CN-Advanced
L36

MultiMedia Networking

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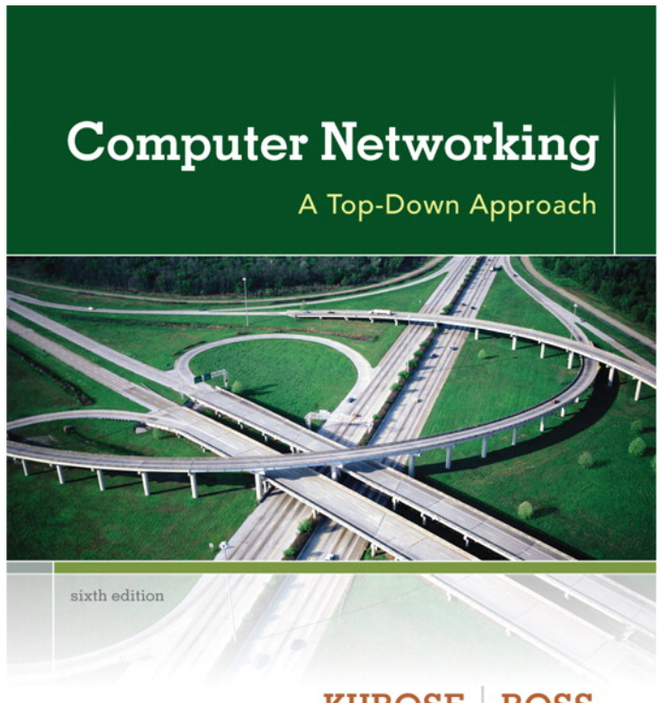
Acknowledgements

Chapter 7
Multimedia Networking



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Computer Networking: A Top Down Approach
6th edition
Jim Kurose, Keith Ross
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Internet based Multimedia Applns

- Multimedia applications on internet
  - YouTube, Vimeo
  - Whats App, Skype, Gtalk
  - Netflix, Amazon Prime
  - … Flipkart video streaming (planning)
- Classification of multimedia applications
  - Streaming stored audio/video
  - Streaming live audio/video
  - Conversational audio/video
- Significant differences from classical applications
  - Email, Web browsing, file transfer etc.

Requirements/Characteristics

- Underlying principles
  - Client buffering and prefetching
  - Adapting video bandwidth quality
  - Delay sensitivity
  - Scheduling
  - Error management (correction, mitigation)
    - Packet loss management
- Content distribution networks (CDN)
  - Akamai, Level 3 communication
- Underlying protocols

Multimedia Application

- Definition: any network application that employs audio or video.
- Service requirements and design issues
- Example of bandwidth requirement
- 3 users using internet for 4000s (~67minutes)
  - User A: view photos on facebook every 10s
    - Each photo is 200KB
  - User B is listening MP3 songs continuously
    - Using bandwidth: 128kbps
  - User C is watching movie at rate 2Mbps
- What is total bytes required for each
  - Simplistic assumption: 1KB=1000bytes=8000bits
    - 80MB / 64MB / 1GB

Multimedia: video

- video: sequence of images displayed at constant rate
  - e.g., 24 images/sec
- digital image: array of pixels
  - each pixel represented by bits
- coding: use redundancy *within* and *between* images to decrease # bits used to encode image
  - spatial (within image)
  - temporal (from one image to next)

spatial coding example: instead of sending N values of same color (all purple), send only two values: color value (purple) and number of repeated values (N)

frame i

temporal coding example: instead of sending complete frame at i+1, send only differences from frame i

frame i+1

Multimedia: video

- CBR: (constant bit rate): video encoding rate fixed
- VBR: (variable bit rate): video encoding rate changes as amount of spatial, temporal coding changes

spatial coding example: instead of sending N values of same color (all purple), send only two values: color value (purple) and number of repeated values (N)

- examples:
  - MPEG 1 (CD-ROM) 1.5 Mbps
  - MPEG2 (DVD) 3-6 Mbps
  - MPEG4 (often used in Internet, < 1 Mbps)

