Feeding An Army: How To Build A Live Video Platform For 40,000+ Concurrent Channels

Ivan Marcin, Yueshi Shen | May 2017, Streaming Media East
About Speakers

Ivan Marcin
Senior Engineering Manager

- Oversees Twitch’s ingest team
- Responsible for scaling RTMP video ingest servers, transcoding server farms, http origin servers, and broadcaster real-time data analytics

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Yueshi Shen
Principal Research Engineer

- Oversees Twitch’s transcoder team
- Responsible for low-level video technologies and QoS: codec, HLS, ABR playback, video quality, low latency

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What is Twitch.TV

social video platform
Interactive Live & VOD
What is Twitch?

Social Video Platform
Interactive Live Video
Video on Demand
Community for Gamers and Creative Arts
Games, eSports and Original Content
What is Twitch.tv? (By the Numbers)

- **9.7 million** daily active users
- **2+ million** unique streamers per month
- **292 billion** total minutes watched in 2016
- **2+ million** peak concurrent sitewide viewers
Twitch’s Live Video Infrastructure

40k+ peak concurrent channels

2+ million peak concurrent viewers
Realization

giving transcoding to our users would help our broadcasters give viewers a better user experience.
Problem

How to scale encoding (transcoding) to all broadcasters

40K+ concurrent streams
2 million+ unique streams/month.
Twitch’s Encoding 2015

Transmux => $ (~95% of users)
Input bit rate = Output bitrate
Broadcasters have to stream at lower bitrates for increased audience.
2 mbps recommended input

Transcode => $$$$$ (~5% of users)
Better availability to viewers with low bandwidth
Better support for higher bitrate input for broadcasters
3.5 mbps recommended input
Challenges

Why is scaling 40K on demand concurrent streams is so different than 50-100

Unfeasible via classical scaling

- Hard to provisioning for peak load + peak times X as overhead.
- Exponential Bandwidth consumption: Input bitrate replicates across many POPS

Variable Workloads

- Thundering herds (mass video ingestions)
- Mass broadcasters streaming newly released games
- Charity broadcasting marathons

High Cost

- Software encoding and bandwidth are very expensive.
Scaling Up (w/ less hardware)

- Ingest Edges (20+ countries)
- Live video/workload services
- Transcode Predictions Service
- Workload mgmt services
- Hardware Transcode Server clusters
- Custom built X264 encoder
- Video serving Origin
- Playlist and Delivery Services
- Live Replication Twitch CDN (20+ countries)
Our Live Stream Transcoder (2015)

In-house software
Run in Twitch’s data center
SW-based H.264 encoder
<5% transcode due to cost

Transcode:
1080p60
720p60
720p30
480p30
360p30
160p30

Transmux:
1080p60
Shop for A Transcoder Solution

**Cost, Cost, Cost!!!**

- 3-year TCO target: \( \frac{1}{5} \) of the original SW solution

**Stability**

- Longevity, robustness against malformatted H.264

**Video quality**

- Baseline: x264 veryfast,
  - Twitch’s test content: https://media.xiph.org/video/derf/

**Software integration**

- API for H.264 transcoding, inserting IDR, rate control
- MTBF, spare part logistics, Linux server, NetBoot, IPMI
- Server product, SW bring-up

**Automated Operation**

**Time to market**
# Shopping for Hardware is Hard

Reviewed a dozen of transcoder solutions (for our purpose):

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Cloud</th>
<th>Software</th>
<th>ASIC</th>
<th>GPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pros</td>
<td>Flexible</td>
<td>Easy to deploy, good video quality</td>
<td>Great density, low power rate (OPEX)</td>
<td>Great density, off-the-shelf server products</td>
</tr>
<tr>
<td>Cons</td>
<td>Instance cost is already high, egress traffic cost is huge</td>
<td>Low density</td>
<td>Need custom-built server</td>
<td>Video quality not as great</td>
</tr>
</tbody>
</table>
Nvidia NVDEC/ENC

NVDEC/ENC: a video codec feature in all Nvidia GPUs since Kepler

H.264 codec 100% implemented in ASIC

Tested Quadro M5000, Tesla M60 (Maxwell)

Extremely high encoder density

Good video quality (SDK release after 03/2016)
Nvidia NVENC (Video Quality)
Nvidia NVDEC/ENC

Not enough density for transcoding - decoder density too low

Excited to test their new-gen (Pascal) Tesla P4
Intel QuickSync

QuickSync: video codec HW core since Sandy Bridge

Hybrid implementation of H.264 codec in ASIC and GPGPU

Significant density improvement since Broadwell (6 ABR per CPU/GPU)

Xeon-E3-based server products offered by a few vendors
# Intel QuickSync (which SKU)

<table>
<thead>
<tr>
<th>4 Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® Xeon® Processor E3-1285L v4</td>
</tr>
<tr>
<td>Intel® Xeon® Processor E3-1285 v4</td>
</tr>
<tr>
<td>Intel® Xeon® Processor E3-1265L v4</td>
</tr>
<tr>
<td>Intel® Xeon® Processor E3-1278L v4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vertical Segment</th>
<th>Server</th>
<th>Server</th>
<th>Server</th>
<th>Embedded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphics Base Frequency</td>
<td>300.00 MHz</td>
<td>300.00 MHz</td>
<td>300.00 MHz</td>
<td>800.00 MHz</td>
</tr>
<tr>
<td>Graphics Max Dynamic Frequency</td>
<td>1.15 GHz</td>
<td>1.15 GHz</td>
<td>1.05 GHz</td>
<td>1.00 GHz</td>
</tr>
</tbody>
</table>
Intel QuickSync (SW development)

Performance-optimized ABR transcoding pipeline offered by Intel SDK

HW & SW stability

Great technical support

// feed source H.264 frame
m_ext_bs_proc_vector[0]->PushInFrame (in_frame);

// force IDR if needed
for (unsigned int i = 1; i < m_session_vector.size(); ++i) {
    if (m_force_idr) {
        m_session_vector[i]->pPipeline->setForceIDR (true);
    }
}

// collect output H.264 frames of multiple variants
std::vector<MediaFramePtr> out_frames; // of one variant
for (unsigned int i = 1; i < m_ext_bs_proc_vector.size(); ++i) {
    m_ext_bs_proc_vector[i]->PopCopyOutFrames (out_frames);
}
Intel QuickSync (Video Quality)
Deployed to Production in 2016/10

Increased our transcoding capacity by 10+ times, to assist smaller broadcasters to build their audiences.

Officially recommended our broadcasters to stream 1080p60 6mbs, to improve the video quality of Source and transcoded variants.
Twitch is a social video platform, with 40k+ peak concurrent channels and highest variant being 1080p60

Must-haves for us are: cost, stability, and automated operation

Cost (3-year TCO) = CAPEX (density) + OPEX (power rate)

The future goal is to transcode every broadcaster, with better video quality
Thank You and Questions

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