College of Information Studies
University of Maryland Hornbake Library Building College Park, MD 20742-4345

Multimedia

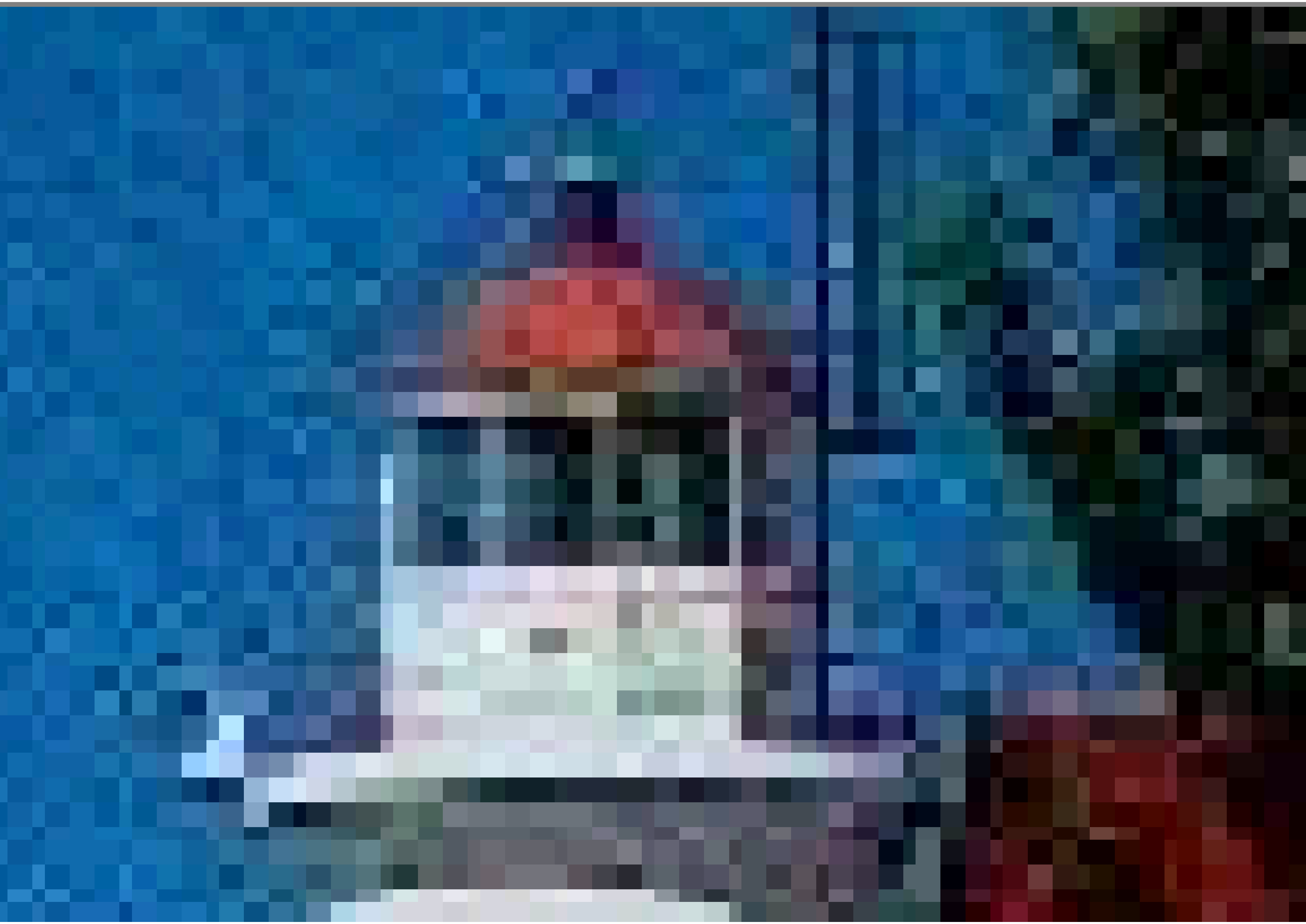
Week 7

LBSC 690

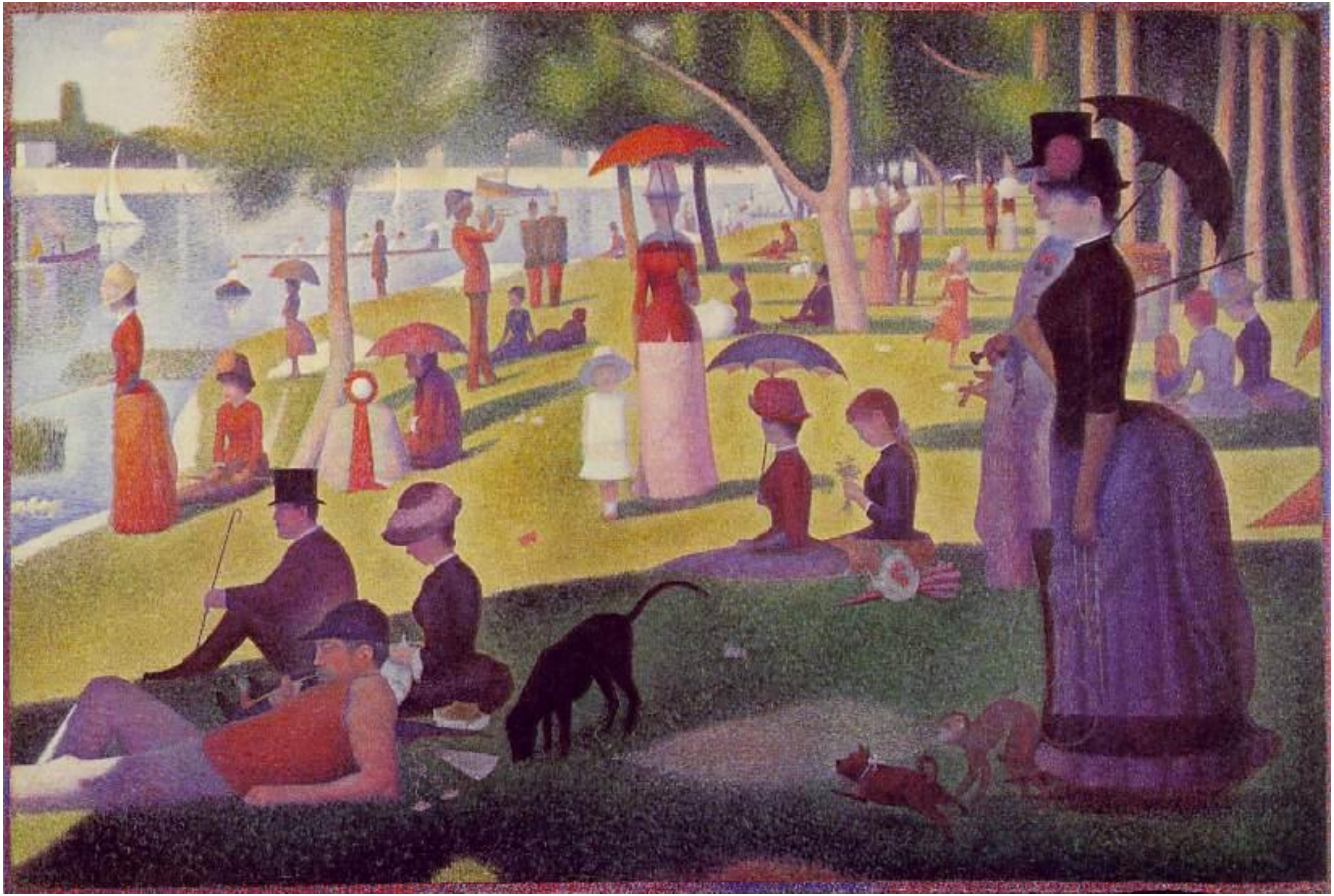
Information Technology

Agenda

- Questions
- Images
- Video
- Audio
- Streaming
- SMILe
- XML?
- (HCI)



Nothing new…



Georges Seurat, A Sunday Afternoon on the Island of La Grande Jatte

Visual Perception

- Closely spaced dots appear solid
  - But irregularities in diagonal lines can stand out
- Any color can be produced from just three
  - Red, Blue and Green: “additive” primary colors
- High frame rates produce apparent motion
  - Smooth motion requires about 24 frames/sec
- Visual acuity varies markedly across features
  - Discontinuities easily seen, absolutes less crucial

Basic Image Coding

- Raster of picture elements (pixels)
  - Each pixel has a “color”
    - Binary - black/white (1 bit)
    - Grayscale (8 bits)
    - Color (3 colors, 8 bits each)
      - Red, green, blue
- Screen
  - A 1024x768 image requires 2.4 MB
    - So a picture is worth 400,000 words!

Monitor Characteristics

- Technology (CRT, Flat panel)
- Size (15, 17, 19, 21 inch)
  - Measured diagonally
  - For CRT, key figure is “viewable area”
- Resolution
  - 640x480, 800x600, 1024x768, 1280x1024, …
- Layout (three dot, lines)
- Dot pitch (0.26, 0.28)
