HLSaaS: High-Level Video Streaming as a Service

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- Video streaming constitutes approximately 64% of all the U.S. Internet traffic in 2014 [1].
- Cisco estimates that the streaming traffic will increase to 80% by 2019 [2].


Basic Video Streaming: Video On-Demand vs Live-Streaming

Video On Demand (VOD)

Live Streaming
High-Level Video Streaming Services: Viewer Requirements

- Alice wants to remove the inappropriate contents from videos dynamically for her kids!
High-Level Video Streaming Services: Publisher Requirements

- Bob wants to blur accidentally captured entities in the video
- Bob wants to watermark videos with his company logo
High-Level Video Streaming Services: Streaming provider requirements

- Convert (transcode) videos based on the client devices characteristics
Challenges in Providing High-Level Video Streaming

• Video processing is computationally expensive

• Video processing has to be done in a real-time manner

• To address these challenges stream providers are becoming reliant on cloud services
- Storage solutions
- Hardware failover
- Networking infrastructure

- Video contents
- Customer experience
Challenges in Utilizing Clouds

- **Minimum cost while maintaining QoS**
- **What are the QoS demands?**

1. No delay in the stream (minimum drop rate)
   - Video processing task should complete within individual deadlines
   - In live streaming missing deadline dropped

2. Minimum start up delay
   - Users judge the quality based on the startup delay
HLSaaS Architecture

• Accepts any high-level video processing request

• It allocates resources from cloud
  – Based on the requested high-level video processing service
  – Based on the workload

• Maintains QoS

• Incurs minimum cost to the provider
Structure of Video Streams

- Videos are streamed as a sequence of segments
- Group Of Pictures (GOP)
  - The unit we consider for processing
HLSaaS Architecture

Estimate GOP processing time

Live Streaming Providers (e.g. Ustream, Livestream)

Video Splitter → Time Estimator → GOP Scheduler

QoS-aware Scheduling method

Video Mergers
HLSaaS Architecture

Elasticity Manager
QoS and cost aware
Work Completed*: On-Demand Transcoding of Video Streams

• Focusing on the stream provider request

• Video transcoding:
  – Converting the video stream to match the characteristics of client devices

• Examples: resolution, codec, bit-rate, frame rate

* CVSS: Cost-efficient and QoD-aware Video Streaming Using Cloud Services, Accepted in IEEE/ACM CCGrid ’16 conference
Netflix Solution for Transcoding: Pre-Transcode

- 5 regional catalogs
- 4 formats supported today
  - 1 VC-1, 3 H.264
  - Multiple bit rates per format
- 10’s of 1000’s of hours of content
- Several petabytes of S3 storage

Long Tail Property of Video Streaming

- We do not need to pre-transcode all videos
- Pre-transcode just for the “trendy” videos
  - The rest can be transcoded “lazily”!
HLSaaS Architecture

QoS-Aware Scheduling Method

Dynamic cost-efficient provisioning policy
QoS-Aware Scheduling Method

Step 1: Search for the shortest completion time VM.
Step 2: Insert GOP from startup queue in front of the GOP in the batch queue.
Step 3: Check if the GOP in the batch queue will miss deadline or not.
Dynamic Cost-Efficient Provisioning Policy

I. Periodic Provisioning Policy

\[ \alpha < \text{deadline miss rate} < \beta \]

II. Remedial Provisioning Policy

• We quickly determine the workload intensity using startup queue
Our dynamic system keeps the QoS violation constantly low and stable in comparison with static methods.

Our method saves cost when the system is not oversubscribed.
Future Directions

1. Different video types have affinities with various services offered by cloud providers
   – Creating a heterogeneous VM cluster!

2. Mixing the idea of HLSaaS with Content Delivery Networks (CDN)

3. Support live streaming and VOD in one system
   – Schedule within a single pool of tasks
Thank You!

Questions?