Outline

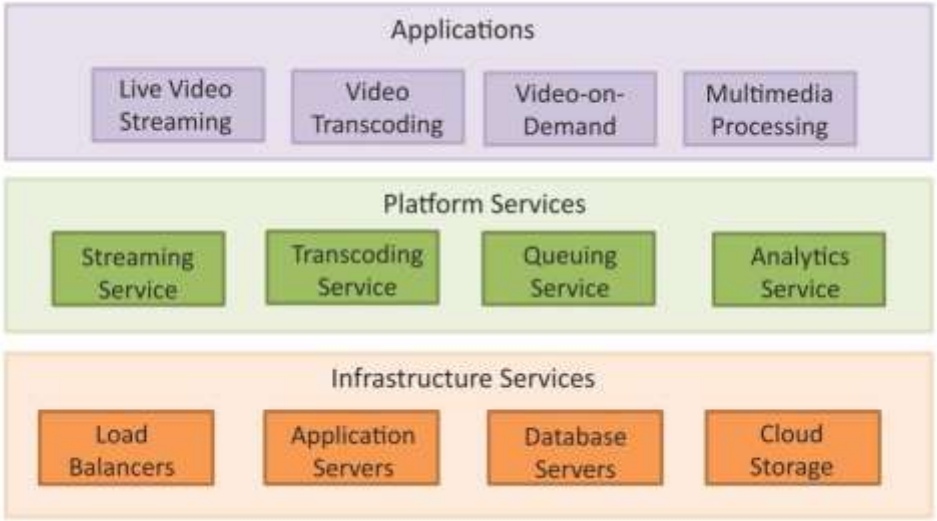
- Reference architecture for Multimedia Cloud
- Case study of a live video streaming cloud application
- Case study of a video transcoding cloud application

Design methodology for PaaS service model

- For applications that use the Platform-as-a-service (PaaS) cloud service model, the architecture and deployment design steps are not required since the platform takes care of the architecture and deployment.
- Component Design
  - In the component design step, the developers have to take into consideration the platform specific features.
- Platform Specific Software
  - Different PaaS offerings such as Google App Engine, Windows Azure Web Sites, etc., provide platform specific software development kits (SDKs) for developing cloud applications.
- Sandbox Environments
  - Applications designed for specific PaaS offerings run in sandbox environments and are allowed to perform only those actions that do not interfere with the performance of other applications.
- Deployment & Scaling
  - The deployment and scaling is handled by the platform while the developers focus on the application development using the platform-specific SDKs.
- Portability
  - Portability is a major constraint for PaaS based applications as it is difficult to move the