- Refresh rate (60, 72, 80 Hz)

Pop Quiz

- How many images can a 1 GB SD store?
  - But mine holds about 500. How?

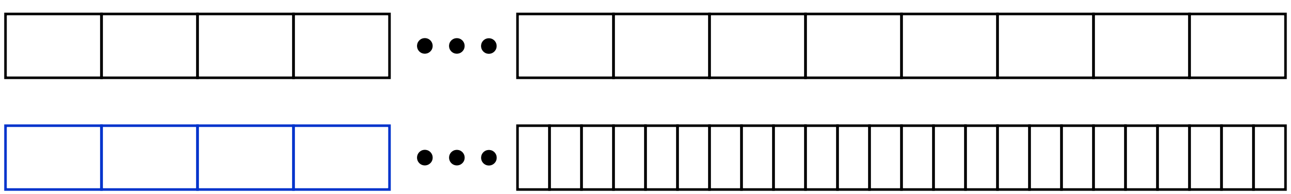
Compression

- Goal: reduce redundancy
  - Send the same information using fewer bits
- Originally developed for fax transmission
  - Send high quality documents in short calls
- Two basic strategies:
  - Lossless: can reconstruct exactly
  - Lossy: can’t reconstruct, but looks the same

Palette Selection

- Opportunity:
  - No picture uses all 16 million colors
  - Human eye does not see small differences
- Approach:
  - Select a palette of 256 colors
  - Indicate which palette entry to use for each pixel
  - Look up each color in the palette

"The rain in Spain falls mainly in the plain"
→ [*=ain,^=in] "The r* ^ Sp* falls m*ly ^ the pl*"



Run-Length Encoding

- Opportunity:
  - Large regions of a single color are common
- Approach:
  - Record # of consecutive pixels for each color

    Sheep go baaaaaaaaaa and cows go moooooooooo
    → Sheep go ba<10> and cows go mo<10>

- An example of <u>lossless</u> encoding

GIF

- Palette selection, then lossless compression
- Opportunity:
  - Common colors are sent more often
- Approach:
  - Use fewer bits to represent common colors

• 1	Blue	75%	75x1= 75	75x2=150
• 01	White	20%	20x2= 40	20x2= 40
• 001	Red	5%	5x3= 15	5x2= 10
			130	200

