Week 10: Application Layer

Internet Technologies COMP90007

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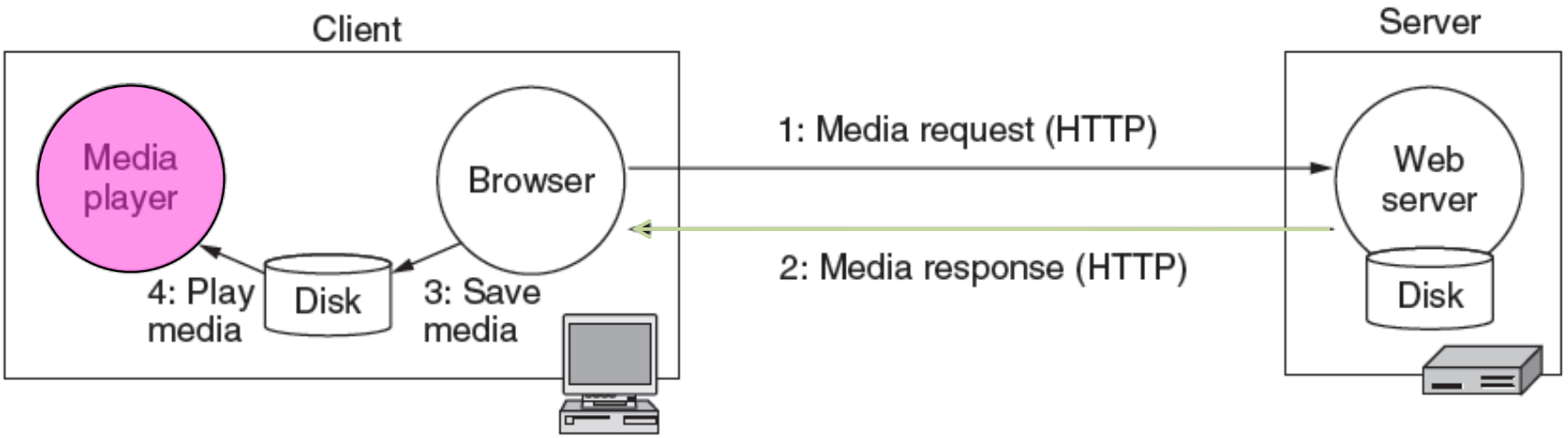
A Key Application Layer Worry: **Dealing with Multimedia Data**

- What is different with Multimedia data?
  - Higher bandwidth requirements
  - Higher QoS requirement, i.e., ***delay sensitivity***

Delivery Through Specialized Companies

- Separate providers
  - Not all communication is one-to-one, quite a bit is multicast/broadcast which is different to most traffic
  - Specialized infrastructure also needs special attention
    - We use separate multimedia servers from web servers: Streaming multimedia service providers are often separated and highly specialised, compared to traditional web hosts

A Basic Model for Multimedia on the Web



Problems with the Basic Model

- The entire media file must be transmitted over the network before playback starts
  - Imagine waiting for all the movie to come to your side for everything you watch: That is not tolerable

Problems with the Basic Model

- Basic model assumes mainly point-to-point data distribution rather than a point-to-multipoint (broadcast) distribution model
  - Recall special methods for efficient multicast; none can be used if we do not realize this special need/mode

Problems with the Basic Model

- Basic model relies on simple browser/plugin/helper integration and traditional service types:
  - This limits the capabilities of the software for delivery

Streaming Media Protocols

- HTTP
- RTP - Real-time Transport Protocol (works over UDP allows for time-stamping etc)
- …
- MPEG-4 (allows for compression)
- …
- Microsoft's Windows Media (closed protocol)
- …
- …***many of these protocols may be used at one time to achieve a successful media stream…***