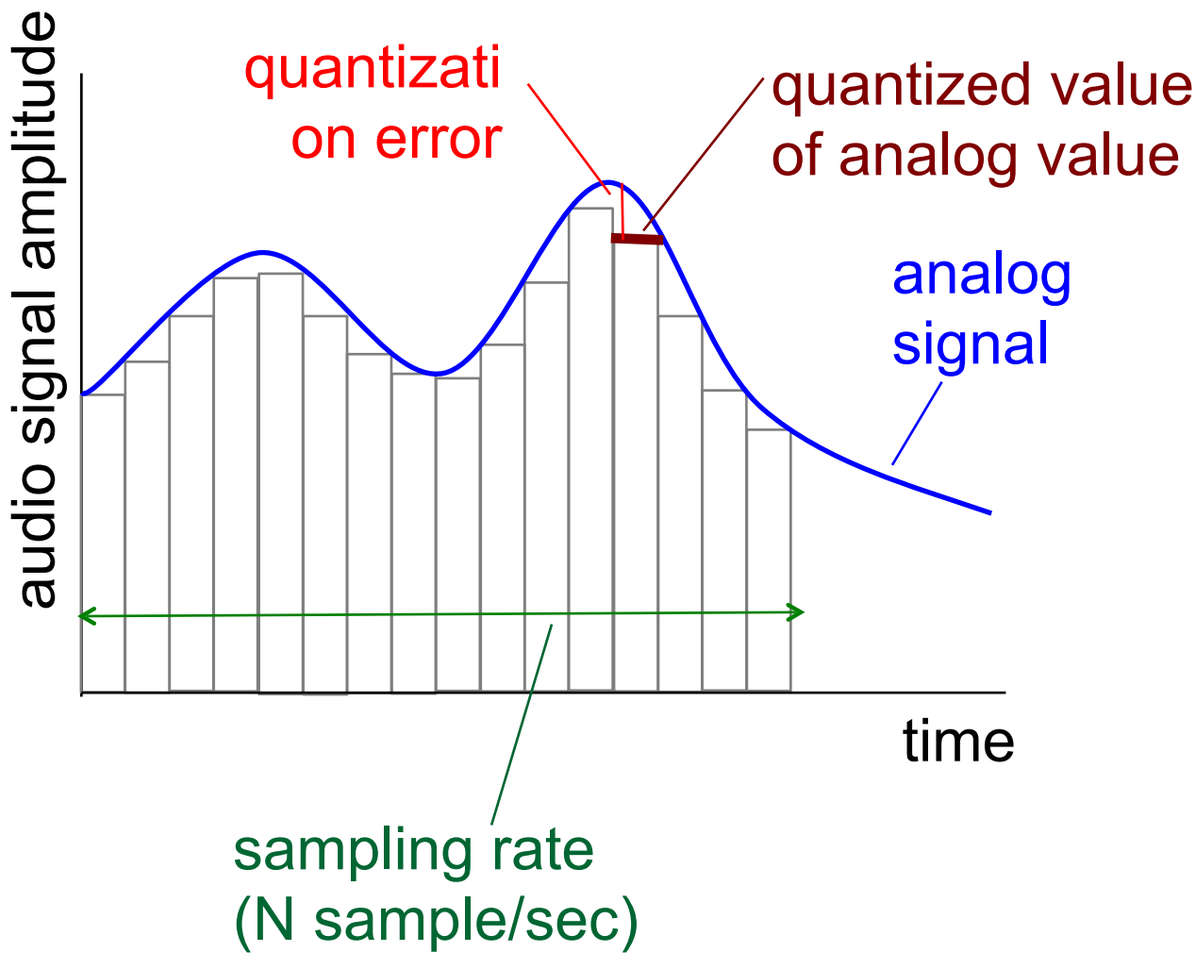
frame i

temporal coding example: instead of sending complete frame at i+1, send only differences from frame i