JPEG

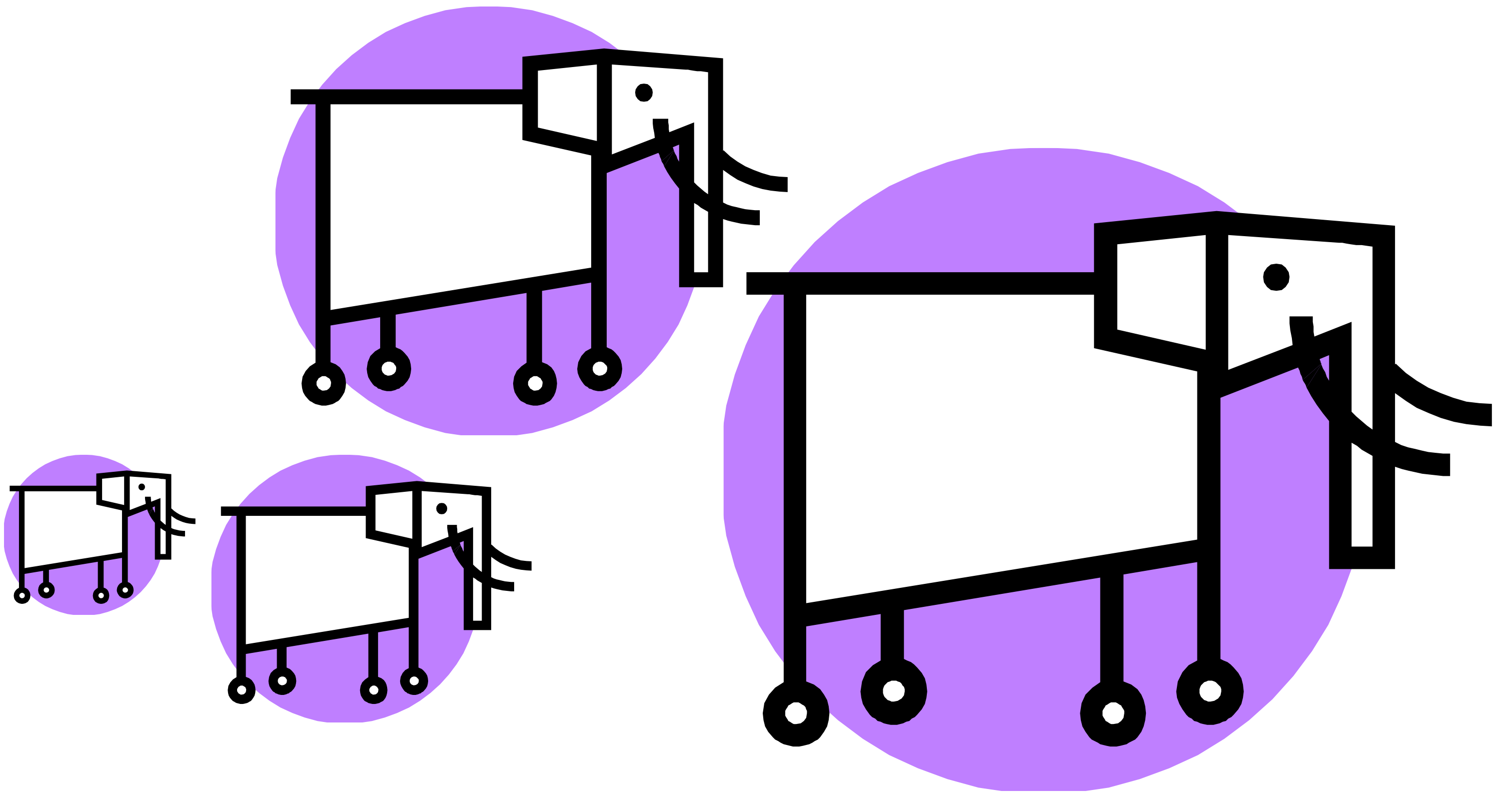
- Opportunity:
  - Eye sees sharp lines better than subtle shading
- Approach:
  - Retain detail only for the most important parts
  - Accomplished with Discrete Cosine Transform
    - Allows user-selectable fidelity
- Results:
  - Typical compression 20:1

Variable Compression in JPEG

37 kB (20%)

4 kB (95%)

Vector Graphics



Vector Graphics

- Raster images (“bitmap graphics”)
  - Actually describe the contents of the image
  - Good for natural scenes
- Vector images
  - Mathematically describe how to draw the image
  - Rescalable without loss of resolution

Discussion Point: Selecting an Image Format

- Should I use GIF, JPEG, or vector graphics for …
  - Color photos?
  - Scanned black & white text?
  - Line drawings?

Basic Video Coding

- Display a sequence of images
  - Fast enough for smooth motion and no flicker
- NTSC Video
  - 60 “interlaced” half-frames/sec, 512x486
- HDTV
  - 30 “progressive” full-frames/sec, 1280x720