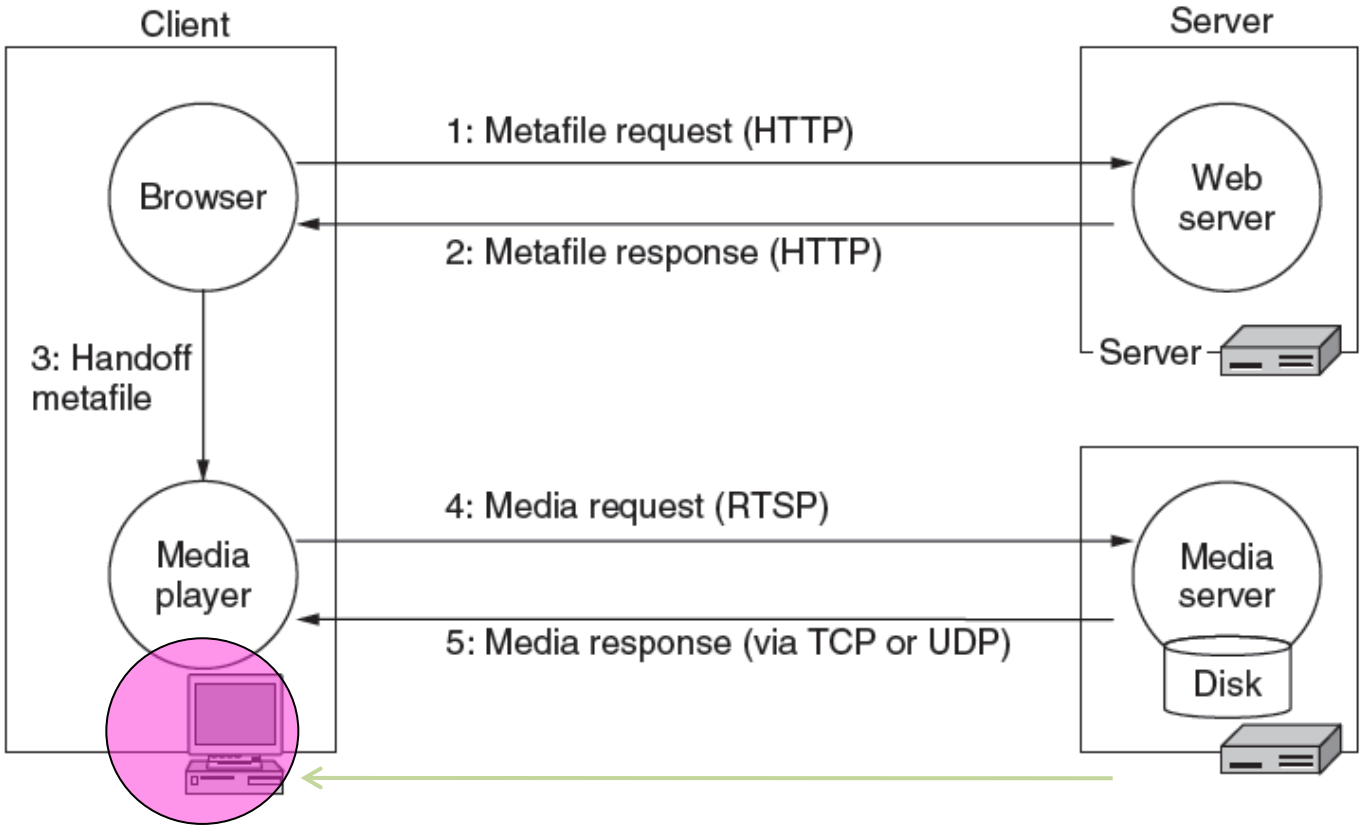
Specialized Multimedia Software

- 4 main tasks of the multimedia playback software
  - First is to deal with the user interface side of the story
    - Functions such as volume control, playback, next, etc..
    - This is commonly what most people see/know
    - But there are 3 others that are less about the UI/controls

