Towards the Application of WebRTC Peer-to-Peer to Scale Live Video Streaming over the Internet

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Luiz Fernando Gomes Soares

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Maio, 2014
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Schedule

- Motivation
- Background
- Proposed Solution
- Conclusion & Future Work
- References
Motivation
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- Audience growth on the Internet & preference for multimedia content consumption
  - Red Bull Stratos 2012
    - 8 million concurrent users [Katz 2012]
Motivation

- Audience growth on the Internet & preference for multimedia content consumption
  - Red Bull Stratos 2012
    - 8 million concurrent users [Katz 2012]
  - FIFA Confederations Cup 2013 to Brazilian residents
    - Almost half a million concurrent users
Motivation

- Online Video Production Quality
Motivation

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  - Netflix is expecting to deliver 4K videos in 2014/2015 [Sandoval 2013]
Motivation

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  - Netflix is expecting to deliver 4K videos in 2014/2015 [Sandoval 2013]
- Prediction of transmission quality of FIFA’s next World Cup in Brazil
Motivation

- The use of Content Delivery Networks (CDN)
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  - Scalability: CDNs scales through the addition of point-of-presence (PoP’s)
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  - *Scalability*: CDNs scales through the addition of point-of-presence (PoP's)
  - *Cost*: Google YouTube spend 1 million dollars per day [Spangler 2009]
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  - Scalability: CDNs scales through the addition of point-of-presence (PoP’s)
  - Cost: Google YouTube spend 1 million dollars per day [Spangler 2009]
  - Users’ Quality of Experience
Motivation

- The use of Content Delivery Networks (CDN)
  - **Scalability:** CDNs scales through the addition of point-of-presence (PoP’s)
  - **Cost:** Google YouTube spend 1 million dollars per day [Spangler 2009]
  - **Users’ Quality of Experience**

http://goo.gl/zixUr7
Motivation

- The use of Content Delivery Networks (CDN)
  - **Scalability:** CDNs scale through the addition of point-of-presence (PoP’s)
  - **Cost:** Google YouTube spend 1 million dollars per day [Spangler 2009]
  - **Users’ Quality of Experience**

"ABC Promised to Livestream the Oscars and Totally Failed"

ABC placed comically harsh restrictions on the inaugural Academy Awards livestream. Yeah, it was a bit of a disaster.

http://goo.gl/sTNb7d
Motivation

Background
### Background

- Current Video Distribution Techniques

<table>
<thead>
<tr>
<th>RTP/RTSP/RTMP</th>
<th>HTTP-Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly on top of UDP</td>
<td>On top of HTTP</td>
</tr>
<tr>
<td>Specialized Media Servers</td>
<td>Segementer + Ordinary Web Servers</td>
</tr>
<tr>
<td>Low Delay</td>
<td>High Delay</td>
</tr>
</tbody>
</table>
Background

- HTTP-Based Streaming Protocols
  - HTTP Dynamic Streaming (HDS) by Adobe
  - HTTP Live Streaming (HLS) by Apple
  - Smooth Streaming by Microsoft
  - DASH by MPEG
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- HTTP-Based
  - HTTP Dynamic Streaming (HDS) by Adobe
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  - DASH by MPEG
Background

- WebRTC
  - Real-Time Communications, Working Draft
  - Capability of share video, audio and data between browsers
Proposed Solution
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- Hybrid Peer-to-Peer/CDN to assist video chunks delivery
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  - P2P Networks usually improves as network size increases [Rossoupolous et al. 2010]
  - Peer-assisted data sharing can decrease CDN requests to about 96% [Cho et al. 2010]

The implementation is available at: http://github.com/flavioribeiro/bemtv
Proposed Solution

- Hybrid Peer-to-Peer/CDN to assist video chunks delivery
  - P2P Networks usually improves as network size increases [Rossoupolous et al 2010]
  - Peer-assisted data sharing can decrease CDN requests to about 96% [Cho et al 2010]
- Decreases the cost of transmission
- Reduces networks bottlenecks
- Improves audience’s experience

The implementation is available at: http://github.com/flavioribeiro/bemtv
Proposed Solution

- Peer Entrance and Signaling
  - ISP-Location & Geolocation Awareness [Kovacevic 2009]
Proposed Solution

- Peer Entrance and Signaling
  - ISP-Location & Geolocation Awareness [Kovacevic 2009]
    1. Node A hits a “swarm name discoverer” URL *
    2. Node A asks Central Server to publish himself on the swarm
    3. Other nodes acknowledge new user entrance
    4. Node A establish a P2P connection with each node on the same swarm (using STUN)