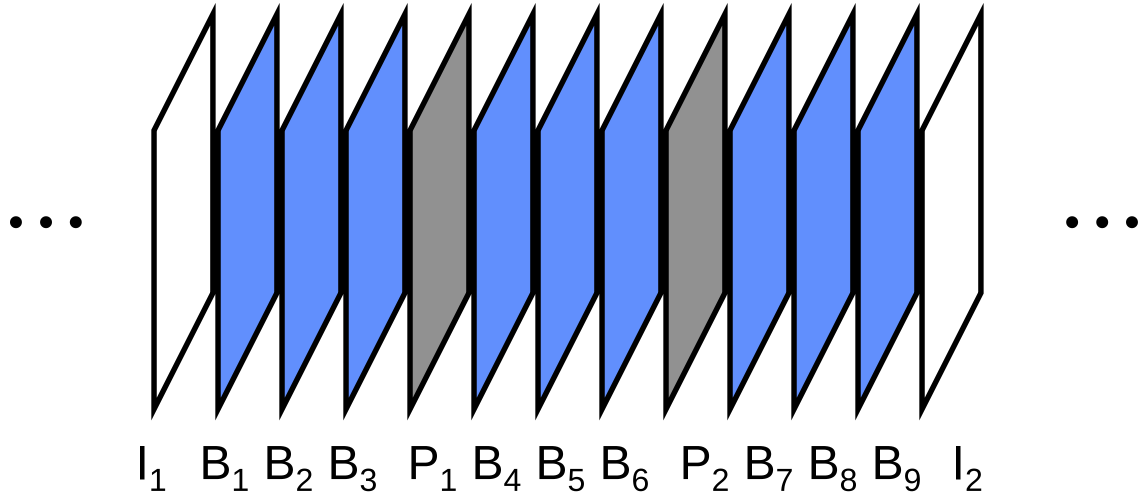
Video Data Rates

- "NTSC" Quality Computer Display
  - 640 X 480 pixel image
  - 3 bytes per pixel (red, green, blue)
  - 30 Frames per Second
- Bandwidth
  - 26.4 MB/second
  - Exceeds bandwidth of most disk drives
- Storage
  - CD-ROM would hold 25 seconds worth
  - 30 minutes would require 46.3 GB

Video Compression

- Opportunity:
  - One frame looks very much like the next
- Approach:
  - Record only the pixels that change
- Standards:
  - MPEG-1: Web video (file download)
  - MPEG-2: HDTV and DVD
  - MPEG-4: Web video (streaming)

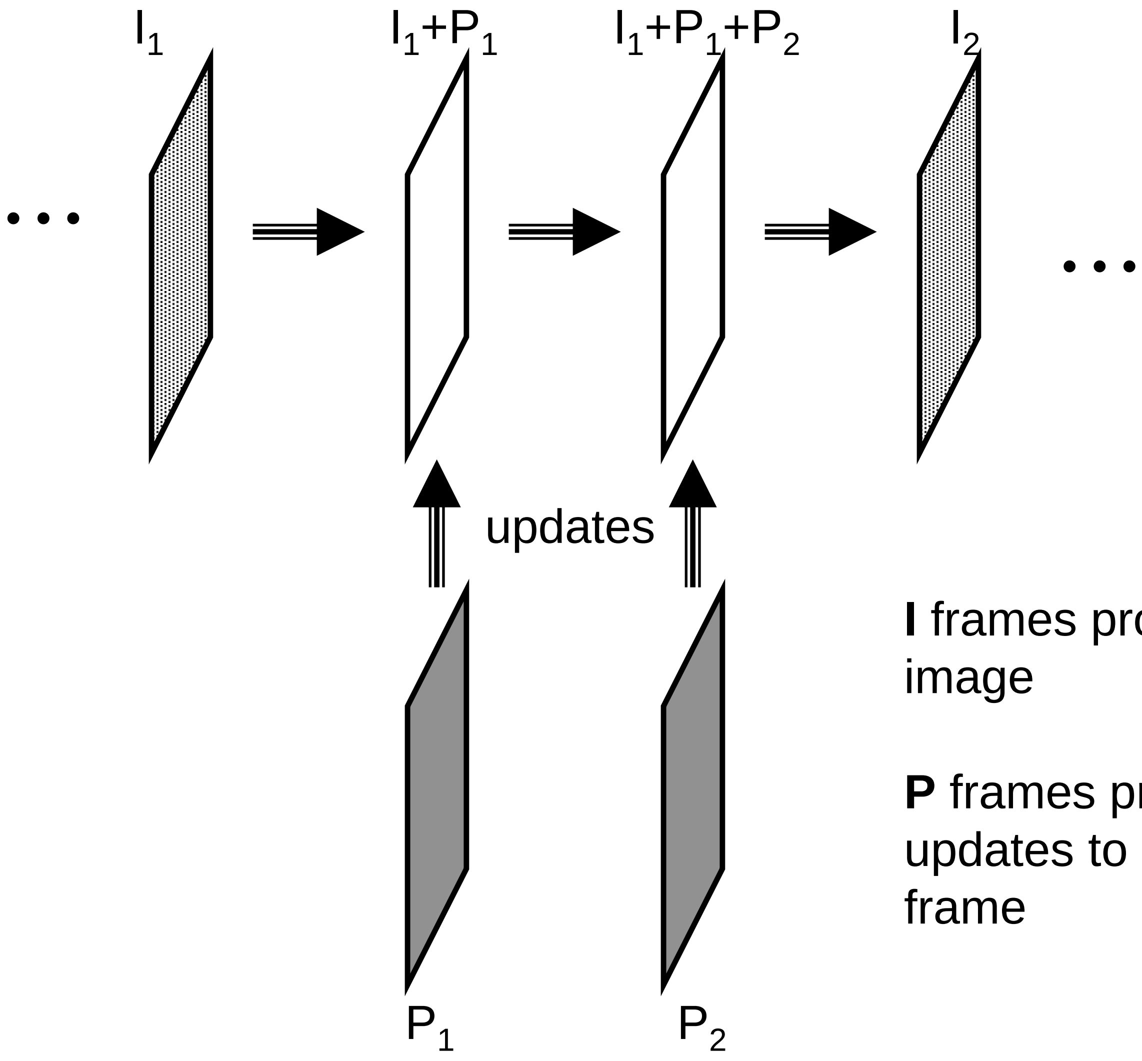
MPEG Encoding



Frame Types

I	Intra	Encode complete image, similar to JPEG
P	Forward Predicted	Motion relative to previous I and P's
B	Backward Predicted	Motion relative to previous & future I's & P's