Specialized Multimedia Software Contd

- Others are:
  - Handle transmission errors in conjunction with transport protocols
    - Using RTP/UDP errors will likely occur, playback software must manage/mask them gracefully
  - Eliminate jitter
    - Small buffer, quick playback but susceptible to jitter/delay
    - Large buffer, delay at start of playback while buffer fills, but less susceptible to delay/jitter
  - Sometimes compress and almost always decompress the multimedia files to reduce size

Specialized Model



Handling Errors: A Common Method

Forward Error Correction (FEC) is simply the error-correcting encoding of data

For every X data packets Y **new packets are added similar to methods we have seen**

These contains **redundant bits that are used to deal with errors**

Methods use **parity or exclusive-OR** sums of the bits in each of the data packets but are more complex than methods we saw so far

Examples are Reed-Solomon, Tornado codes, etc.

Handling Errors: Other Directions

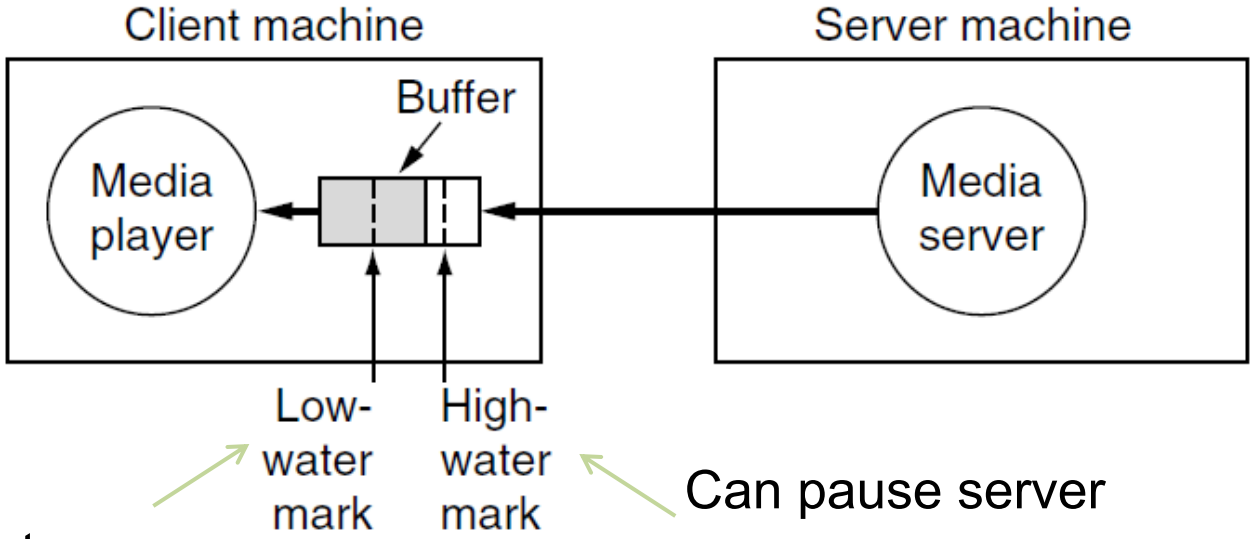
Error Resilience: Remarking for re-sync so that a packet loss does not create a total loss, mainly on sender side

Error Concealment: Done by the receiver e.g., interpolation between frames to reduce displeasing experiences

Retransmission: Less meaningful for streaming data but for watching a movie this can be deployed for lost packets of the movie

