Atlastream

Adaptation Algorithms for Multi-CDN
Parallel Strategy

Dr Abdelhak Bentaleb | CTO Atlastream | Research Fellow NUS
ATLASTREAM (WHO WE ARE)

● A SaaS-based platform with Products to power modern OTT video infrastructure

● Award winning technology

● Singapore-based

● Website: https://atlastream.net/
ATLASTREAM & STREAMING ECOSYSTEM

A CLIENT-SIDE SOLUTION BETWEEN PLAYERS & CDNs

* CDNs are a caching servers that store popular content near to the user
ATLASTREAM TECHNOLOGY

A HTML 5 Video Player

An API Integrable to Video Player

Easy and Seamless Integration

Reuse Existing Codecs
No Re-encoding Needed

Fully Client Side Solution
Zero Infrastructure Change

Multi-CDN
(for Video-on-Demand)

Better Bandwidth Estimation
(for Live)

Patent pending

Video-on-Demand: PCT
Low-Latency Live: Application Filed

Proprietary & Confidential
OUR PRODUCTS

MULTI-CDN
Content Provider struggles with following issue while multiple CDNs servers:

- Avoid bottleneck server to reduce rebuffering
- Full utilization of all available servers to increase the quality
- Fair distribution of resources, so that all end users should get the same quality
Single Source vs. Multi-Source DASH

**Solution:**
- Leveraging existing multiple DASH servers in parallel.

**Benefits:**
- Multiple DASH servers with heterogeneous capacities that can be used simultaneously.
- Benefiting from the fact of distribution of videos contents over multiple CDNs.
- Multipath capabilities:
  - The aggregate bandwidth from multiple paths
  - Fault-tolerance
  - Robustness through path diversity
Atlastream Parallel Multi-CDN Solution

Based on:

- HTTP-based multi-source mechanism.
- Queuing theory (Mx/D/1/K queue) based ABR scheme that considers the aggregate bandwidth.
- Download the imminently required segment from the server with the highest throughput.
- Intelligent and robust bottleneck detection and prevention strategy (Netflix-like).

Example:

- The available throughput from five different servers is 2 Mbps, 1 Mbps, 1.5 Mbps, 0.5 Mbps, and 1 Mbps.
- The DASH client should be able to play a video quality equivalent to 6 Mbps without any stalls.
# Atlastream Parallel Multi-CDN Solution

**VALUE PROPOSITION**

<table>
<thead>
<tr>
<th>Content Providers</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Retention of customers</td>
<td>Up to 50% higher quality than existing solutions</td>
</tr>
<tr>
<td>No additional costs existing video content and servers</td>
<td>Less rebuffering with bottleneck avoidance</td>
</tr>
<tr>
<td>Saving &gt;20 % CDN Cost via smart load balancing</td>
<td>Minimal fluctuation in video quality</td>
</tr>
</tbody>
</table>

---

**Atlastream Parallel Multi-CDN Solution**

**Value Proposition**

- **High Retention** of customers
- **No additional costs** existing video content and servers
- **Saving >20 % CDN Cost** via smart load balancing
- **Up to 50% higher quality** than existing solutions
- **Less rebuffering** with bottleneck avoidance
- **Minimal fluctuation** in video quality
Atlastream Parallel Multi-CDN Solution

ARCHITECTURE

Buffer Controller | Throughput Estimator | ABR Controller | Scheduler
Atlastream Parallel Multi-CDN Solution
RULES

1. Accurate throughput measurements from existing servers.

2. Parallel requests for multiple segments from existing servers.


4. Server bottleneck detection strategy.
Our ABR scheme is modeled as $M^x/D/1/K$ queue:

- The arrival rate ($\lambda$) of segments from different servers are modeled as a batch process.
- Calculate the total effective arrival rate by summing the individual arrival rate ($\lambda_m$) from each server ($s_m$).
- The segments in the same batch are downloaded at the same bitrate level.
- ABR selection considers the aggregate arrival rate from different servers.

\[ \rho = \sum \frac{\lambda_m}{\mu} \]

The queue server utilization is $\rho$, bitrate level $l$, and segment duration $\tau$. 
Atlastream Parallel Multi-CDN Solution

EVALUATION

- Extensive VoD experiments.

- Network Profiles (DASH-IF guidelines):

<table>
<thead>
<tr>
<th>Network Profile</th>
<th>Throughput Values (Mbps)</th>
<th>Inter-variation Duration (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>4, 3.5, 3, 2.5, 3, 3.5</td>
<td>30</td>
</tr>
<tr>
<td>P2</td>
<td>2.5, 3, 3.5, 4, 3.5, 3</td>
<td>30</td>
</tr>
<tr>
<td>P3</td>
<td>5, 0.25</td>
<td>180</td>
</tr>
<tr>
<td>P4</td>
<td>9, 4, 3.5, 3, 3.5, 4, 9, 4</td>
<td>30</td>
</tr>
<tr>
<td>P5</td>
<td>3, 3.5, 4, 9, 4, 3.5, 3, 3.5</td>
<td>30</td>
</tr>
</tbody>
</table>

- Video Parameters:
  - Big Buck Bunny (BBB) from the DASH dataset with $T = 600s$, \{1, 2, 4\}s segments, \{30, 60, 120\}s buffer capacities.
  - 9 bitrate levels $L = \{4.2, 3.5, 3, 2.5, 2, 1.5, 1, 0.75, 0.35\}$ Mbps, content resolutions $R = \{240, 360, 480, 720, 1080, 1920\}$p.
Atlastream Parallel Multi-CDN Solution

EVALUATION

- Comparison Schemes:
  - Single source (one-to-one) DASH
  - Four CDN-based load balancing rules (request redirect rules) implemented over NGINX:
    - Round Robin (CDN-RR)
    - Least Connected (CDN-LC)
    - Session Persistence (CDN-SP)
    - Weighted (CDN-WD).