* http://server.bem.tv/room
Proposed Solution

- Video Chunks Exchange Protocol
Proposed Solution

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Proposed Solution

› Video Chunks Exchange Protocol
Proposed Solution

- Video Chunks Exchange Protocol

A needs chunk bbb_3.ts
Proposed Solution

- Video Chunks Exchange Protocol

Monday, May 5, 14
Proposed Solution

- Video Chunks Exchange Protocol

A

B
checking if have bbb_3.ts

C
checking if have bbb_3.ts

&lt;A&gt; DESIRE: bbb_3.ts
Proposed Solution

- Video Chunks Exchange Protocol

Monday, May 5, 14
Proposed Solution

- Video Chunks Exchange Protocol

\[<A> \text{ DESIRE:bbb\_3.ts}\]
\[<B-A> \text{ DESACK:bbb\_3.ts}\]
\[<C-A> \text{ DESACK:bbb\_3.ts}\]
Proposed Solution

- Video Chunks Exchange Protocol

choosing the best peer

\[<A> \text{ DESIRE:bbb}_3.ts\]
\[<B-A> \text{ DESACK:bbb}_3.ts\]
\[<C-A> \text{ DESACK:bbb}_3.ts\]
Proposed Solution

- Video Chunks Exchange Protocol

A  
C is the best!

B

C

<A> DESIRE:bbb_3.ts
<B-A> DESACK:bbb_3.ts
<C-A> DESACK:bbb_3.ts
Proposed Solution

- Video Chunks Exchange Protocol

\[
\begin{align*}
\langle A \rangle & \hspace{1em} D E S I R E : b b b _ { - } 3 . t s \\
\langle B - A \rangle & \hspace{1em} D E S A C K : b b b _ { - } 3 . t s \\
\langle C - A \rangle & \hspace{1em} D E S A C K : b b b _ { - } 3 . t s \\
\langle A - C \rangle & \hspace{1em} R E Q : b b b _ { - } 3 . t s
\end{align*}
\]
Proposed Solution

- Video Chunks Exchange Protocol

- **<A> DESIRE:** bbb_3.ts
- **<B-A> DESACK:** bbb_3.ts
- **<C-A> DESACK:** bbb_3.ts
- **<A-C> REQUEST:** bbb_3.ts
- **<A-C> OFFER:** bbb_3.ts:<blob>
Proposed Solution

- Video Chunks Exchange Protocol

A have chunk bbb_3.ts!

\[<A> \text{ DESIRE:} bbb\_3.ts\]
\[<B-A> \text{ DESACK:} bbb\_3.ts\]
\[<C-A> \text{ DESACK:} bbb\_3.ts\]
\[<A-C> \text{ REQ:} bbb\_3.ts\]
\[<C-A> \text{ OFFER:} bbb\_3.ts:<blob>\]
Proposed Solution

- Video Chunks Exchange Protocol

\(<A>\) DESIRE:bbb_3.ts
\(<B-A>\) DESACK:bbb_3.ts
\(<C-A>\) DESACK:bbb_3.ts
\(<A-C>\) REQ:bbb_3.ts
\(<C-A>\) OFFER:bbb_3.ts:<blob>

timeout? go to CDN
Proposed Solution

- Early Experiments
Proposed Solution

- Early Experiments
  - 10 Apple MacBooks White (2GB SDRAM)
  - Mozilla Firefox 27.1 (WebRTC compatible)
  - Same Wireless hotspot (10/100Mbps)
- Video Streaming
  - Chunks with 5 seconds of duration
  - 600 Kbps of bitrate quality
- CDN + Room Discoverer + P2P Signaling Server
  - 1 server with 512MB of SDRAM in New York
Proposed Solution

- Early Experiments
Proposed Solution

- Early Experiments
Proposed Solution

- Results

![CDN-only x CDN-P2P Requests per minute graph]

CDN-only

CDN-P2P
Proposed Solution

- Results

  - CDN-only: 7457 requests to CDN
  - CDN-P2P: **4482** requests to CDN
Proposed Solution

Results

- CDN-only: 7457 requests to CDN
- CDN-P2P: 4482 requests to CDN

Reduction of 39.89%
Conclusion & Future Work
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- Our approach is promising!
Conclusion & Future Work

- Our approach is promising!

- Improvements:
  - Peers Convergence and Over Swarming
    - Reputation [Xiong and Liu 2004], Partnership [Li et al 2010], Leader Election [Kutten 2013]
  - Video Chunks Exchange Protocol
  - Content Security [Medina-López et al 2013]
    - Poisoned Chunks
  - DoS Starvation
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