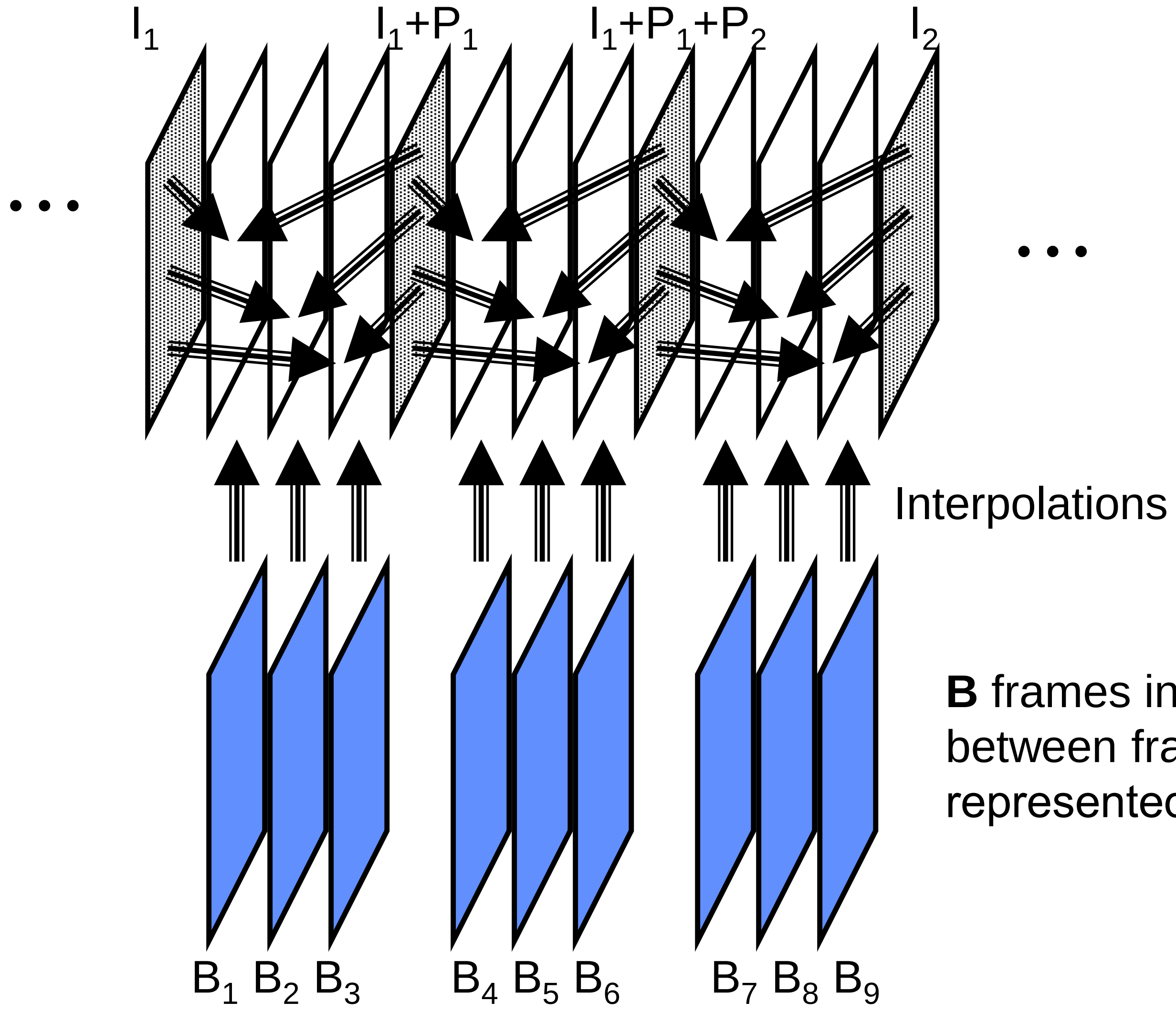
Frame Reconstruction



I frames provide complete image

P frames provide series of updates to most recent I frame

Frame Reconstruction



B frames interpolate between frames represented by I's & P's

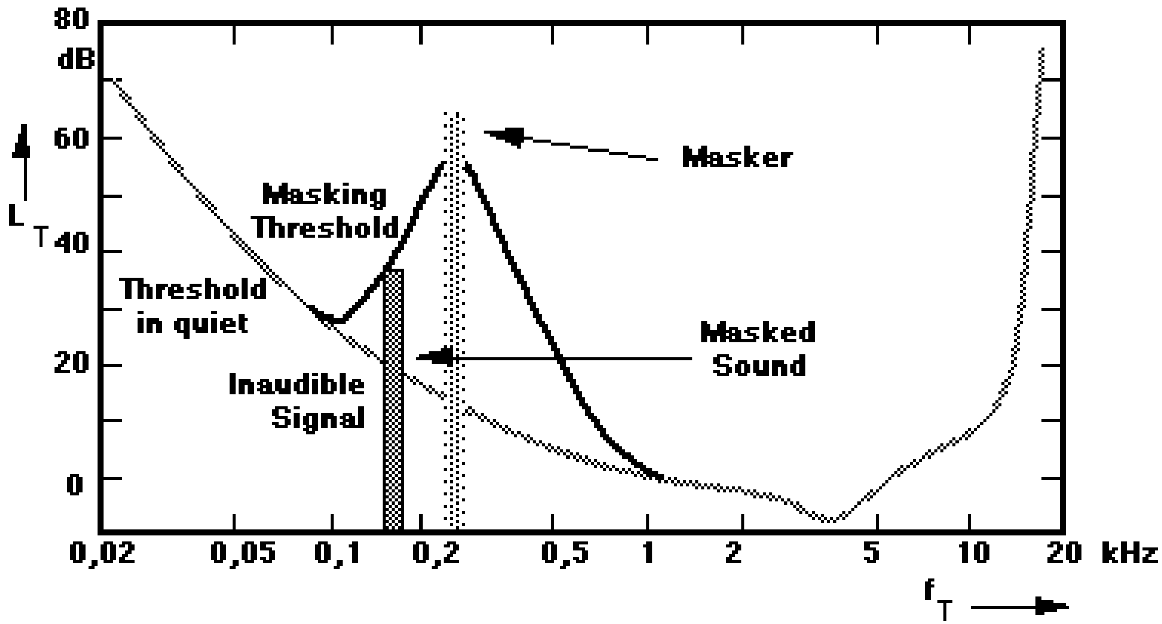
Basic Audio Coding

- Sample at twice the highest frequency
  - 8 bits or 16 bits per sample

- Speech (0-4 kHz) requires 8 kB/s
  - Standard telephone channel (1-byte samples)
- Music (0-22 kHz) requires 172 kB/s
  - Standard for CD-quality audio (2-byte samples)

