Augmented Reality & Video Service Emerging Technologies

Video Streaming & MPEG-DASH

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Video Streaming & MPEG-DASH

Video Frames & HTTP

Adaptive Media Streaming

❖ Video frames

- I frame (Intra-coded frame)
  - Independently encoded picture
- P frame (Predicted frame)
  - Depends on one previously decoded I or P frame
- B frame (Bi-predictive frame)
  - Depends on multiple previously decoded pictures
- P and B frames have a high compression rate
  - Encodes the motion-compensated differences (relative information) of other frames

Adaptive Media Streaming

❖ Video frames

- Video fragments are made of one or multiple GoPs
  - GoP: Group of Pictures
- Each GOP (Group of Pictures) begins with an I frame followed by P (or B) frames
  - This results in a much smaller video file size compared to using all I frames
  - Very high data compression rate is achieved due to the P and B frames in the GOP

Adaptive Media Streaming

❖ Video frames

- GoP Types
  - Closed GoP
    - P (and B) frame decoding depends only on frames within its GoP
  - Open GoP
    - P (and B) frame decoding may depend on frames of other GoPs

Adaptive Media Streaming

❖ HTTP Progressive Download

- One of the most widely used pull-based media streaming methods
- Used in almost all applications and web services over the Internet

DASH (Dynamic Adaptive Streaming over HTTP)

❖ **YouTube uses HTTP over TCP**

- TCP supports recovery of errors reordering of data segments ➔ Erroneous and Lost packets are recovered by TCP
- YouTube needs to provide adaptive transmission control to avoid video stalling ➔ MPEG-DASH

DASH (Dynamic Adaptive Streaming over HTTP)

❖ **Pull Based Media Streaming**

- HTTP (Hypertext Transfer Protocol) is the most common protocol for pull based media delivery
- Media client is the active entity that requests content from the media server
- Server response depends on the request from the client

DASH (Dynamic Adaptive Streaming over HTTP)

❖ Push Based Media Streaming

- Client decides the bitrate to receive the media packets
- Bitrate deciding factors
  - Buffer status of the client
  - Available network data transfer rate and delay

DASH (Dynamic Adaptive Streaming over HTTP)

❖ HTTP (Hypertext Transfer Protocol)

- HTTP is an application protocol that enables data communication for the WWW (World Wide Web)
- HTTP supports distributed, collaborative, hypermedia information systems
- HTTP is the protocol used to exchange or transfer hypertext

HTTP (Hypertext Transfer Protocol)

❖ HTTP (Hypertext Transfer Protocol)

- Hypertext is structured text (i.e., text with a special format) that uses hyperlinks (e.g., web site address) between PCs, smartphones, and servers

HTTP (Hypertext Transfer Protocol)

❖ HTTP History

- Created in 1989 by Sir Tim Berners-Lee from CERN (European Organization for Nuclear Research = Conseil Européen pour la Recherche Nucléaire)
- Standardized by the IETF (Internet Engineering Task Force) and the W3C (World Wide Web Consortium)

HTTP (Hypertext Transfer Protocol)

❖ HTTP Version

- HTTP/1.0 is the original HTTP
- HTTP/1.0 makes a separate connection to the same server for every resource request received
- HTTP/1.1 was standardized as RFC 2068 in 1997
- HTTP/1.1 can reuse a connection multiple times for downloading video, audio, data, etc.

HTTP (Hypertext Transfer Protocol)

❖ HTTP Version

- HTTP/1.1 was revised and RFC 2068 was obsoleted (replaced) by RFC 2616 in 1999
- HTTP/1.1 is the commonly used HTTP version in the Internet
- HTTP/2 was standardized in 2015, which is now supported by major web servers

HTTP (Hypertext Transfer Protocol)

❖ HTTP

- HTTP functions as a request–response protocol in the client–server computing model
- Example
  - Client ➔ Web browser
  - Server ➔ Application running on a computer hosting a web site

HTTP (Hypertext Transfer Protocol)

❖ HTTP

- Client sends a HTTP request message to the Server

HTTP (Hypertext Transfer Protocol)

❖ **HTTP**

- Server provides resources (e.g., HTML files and video content) or functions to the Client
- Server sends back a response message to the Client
- Server's response includes status information of the request processed

HTTP (Hypertext Transfer Protocol)

❖ **HTTP**

- HTTP permits intermediate network elements to improve or enable communications between the Client and Server
- HTTP is an application layer protocol that needs a reliable transport layer protocol like TCP (Transmission Control Protocol)

HTTP (Hypertext Transfer Protocol)

❖ **HTTP**

- HTTP can also use unreliable protocols like UDP (User Datagram Protocol) as in HTTPU and SSDP (Simple Service Discovery Protocol)

HTTP (Hypertext Transfer Protocol)

❖ **HTTP**

- HTTP resources are identified in the Internet using an URL (Uniform Resource Locator)
- URLs use the URI (Uniform Resource Identifier) of http and https
- URIs and hyperlinks in HTML (Hypertext Markup Language) documents form inter-linked hypertext documents

HTTP (Hypertext Transfer Protocol)

❖ HTTP Pros

- Security Friendly
  - HTTP is commonly supported by firewalls, so connection blocking due to security issues rarely occur
  - Client (i.e., PC, Smartphone, etc.) device controls the streaming
  - Server does not need to maintain session state information of the Client device

HTTP (Hypertext Transfer Protocol)

❖ HTTP Pros

- HTTP/1.1 can reuse a connection multiple times for downloading video, audio, data, etc.
  - Popular websites can benefit from web cache servers
    - Can send previously stored content on behalf of an upstream server to reduce the response time
  - HTTP proxy servers at private network boundaries can facilitate communication for clients without a globally routable address
    - Enabled by relaying messages with external servers

Adaptive HTTP-Streaming

❖ Adaptive HTTP-Streaming

- Combination of Adaptive Video Rate Control & Progressive Downloading
- Adaptive HTTP-Streaming based Proprietary Services
  - Microsoft Smooth Streaming
  - Adobe HTTP Dynamic Streaming
  - Apple HTTP Live Streaming

Adaptive HTTP-Streaming Operations

❖ Adaptive HTTP-Streaming

- Combination of Adaptive Video Rate Control & Progressive Downloading
- Several representations with different quality (resolution and bitrate levels) of the same video are stored in the server
- Videos are commonly divided into fragments of 2~10 s in length

Adaptive HTTP-Streaming Operations

❖ Adaptive HTTP-Streaming

- Client device periodically checks the network's conditions every 2~10 s and may make changes
- Client device tries to avoid video stalling due to an empty buffer (buffer starvation)
  - Selects the video player quality level at a slightly lower bitrate than the bitrate supported by the network
  - Has the effect of saving network bandwidth

Adaptive HTTP-Streaming Operations

❖ Adaptive HTTP Streaming Phases

- Phase 1: Burst Downloading Phase
  - Very fast client buffer fill up
  - Quick video play back
- Phase 2: Throttle Downloading Phase
  - Maintain buffer fill-up level to avoid video stalling