frame i+1

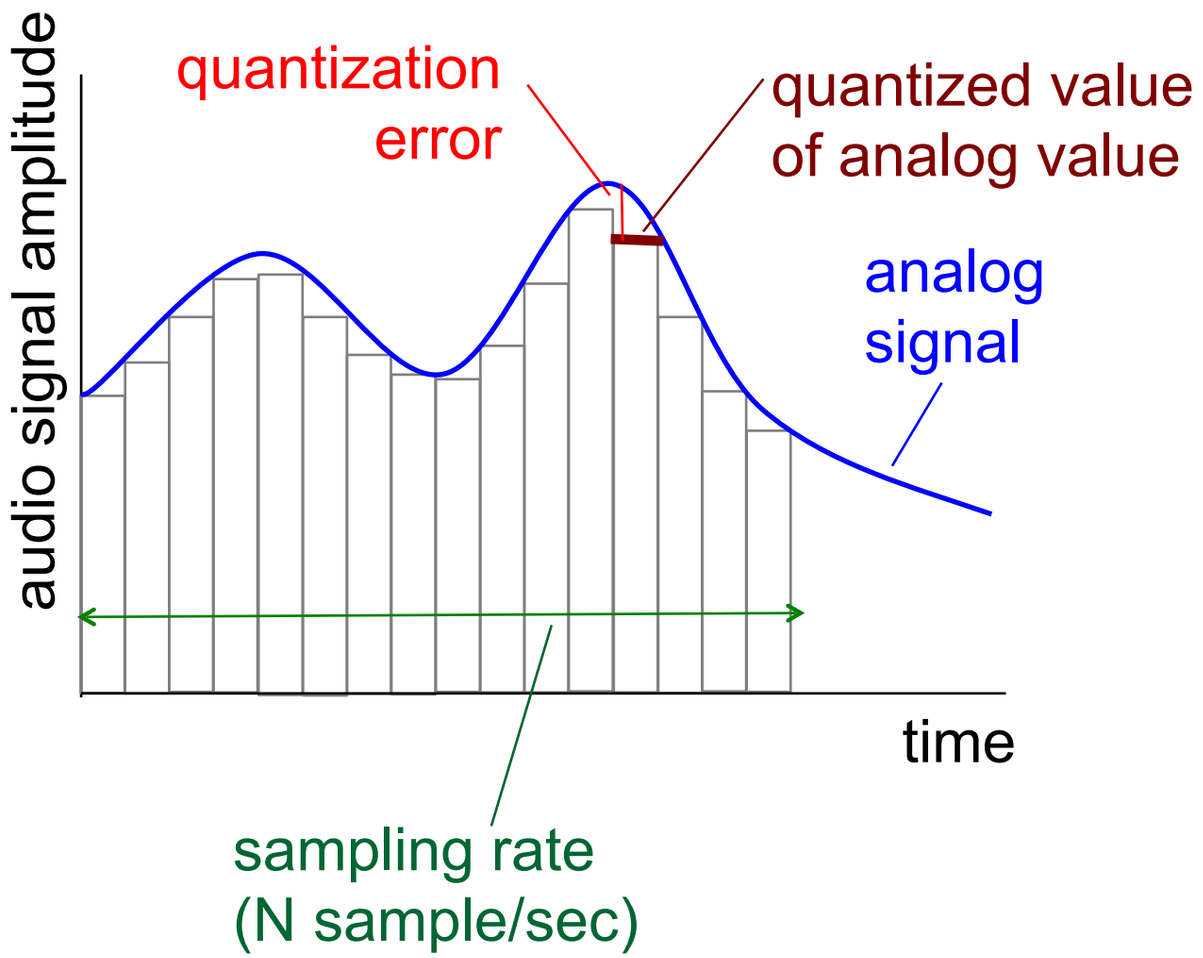
Multimedia: audio

- Analog audio signal sampled at constant rate
  - Telephone: 8,000 samples/sec
  - CD music: 44,100 samples/sec
- Each sample quantized, i.e., rounded
  - e.g., 2^8=256 possible quantized values
  - each quantized value represented by bits, e.g., 8 bits for 256 values