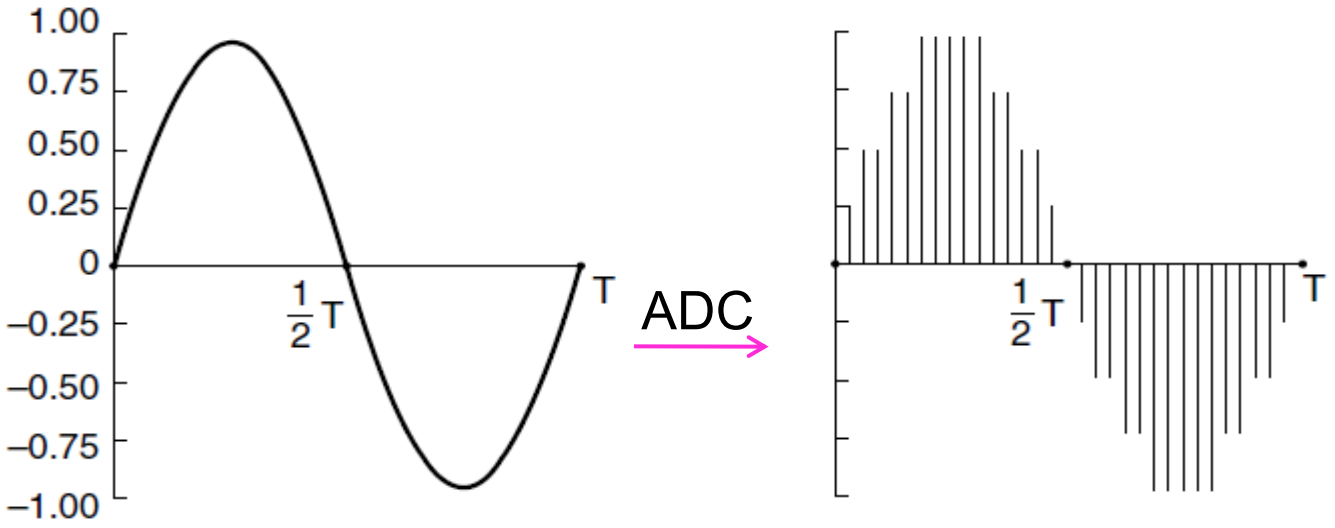
Jitter Management is Crucial for Multimedia

Jitters happens because of variable bandwidth and loss/retransmissions. So ***we use buffers…***



Dealing with Large File: Compression

ADC (Analog-to-Digital Converter) produces digital data, say from a microphone



Continuous audio (sine wave)

Digital audio (sampling theory in play)

Example: Audio Compression

- We can use Nyquist and Shannon theorems again: to convert analog data to digital first

- Then apply techniques to eliminate some data…

For example: **perceptual coding** is that some data can mask other data, e.g., in audio, which can be used to eliminate the data

- **Frequency masking**: Some sounds mask/hide others so there is no point encoding them
- **Temporal masking**: Human ears can miss soft sounds immediately after loud sounds, takes time for the ear to adjust, no need to store them either

An Example Format: MP3

- MP3 is MPEG Audio Layer 3
- MP3's compression is **based on perceptual coding**
- MP3 audio compression results in significant **file size savings without a perceived loss of audio quality**
- Typical MP3 audio compression rates for CD quality audio reduce the need for bandwidth **from 1.4Mbps for stereo down to 96-128Kbps**

For Digital Video

- Video is digitized as pixels
  - TV quality: 640x480 pixels, 24-bit color, 30 times/sec ~ 200Mbs uncompressed
- Video is sent compressed due to its large bandwidth requirements
  - Lossy compression exploits human perception
    - E.g., JPEG for still images, MPEG for video
  - Large compression ratios achieved (often 50X for video)

Compression with JPEG

- JPEG lossy compression
- JPEG often provides compression ratios of 20:1
- JPEG compression is **symmetric, decoding takes as long as encoding**
- This is not the case in all types of compression

MPEG

- MPEG - Motion Picture Experts Group
- MPEG can compress both audio and video together
- The evolution of MPEG:
  - MPEG-1: VCR quality at 1.2 Mbps (40:1)
  - MPEG-2: Broadcast quality at 4-6Mbps (200:1)
  - MPEG-4: DVD quality at 10Mbps (1200:1)