- Seven machines running Ubuntu 16.04 LTS for 5 DASH clients (Google Chrome), 5 DASH servers (VMs running over station machine), and logging.
- tc-NetEm network to limit the bandwidth
- One out of five server is bottleneck.
- Various buffer capacity configuration (max. threshold): 30s, 60s, 120s. The underflow prevention (min. threshold): 8s.
- Average results of 5 clients, Error bars: 95% confidence interval and 5% margin of error
Atlastream Parallel Multi-CDN Solution

EVALUATION

\[
\begin{align*}
\text{Avg. Quality} & : \delta_1 \sum_{k=1}^{K} q_p^k(l_p^k) - \delta_2 \sum_{k=1}^{K-1} \left| q_p^{k+1}(l_p^{k+1}) - q_p^k(l_p^k) \right| \\
\text{Avg. Quality Switch} & : - \delta_3 S E_p^k \\
\text{Stall duration} & : - \delta_4 T_p^{sd} \\
\text{Startup Delay} & : 
\end{align*}
\]
Atlastream Parallel Multi-CDN Solution

- Atlastream (5 players) vs. One-to-One DASH

Atlastream achieves better average Bitrate of 3.9-4 Mbps, and less Number of Switch of 2-13 for different buffer capacities compared to single DASH.
Atlastream Parallel Multi-CDN Solution

RESULTS

- Atlastream (5 players) vs. Single Server DASH

Atlastream achieves better average QoE of 4-33 %, and without Stalls for different buffer capacities compared to single DASH
Atlastream Parallel Multi-CDN Solution

RESULTS

- Atlastream (5 players) vs. CDN-based Load Balancing Rules (5 players)

Atlastream achieves better/stable average Bitrate of 3.9-4 Mbps, and less Switch of 2-10 for different buffer capacities compared to CDN-based rules.
Atlastream Parallel Multi-CDN Solution

RESULTS

- Atlastream (5 players) vs. CDN-based Load Balancing Rules (5 players)

Atlastream achieves better average QoE of 23-50%, and without Stalls for different buffer capacities compared to CDN-based rules.
Atlastream Parallel Multi-CDN Solution

RESULTS

- Test scalability of Atlastream in constrained network (e.g., last mile network)
- 100 clients (Google Chrome), 4 DASH servers with profiles (60, 70, 80, and 90) Mbps, and various total last-mile bandwidth of the single bottleneck link of 300 Mbps.
- The 100 clients start one by one in the gap of 0.5 seconds (total gap of 50 seconds).
- In weighted load balancing rule, the four servers \{s1, \ldots, s4\} are allocated with weight 1, 2, 3, and 4, respectively.

Atlastream achieves better average QoE of 10-70%, Bitrate of 3.2-3.9 Mbps, less Switch of 5-20, without Stalls, for different buffer capacities compared to CDN-based rules.
Atlastream Parallel Multi-CDN Solution DEMO

Click to Play
Atlastream Parallel Multi-CDN Solution
TEST Your Content

https://server-d.atlastream.net/poc/
OUR PRODUCTS

Low-Latency Live
CMAF-based
VALUE PROPOSITION

**Content Providers**

- **High Retention**
  - of customers

- **No additional costs**
  - By using standard Video Codec

- **Easier & Faster Integration**
  - that requires less manpower

**Users**

- **Ultra Low Latency**
  - 1 - 2 seconds

- **Less rebuffering**
  - with smart bandwidth estimation

- **50% higher quality**
  - than existing solutions
ATLASTREAM: LOW-LATENCY LIVE STREAMING

Click to Play
Atlastream LOW-LATENCY LIVE STREAMING
TEST Your Content

http://live-demo.atlastream.net/demo.html
Our technology track records

Jun 2020  Twitch.tv Grand Challenge on Adaptation Algorithms for Near-Second Latency
Oct 2019  SIGMM Award for Outstanding PhD Thesis
Jun 2019  First place in the DASH Industry Forum Best PhD Dissertation Award
Jun 2019  First place in the Excellence in DASH Award at the ACM MMSys’19
Jan 2018  Research Achievement Award, SoC, NUS
Aug 2018  Research Excellence Award, SoC, NUS
Jan 2017  Research Achievement Award, SoC, NUS
Our team

Founders

Praveen Kumar Yadav
CEO
PhD, School of Computing, NUS

Abdelhak Bentaleb
CTO
PhD, School of Computing, NUS

Advisory Board

Academy

Dr. Roger Zimmermann
Distinguished member IEEE
School of Computing, NUS

Dr. Wei Tsang Ooi
Member ACM
School of Computing, NUS

Industry

Dr. Ali C Begen
Member
MPEG Standardization Committee

Business

Sang Bin
Executive Partner-
Waimea LLC (US) &
Managing Director Ritz Capital

Amir Nivy
Founder & CEO Hapticus
Mentor, Venture Creation,
NUS
Thank You

contact@atlastream.net
www.atlastream.net
+65 9893 8387