Multimedia: audio

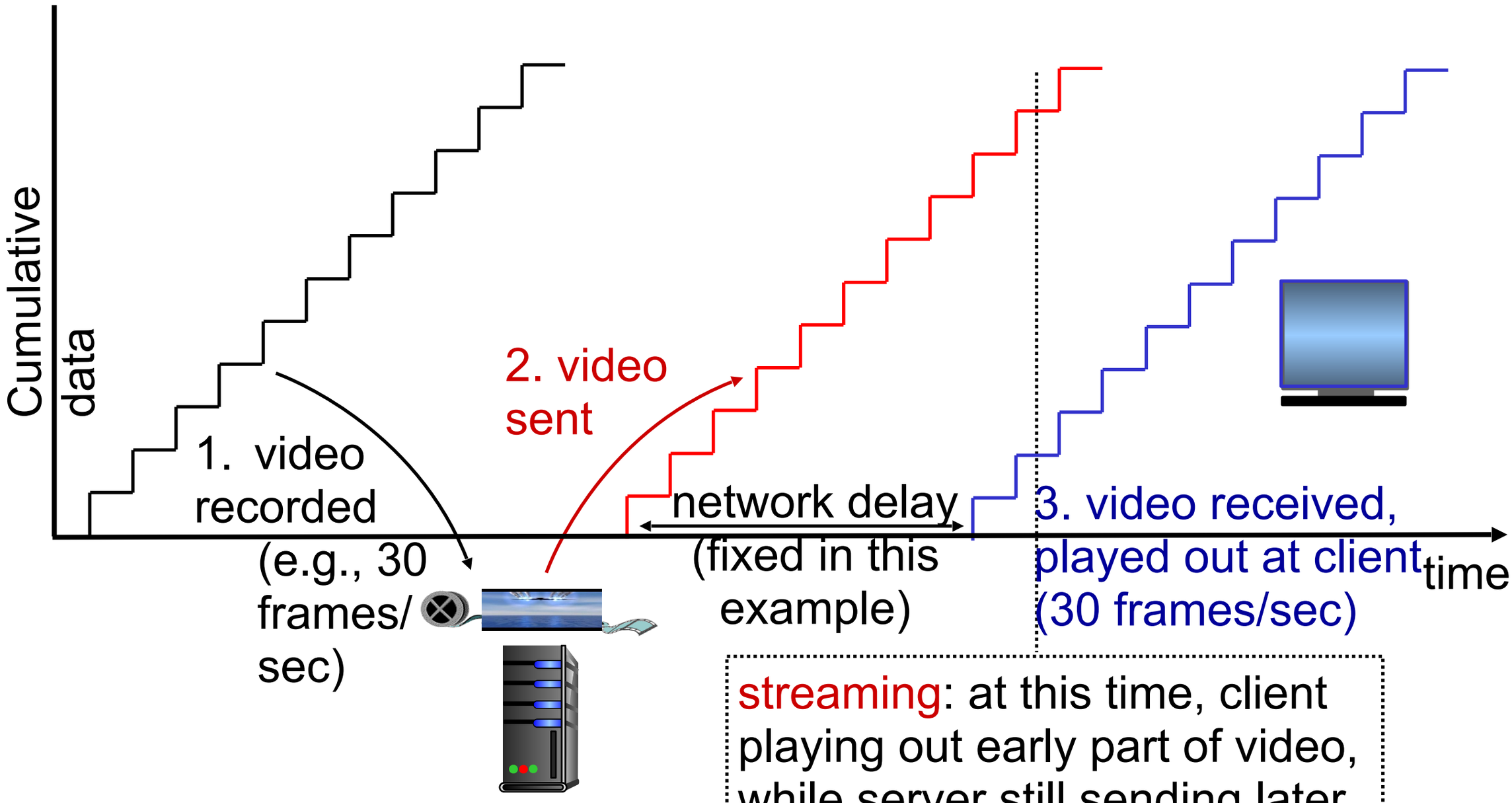
- example: 8,000 samples/sec, 256 quantized values: 64,000 bps (PCM coding)
- receiver converts bits back to analog signal:
  - some quality reduction
- example rates
  - CD (stereo): 1.411 Mbps
  - MP3: 96, 128, 160 kbps
  - Internet telephony: 5.3 kbps and up
- Audio is more sensitive to glitches than video.
  - brief video freeze often acceptable



