Empowering the Creative User: Personalized HTTP-based Adaptive Streaming of Multi-path Nonlinear Video

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Most of us have seen Tom & Jerry movies, what if they could create their own versions of these movies??
For a minute...think that you are Tom
For a minute...think that you are Tom

Likes:
For a minute... think that you are Tom

Likes:
For a minute...think that you are Tom

Dislikes:
“We do not, in any way, shape or form, claim any ownership to the characters, sounds, images, or anything else related to ‘Tom and Jerry’. Those rights belong to Time Warner and Turner Entertainment. This presentation is for educational purposes only.”
Now, let's look at his opponent Jerry
Now, let's look at his opponent Jerry

Likes:
Now, let's look at his opponent Jerry's Likes:
Now, let's look at his opponent Jerry

Dislikes:
Jerry’s video

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Contributions

• Framework that allows the creator to easily create customized playback experiences for the viewer
  • Combines ideas of personalized multi-path video and HTTP-based adaptive streaming (HAS)
• Creator can use a light-weight personalized metafile to define any arbitrary set of paths and path choices through some original video (or file that concatenate multiple linear video clips)
• Allows viewer to traverse through the video by interacting with the player and choosing among multiple path options
• Seamless video playback using rate-adaptive prefetching and buffer management based on current network conditions
HTTP-based streaming

- HTTP-based streaming
  - Split into fragments
  - Use of HTTP allows: Easy caching, get through NATs/firewalls, etc.
  - Some support for interactive VoD
HTTP-based adaptive streaming (HAS)

- HTTP-based adaptive streaming
  - Multiple encodings of each fragment (defined in manifest file)
  - Clients adapt quality encoding based on (buffer and network) conditions
Nonlinear multi-path video

- **Nonlinear segments**: non-contiguous fragments of video can be stitched together to form what we term nonlinear video segments

<table>
<thead>
<tr>
<th>Fragments 1-5</th>
<th>Fragments 11-15</th>
<th>Fragments 7-9</th>
</tr>
</thead>
</table>

  Segment $S_1$

- **Multi-path and branch points**: The video can include branch points at which there are multiple choices of which segment to play back next
A separate flexible and personalizable metafile

• In addition to regular manifest file, we use a separate metafile
• Allows the creator to define any arbitrary set of paths and path choices through some original video (or a file that is the concatenation of multiple linear video clips, for example)
  • Nonlinear segments and branch points
• Longest path matching
  • Maintain history of player path
  • Break ties when multiple contenders
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length: 4 3 2 2 3 2 2 2 2 2
begin 1(2,3,4)
12(3,4)
24(5,6)
13(4,5)
34(5,7)
14(5,6)
146(7,9) end
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</tr>
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<tbody>
<tr>
<td>4</td>
<td>1(2,3,4)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>12(3,4)</td>
<td></td>
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<tr>
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<table>
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<tr>
<th>length: 4223222222</th>
<th>begin</th>
<th>1(2,3,4)</th>
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<tbody>
<tr>
<td>12(3,4)</td>
<td></td>
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<td>146(7,9) end</td>
<td></td>
<td></td>
</tr>
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</table>
The player

Multi-path navigation
Prefetching and rate adaptation

- Adapt prefetch quality requests based on branch points and buffer/network conditions

- Player modifications include
  - Internal prefetch buffer
  - Prefetch module for requests
  - Buffer management for branch points
Proof-of-concept evaluation

- Setup
  - Server (Adobe media server 5.0); Client (Firefox)
  - Available bandwidth (dummynet: 1, 2, 3 Mbps)
- Prefetch ahead of branch points
- No stall events (late data)
- Adapt prefetch quality to current conditions
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<thead>
<tr>
<th>Scenario</th>
<th>Policy</th>
<th>Late data (stall events)</th>
<th>Branch time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Mb/s</td>
<td>No prefetching</td>
<td>100%</td>
<td>3.39 (0.94)</td>
</tr>
<tr>
<td></td>
<td>Adaptive prefetch</td>
<td>0%</td>
<td>0.49 (0.10)</td>
</tr>
<tr>
<td>2Mb/s</td>
<td>No prefetching</td>
<td>100%</td>
<td>4.96 (1.08)</td>
</tr>
<tr>
<td></td>
<td>Adaptive prefetch</td>
<td>0%</td>
<td>0.64 (0.19)</td>
</tr>
<tr>
<td>1Mb/s</td>
<td>No prefetching</td>
<td>100%</td>
<td>4.14 (1.10)</td>
</tr>
<tr>
<td></td>
<td>Adaptive prefetch</td>
<td>0%</td>
<td>0.68 (0.17)</td>
</tr>
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Conclusions and future work

• Conclusions
  • We have designed and developed an interactive multi-path nonlinear media player; leveraging fragment-based nature and differentiated quality levels of HTTP-based adaptive streaming
  • Endless personalization of content using a simple metafile
  • Seamless playback achieved by careful prefetching and buffer management policies

• Future work
  • Design and evaluation of improved prefetching and buffer management policies
  • Detailed player evaluation under a wider range of scenarios
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