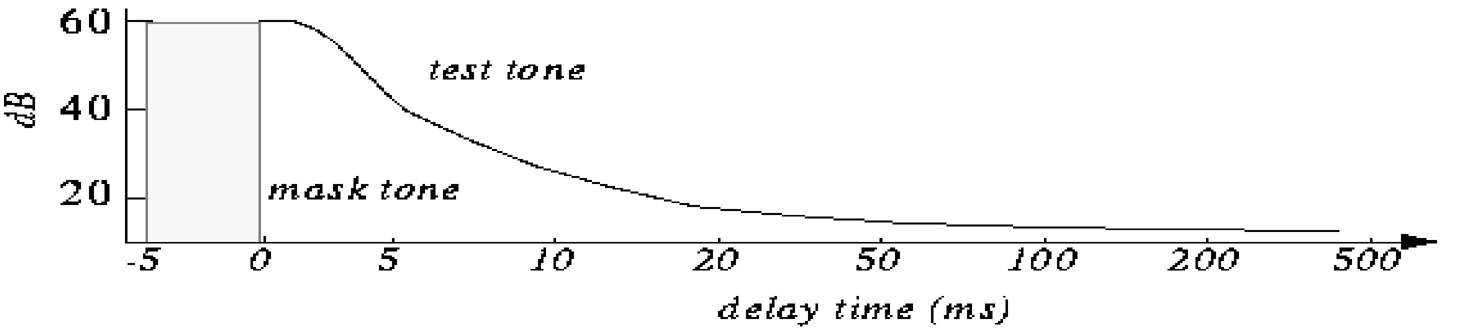
Music Compression

- Opportunity:
  - The human ear cannot hear all frequencies at once
- Approach:
  - Don’t represent “masked” frequencies
- Standard: MPEG-1 Layer 3 (.mp3)



Temporal Masking

If we hear a loud sound, then it stops, it takes a while until we can hear a soft tone at about the same frequency.



"Psychoacoustic compression"

- Eliminate sounds below threshold of hearing
- Eliminate sounds that are frequency masked
- Eliminate sounds that are temporally masked
- Eliminate stereo information for low frequencies

Speech Compression

- Opportunity:
  - Human voices vary in predictable ways
- Approach:
  - Predict what's next, then send only any corrections
- Standards:
  - Rule of thumb: 1 kB/sec for (highly compressed) speech
- Demo at http://www.data-compression.com/speech.html
  - Scroll down to near the bottom

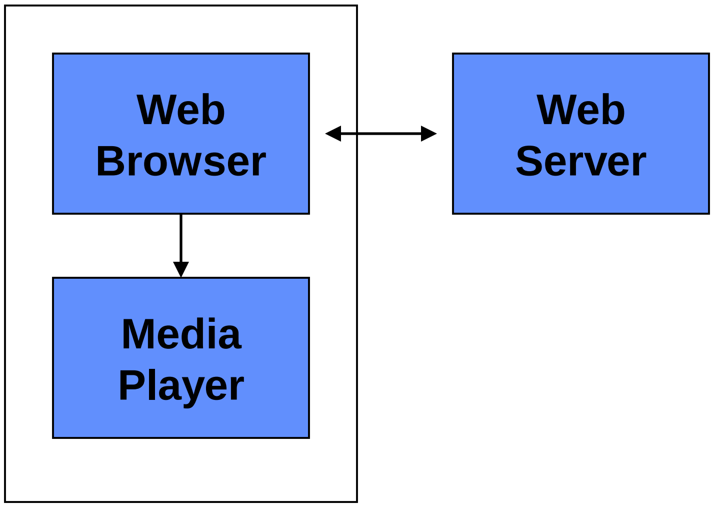
Narrated PowerPoint

- Create your slides
- Slide Show -> Record Slide Show
  - Set microphone level
- Record the narration
  - Slide transitions are automatically captured
- Narration plays automatically when displayed

The “Last Mile”

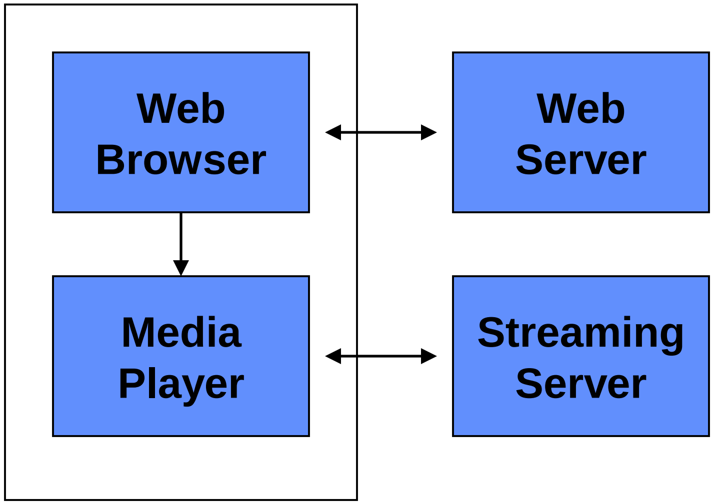
- Traditional modems
  - “56” kb/sec modems really move ~3 kB/sec
- Digital Subscriber Lines
  - 384 kb/sec downloads (~38 kB/sec)
  - 128 kb/sec uploads (~12 kB/sec)
- Cable modems
  - 10 Mb/sec downloads (~1 MB/sec)
  - 256 kb/sec uploads (~25kB/sec)