Multimedia networking: 3 application types

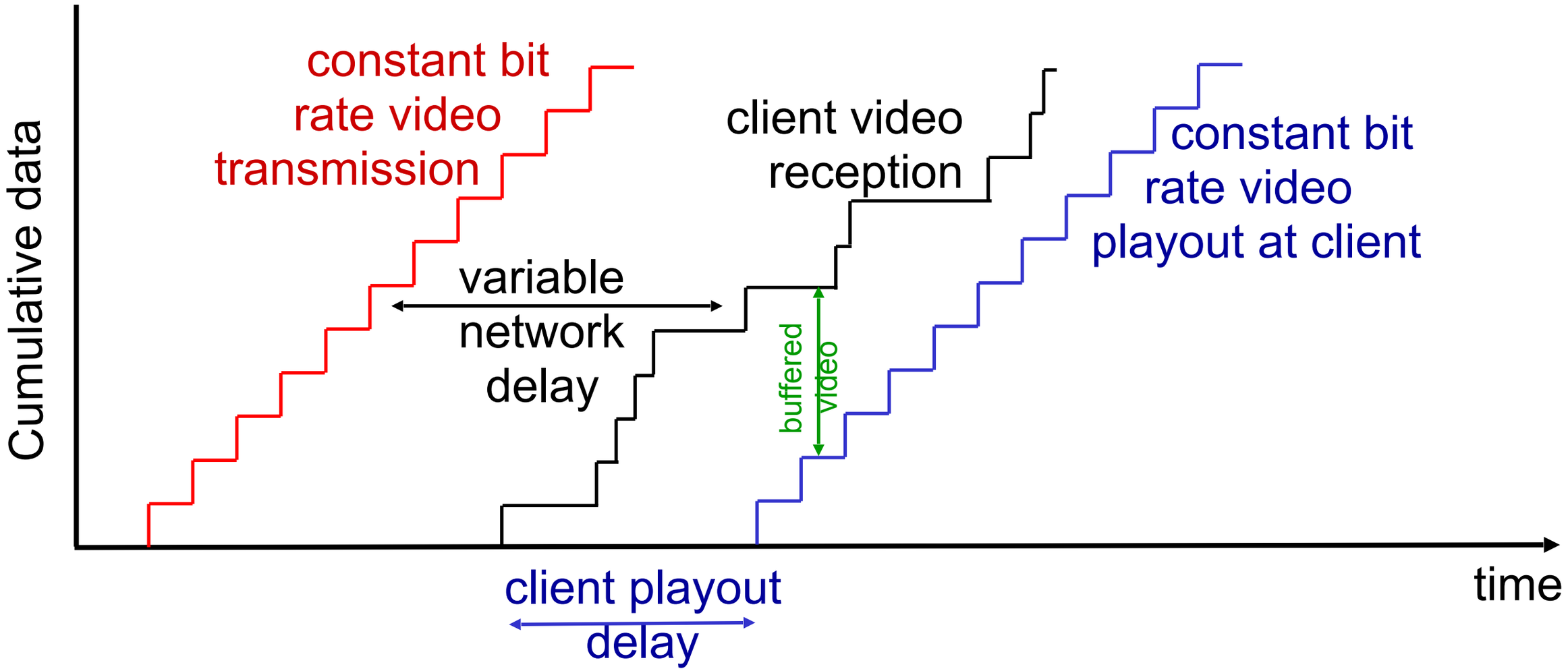
- *streaming, stored* audio, video
  - *streaming:* playout begins before full file download
  - *stored (at server):* to transmit faster than audio/video rendering at client (implies storing/buffering)
  - e.g., YouTube, Amazon prime, Netflix, Hulu
  - some delay tolerate acceptable
- *conversational* voice/video over IP
  - interactive nature of human-to-human conversation limits delay tolerance (100ms - 400ms)
  - e.g., Skype, whatsapp
- *streaming live* audio, video
  - e.g., live sporting event (cricket, kabaddi, soccer)
  - Few second delay tolerance accepted

