaling, e.g., with RTSP »
  - Media transport, e.g., with HTTP »
  - Media playout, with buffer
  - Evolving standards, e.g., HTML5
- Typically to an individual party
  - Use CDNs to reach many viewers

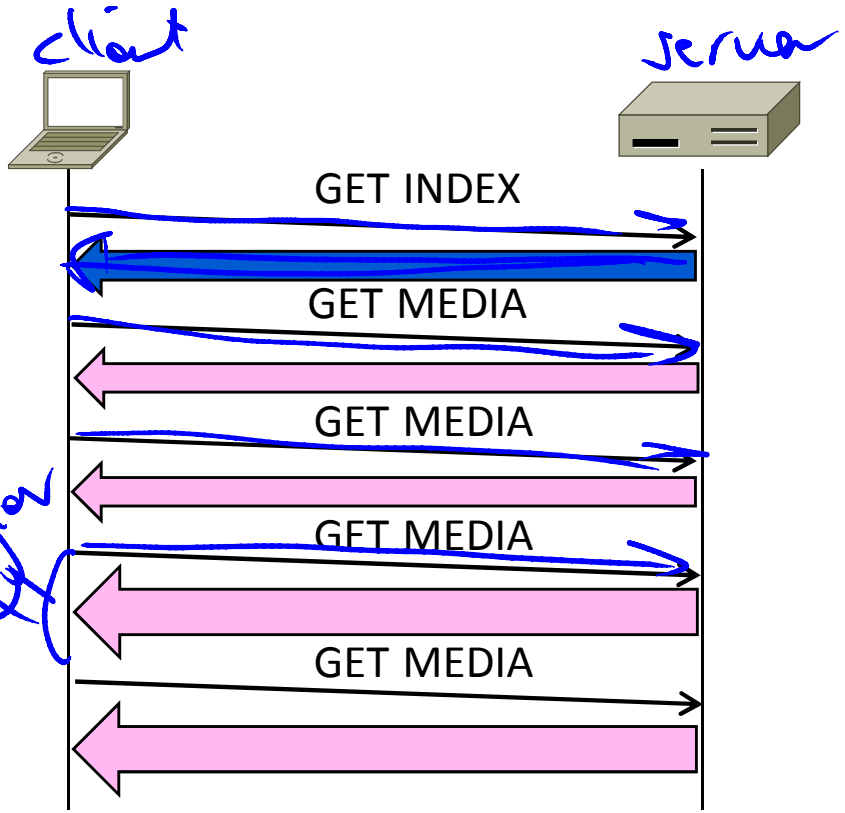
Streaming with RTSP

- Video started using HTTP to get metafile
- Invokes media player
  - Talks RTSP (Real-Time Streaming Protocol) to media server
- Media sent with, e.g., RTP over TCP/UDP



Streaming with HTTP

- Fetch media description data
  - Gives index of clips, rates
- Fetch small segments
  - Put in playout buffer
- Adapt selection of encoding
  - Based on buffer occupancy
- Evolving standards, e.g., DASH
  - Leverages HTTP and HTML5
  - Server is otherwise stateless



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