Multimedia on a Web Server



- Object stored in a file
- File transferred as an HTTP object:
  - Received entirely at the client
  - Passed to media player

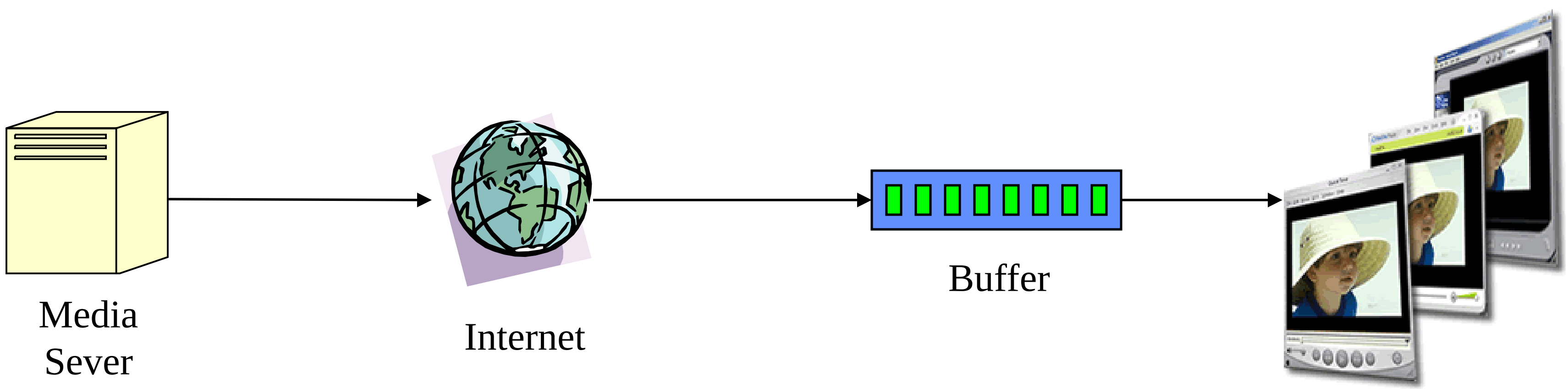
Streaming



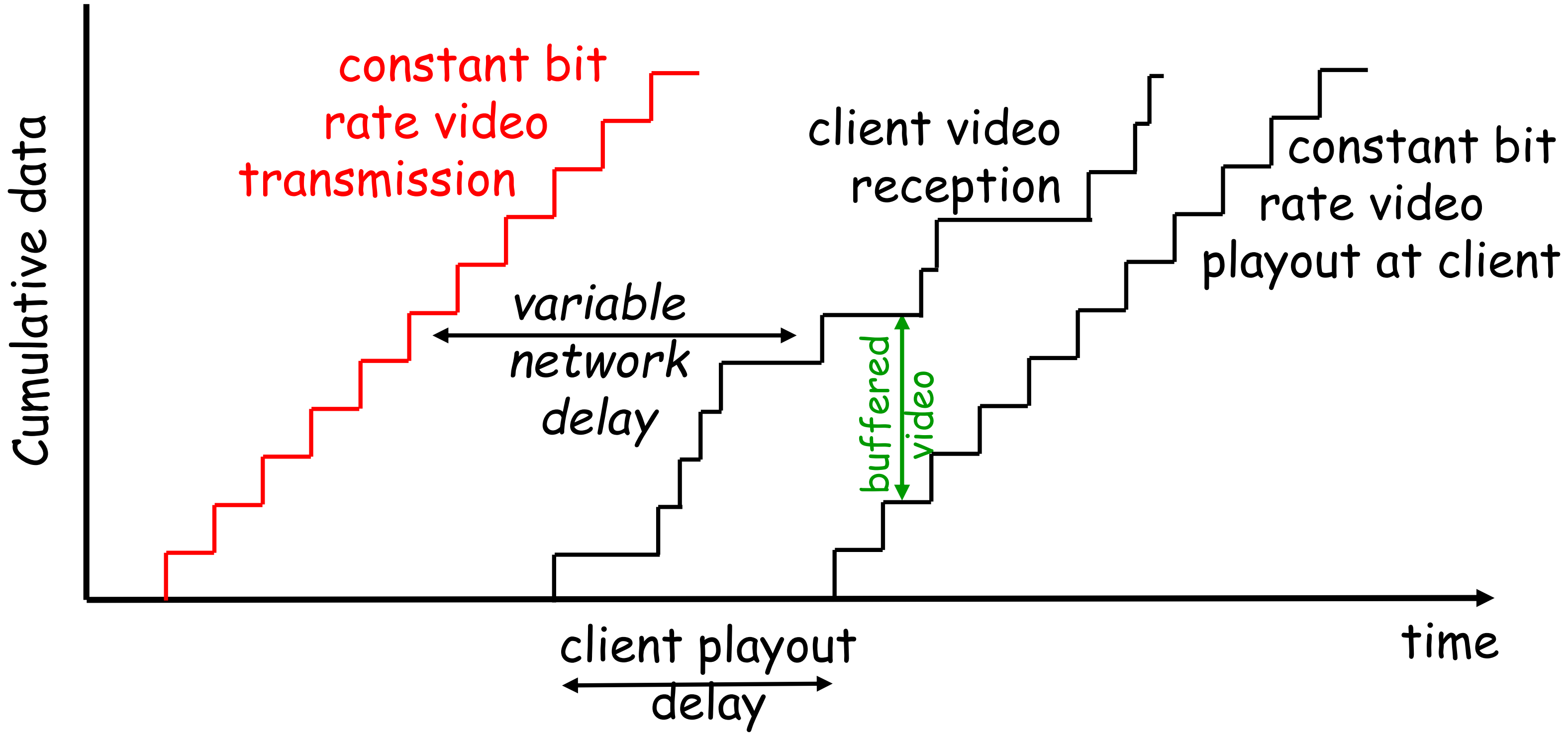
- Browser gets metafile over HTTP
  - Launches media player to interpret the metafile
- Media player contacts streaming server