Streaming stored video:



streaming: at this time, client playing out early part of video, while server still sending later part of video

Streaming stored video: revisted

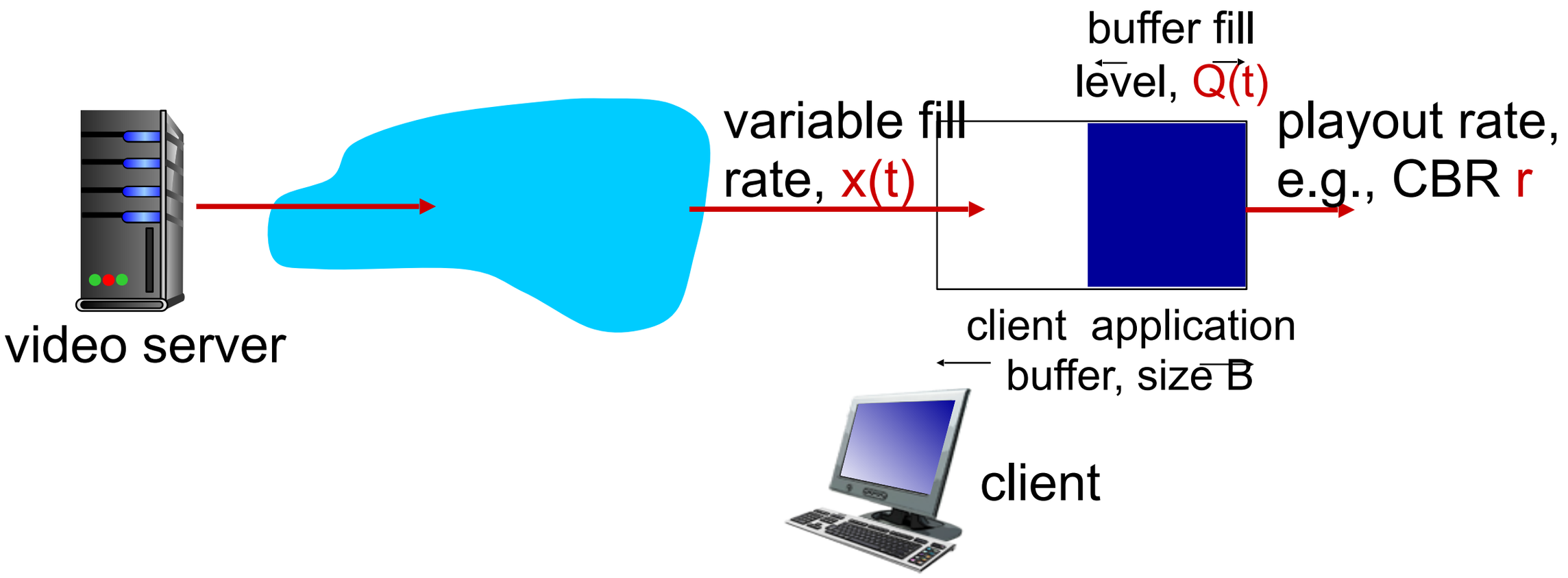


- *client-side buffering and playout delay:* compensate for network-added delay, delay jitter

