Improving caching efficiency and quality of experience with CF-Dash

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Introduction to DASH
“Cisco reported that mobile data traffic will reach 11.2 exabytes per month by 2017”.

Shift toward HTTP adaptive streaming (HAS) solutions
HTTP adaptive streaming
HTTP adaptive streaming

Methodology:
1) Digging into HAS properties.
2) Studying the Impacts on Content Delivery infrastructures and QoE.
3) Leveraging these findings to design efficient caching strategies.
4) Evaluation.
246,913 unique active clients during the measurement period.
Collection from November 7th 2012 until January 9th 2013, involving mainly Apple HTTP Live Streaming (HLS) and Microsoft smooth streaming sessions (HSS).
1,763,516 adaptive streaming sessions (92,595,115 HTTP GET requests).
Type of the contents: Live and catch-up.
Switching behavior of DASH users & Cache-Friendly Dash
Distribution of the requested profiles

<table>
<thead>
<tr>
<th>Profile i</th>
<th>Encoding bitrate (kbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile 0 ($P_0$)</td>
<td>$&lt; 50$</td>
</tr>
<tr>
<td>Profile 1 ($P_1$)</td>
<td>[50-150)</td>
</tr>
<tr>
<td>Profile 2 ($P_2$)</td>
<td>[150-280)</td>
</tr>
<tr>
<td>Profile 3 ($P_3$)</td>
<td>[280-420)</td>
</tr>
<tr>
<td>Profile 4 ($P_4$)</td>
<td>[420-600)</td>
</tr>
<tr>
<td>Profile 5 ($P_5$)</td>
<td>[600-1000)</td>
</tr>
<tr>
<td>Profile 6 ($P_6$)</td>
<td>[1000-2000)</td>
</tr>
<tr>
<td>Profile 7 ($P_7$)</td>
<td>$\geq 2000$</td>
</tr>
</tbody>
</table>

- For catch-up contents:
  Clients request mostly profiles: 5, 4 and 3.
In average, the number of transitions during a HAS session is bounded between $[1/6; 1/2]$ of the total requested chunks per session.

⇒ Implications on caching efficiency: This reduces the performance of the cache in term of hit-ratio.
Simulation Scenario

- Proxy cache server
- LRU caching logic

Assumptions
- Single profile: 640kbps
- Multi-profile: [40, 64, 240, 360, 440, 640, 1840, 2540]
- All chunks are 10 second length.
- We only consider the Catch-up TV sessions.
- LRU
- Clients do not make any jump forward/backward during the video session.
QoE evaluation

- Subjective quality evaluation: Film, Sport, News.

<table>
<thead>
<tr>
<th>Profile</th>
<th>Video resolution</th>
<th>Bitrate (kbps)</th>
<th>User perception (MOS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile 1</td>
<td>176*144</td>
<td>100</td>
<td>Bad(1)</td>
</tr>
<tr>
<td>Profile 2</td>
<td>280*160</td>
<td>210</td>
<td>Bad(1.2)</td>
</tr>
<tr>
<td>Profile 3</td>
<td>320*180</td>
<td>250</td>
<td>medium (2.2)</td>
</tr>
<tr>
<td>Profile 4</td>
<td>400*224</td>
<td>510</td>
<td>good (3.3)</td>
</tr>
<tr>
<td>Profile 5</td>
<td>480*270</td>
<td>900</td>
<td>good (3.8)</td>
</tr>
<tr>
<td>Profile 6</td>
<td>640*360</td>
<td>1500</td>
<td>Excellent (4)</td>
</tr>
<tr>
<td>Profile 7</td>
<td>1024*576</td>
<td>3500</td>
<td>Excellent (4.5)</td>
</tr>
</tbody>
</table>
CF-Dash (Cache Friendly-Dash):

Goal is 2-fold

- sustain the quality of experience of mobile clients: Prevent clients to turn systematically to the highest profiles even though they experience a high bandwidth. This increases the probability to other clients to download chunks from the cache.
  \(\Rightarrow\) Fairness.

- improving caching efficiency: Reduce the number of switching between qualities.
  \(\Rightarrow\) Stability.

Rational:

\(\Rightarrow\) Defining a **profile-limit (PL)**, where this profile should afford a good user-experience and improves the caching efficiency.

\(\Rightarrow\) Clients do not scales systematically above the PL. If desired they have to manually fix this profile.
Testbed experiments
**MPEG-DASH architecture**

- **HTTP Module**: Exchange of messages between the client-player and the cache to learn about the *profile-limit*.

- **MPD Parser and Downloading controller**: to hinder the client-player from switching systematically to profiles above the *profile-limit*. 
Testbed implementation (PoC)

- HTTP server: Catalogue of 20 videos (Zipf popularity)
- Gpac framework installed on both clients:
  200 simultaneous sessions.
Switching between qualities:

Gain in Hit-Ratio:

![Graph showing switching between qualities](image1)

![Bar chart showing gain in hit-ratio](image2)
Conclusion

• CF-Dash aims to give the network delivery actors (CDNs, operators,...) to assist the client-player to select the video quality that both clients’ players and content delivery actors find it convenient to serve. This is in line with dash2.0 (SAND).

• Futur works:
we will further investigate the ideal profile to be cached and define incentive strategies to encourage clients requesting the same encoding profiles.
Any question?

Thank you