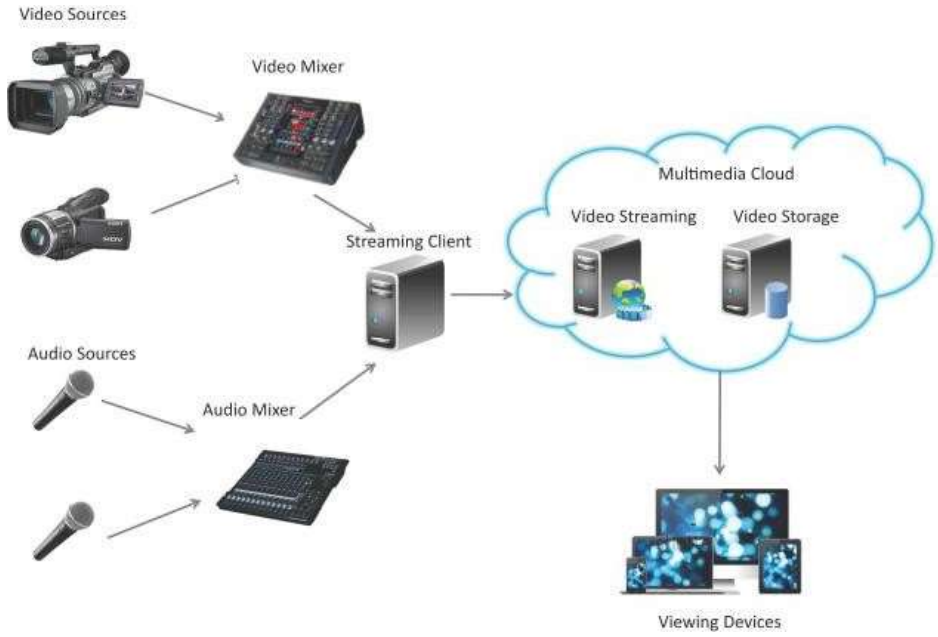
Multimedia Cloud Reference Architecture

- Infrastructure Services
  - In the Multimedia Cloud reference architecture, the first layer is the infrastructure services layer that includes computing and storage resources.
- Platform Services
  - On top of the infrastructure services layer is the platform services layer that includes frameworks and services for streaming and associated tasks such as transcoding and analytics that can be leveraged for rapid development of multimedia applications.
- Applications
  - The topmost layer is the applications such as live video streaming, video transcoding, video-on-demand, multimedia processing etc.
  - Cloud-based multimedia applications alleviates the burden of installing and maintaining multimedia applications locally on the multimedia consumption devices (desktops, tablets, smartphone, etc) and provide access to rich multimedia content.
- Service Models
  - A multimedia cloud can have various service models such as IaaS, PaaS and SaaS that offer infrastructure, platform or application services.



Multimedia Cloud - Live Video Streaming

- Workflow of a live video streaming application that uses multimedia cloud:
  - The video and audio feeds generated by a number cameras and microphones are mixed/multiplexed with video/audio mixers and then encoded by a client application which then sends the encoded feeds to the multimedia cloud.
  - On the cloud, streaming instances are created on-demand and the streams are then broadcast over the internet.
  - The streaming instances also record the event streams which are later moved to the cloud storage for video archiving.



Workflow for live video streaming using multimedia cloud

Streaming Protocols

- RTMP Dynamic Streaming (Unicast)
  - High-quality, low-latency media streaming with support for live and on-demand and full adaptive bitrate.
- RTMPE (encrypted RTMP)
  - Real-time encryption of RTMP.
- RTMFP (multicast)
  - IP multicast encrypted with support for both ASM or SSM multicast for multicast-enabled network.
- RTMFP (P2P)
  - P2P live video delivery between Flash Player clients.
- RTMFP (multicast fusion)
  - IP and P2P working together to support higher QoS within enterprise networks.
- HTTP Dynamic Streaming (HDS)
  - Enabling on-demand and live adaptive bitrate video streaming of standards-based MP4 media over regular HTTP connections.
- Protected HTTP Dynamic Streaming (PHDS)
  - Real-time encryption of HDS.
- HTTP Live Streaming (HLS)
  - HTTP streaming to iOS devices or devices that support the HLS format; optional encryption with AES128 encryption standard.

RTMP Streaming

- Real Time Messaging Protocol (RTMP) is a protocol for streaming audio, video and data over the Internet.
- The plain version of RTMP protocol works on top of TCP. RTMPS is a secure variation of RTMP that works over TLS/SSL.
- RTMP provides a bidirectional message multiplex service over a reliable stream transport, such as TCP.
- RTMP maintains persistent TCP connections that allow low-latency communication.
- RTMP is intended to carry parallel streams of video, audio, and data messages, with associated timing information, between a pair of communicating peers.
- Streams are split into fragments so that delivery of the streams smoothly.
- The size of the stream fragments is either fixed or negotiated dynamically between the client and server.
- Default fragment sizes used are 64-bytes for audio data, and 128 bytes for video data.
- RTMP implementations typically assign different priorities to different classes of messages, which can affect the order in which messages are enqueued to the underlying stream transport when transport capacity is constrained.

HTTP Live Streaming

- HTTP Live Streaming (HLS) can dynamically adjust playback quality to match the available speed of wired or wireless networks.
- HLS supports multiple alternate streams at different bit rates, and the client software can switch streams intelligently as network bandwidth changes.
- HLS also provides for media encryption and user authentication over HTTPS, allowing publishers to protect their work.
- The protocol works by splitting the stream into small chunks which are specified in a playlist file.
- Playlist file is an ordered list of media URIs and informational tags.
- The URIs and their associated tags specify a series of media segments.
- To play the stream, the client first obtains the playlist file and then obtains and plays each media segment in the playlist.

HTTP Dynamic Streaming

- HTTP Dynamic Streaming (HDS) enables on-demand and live adaptive bitrate video delivery of standards-based MP4 media (H.264 or VPC) over regular HTTP connections.
- HDS combines HTTP (progressive download) and RTMP (streaming download) to provide the ability to deliver video content in a steaming manner over HTTP.
- HDS supports adaptive bitrate which allows HDS to detect the client's bandwidth and computer resources and serve content fragments encoded at the most appropriate bitrate for the best viewing experience.
- HDS supports high-definition video up to 1080p, with bitrates from 700 kbps up to and beyond 6 Mbps, using either H.264 or VP6 video codecs, or AAC and MP3 audio codecs.
- HDS allows leveraging existing caching infrastructures, content delivery networks (CDNs) and standard HTTP server hardware to deliver on-demand and live content.