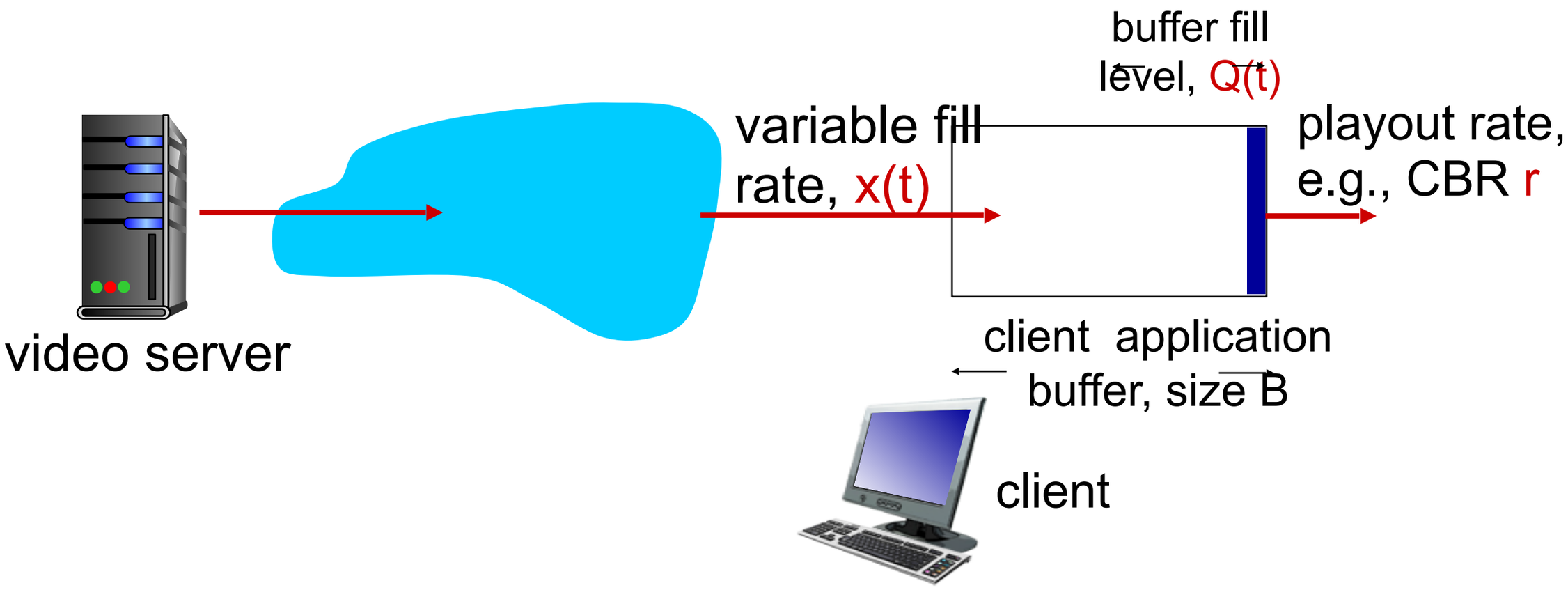
Streaming stored video: challenges

- continuous playout constraint:
  - on playout, playback must match original timing
  - … but network delays are variable (jitter),
    - need client-side buffer
- other challenges:
  - client interactivity:
    - pause, rewind, jump through (reposition) video
  - video packets may be lost, retransmitted