Streaming Audio and Video

- Begin replay after only a portion received
- Buffer provides time to recover lost packets
- Interrupts replay when “rebuffering”



Client Buffering



- Client-side buffering:
  - Playout delay compensates for network delay

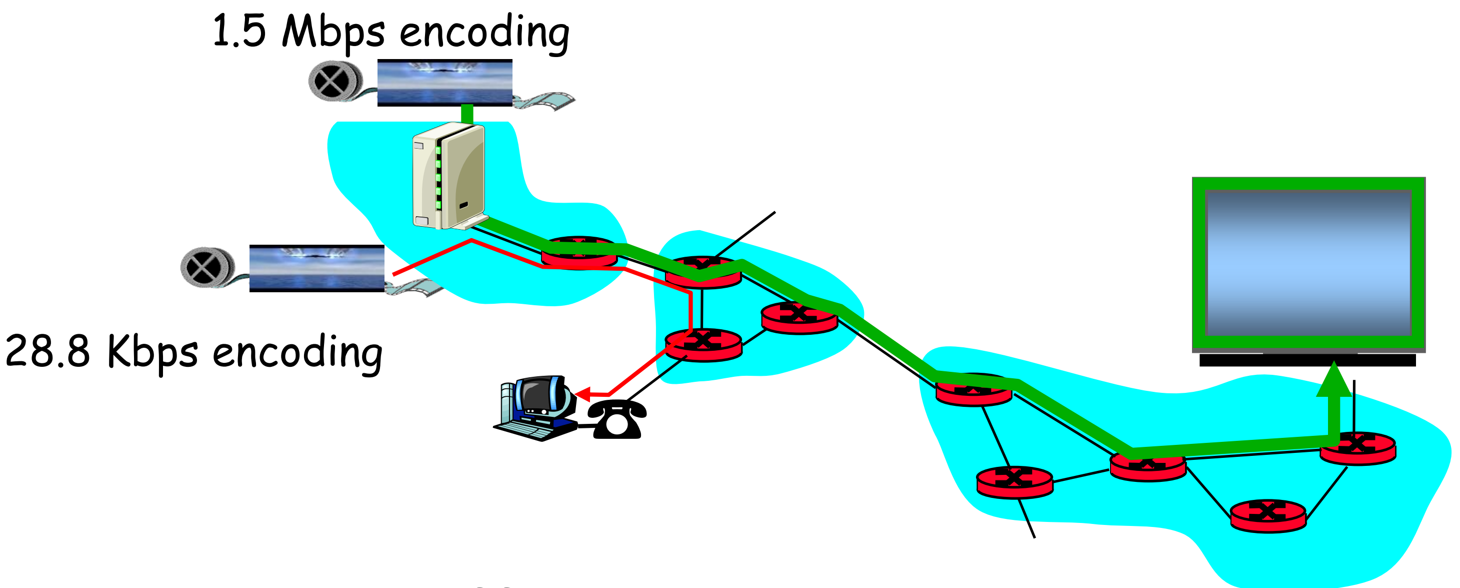
Playout Delay

- Receiver attempts to playout each chunk exactly q ms after chunk was generated
  - Chunk has time stamp t: play out chunk at $t+q$
  - Arrives after $t+q$: too late for playout, data “lost”
- Tradeoff for q:
  - Large q: less packet loss
  - Small q: better interactive experience
- Easy to increase q by inserting a pause
  - Decreasing q requires skipping or accelerating

Lost Packets

- Network loss
  - Packets completely lost (e.g., due to collisions)
- Delay loss
  - Packets arrives too late for playout
    - Queueing; sender and receiver processing delays
- Loss tolerance
  - 1% to 10% packet loss may be tolerable
    - Some encoding schemes are more tolerant than others

Multiple Client Rates

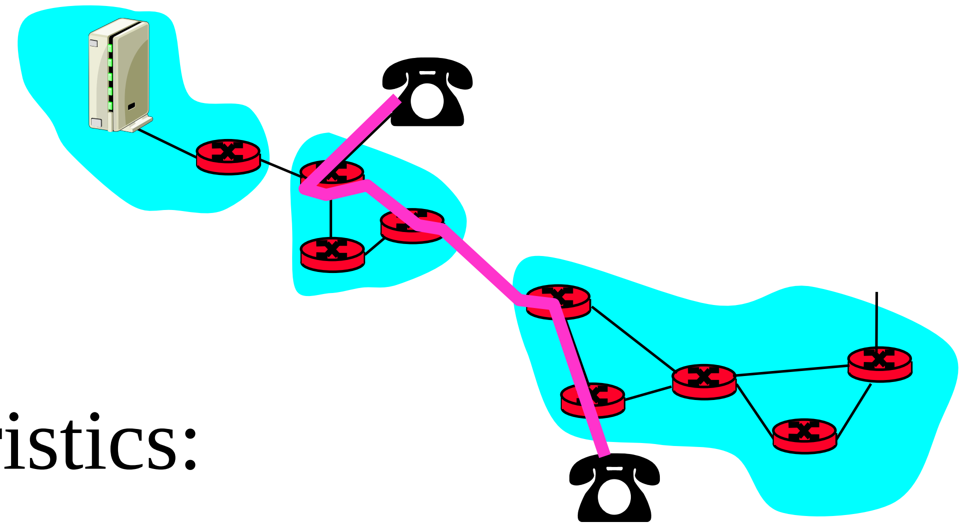


Q: how to handle different client receive rate capabilities?

- 28.8 Kbps dialup
- 100Mbps Ethernet

A: server stores, transmits multiple copies of video, encoded at different rates

Internet Telephony



- Characteristics:
  - “Live” (<400 ms delay)
  - Alternating talk spurts

Before You Go!

- On a sheet of paper (no names), answer the following question:

  What was the muddiest point in today's class?