Client-side buffering, playout

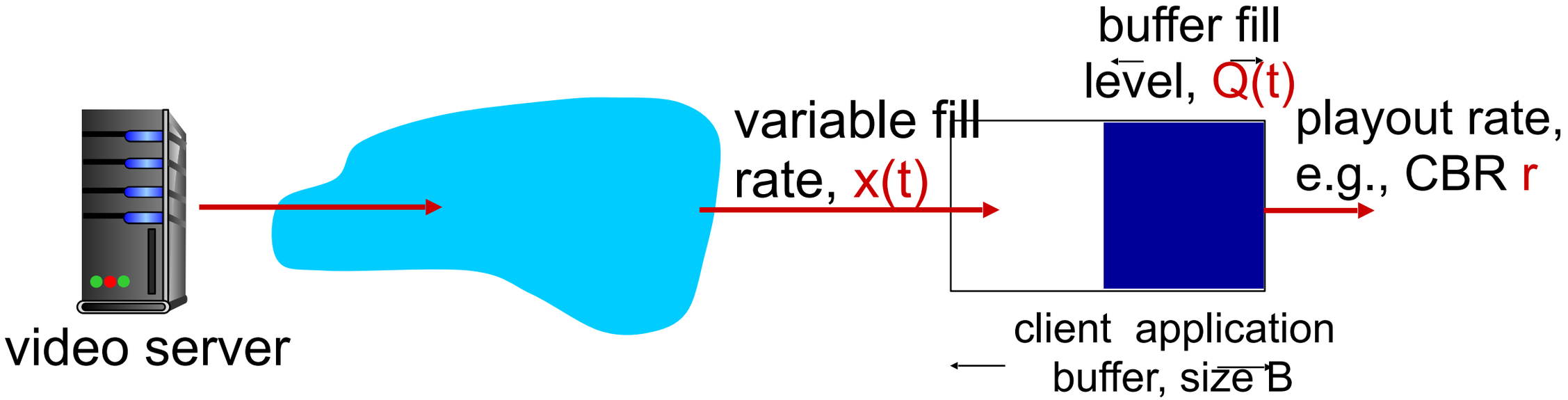


Client-side buffering, playout



1. Initial fill of buffer until playout begins at t_p
2. playout begins at t_p,
3. buffer fill level varies over time as fill rate x(t) varies and playout rate r is constant

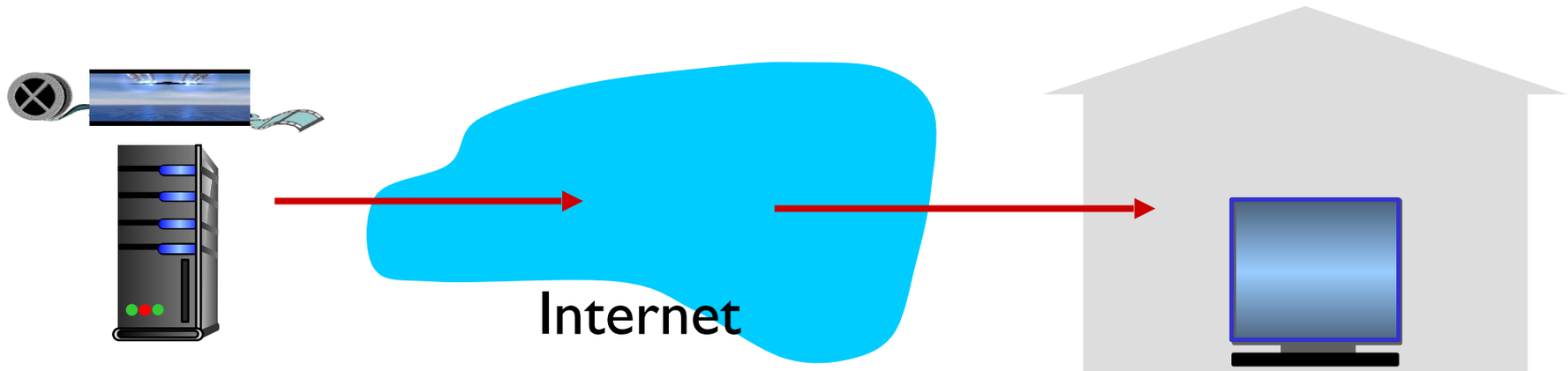
Client-side buffering, playout



- *playout buffering: average fill rate (x), playout rate (r):*
- x < r:
  - buffer eventually empties (freezing of video)
- x > r: buffer will not empty, provided initial playout delay is large enough to absorb variability in x(t)
- *initial playout delay tradeoff:*
  - buffer starvation less likely with larger delay,
  - larger delay until user begins watching

Streaming stored video:

simple scenario:



video server
(stored video)

client

Summary

- Multimedia audio
- Multimedia video
- 3 Application types
  - Streaming stored audio/video
  - Conversational audio/video
  - Streaming live audio/video

Questions

- There are two types of redundancies in video streaming. How these are dealt with to improve video streaming?
- Suppose an analog audio signal is sampled 16,000 times per second, and each sample is quantized into one of 1024 levels. What would be the resulting bit rate of the PCM digital audio signal?
- Differentiate between the 3 categories of multimedia applications