

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

Vengatanathan Krishnamoorthi¹, Patrik Bergström¹, Niklas Carlsson¹,
Derek Eager², Anirban Mahanti³, Nahid Shahmehri¹

¹ Linköping university, Sweden

² University of Saskatchewan, Canada

³ NICTA, Australia

Proc. ACM FhMN, Hong Kong, China, August 16, 2013

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:





Tom's video

THE VIDEO HAS BEEN REMOVED FROM THIS VERSION OF THE PERSENTATION TO LIMIT THE FILE SIZE. PLEASE USE THE OTHER VERSION ON MY SITE TO WATCH THE VIDEO

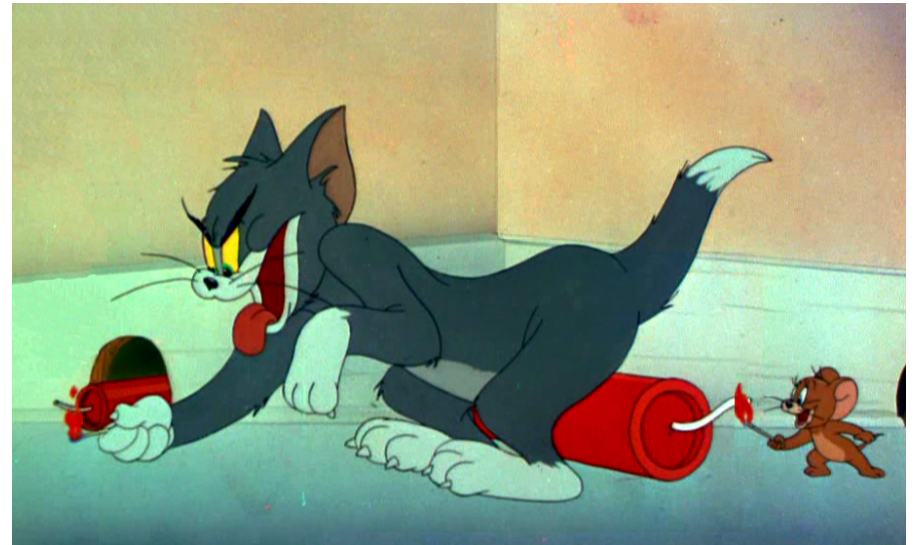


Now, lets look at his opponent Jerry



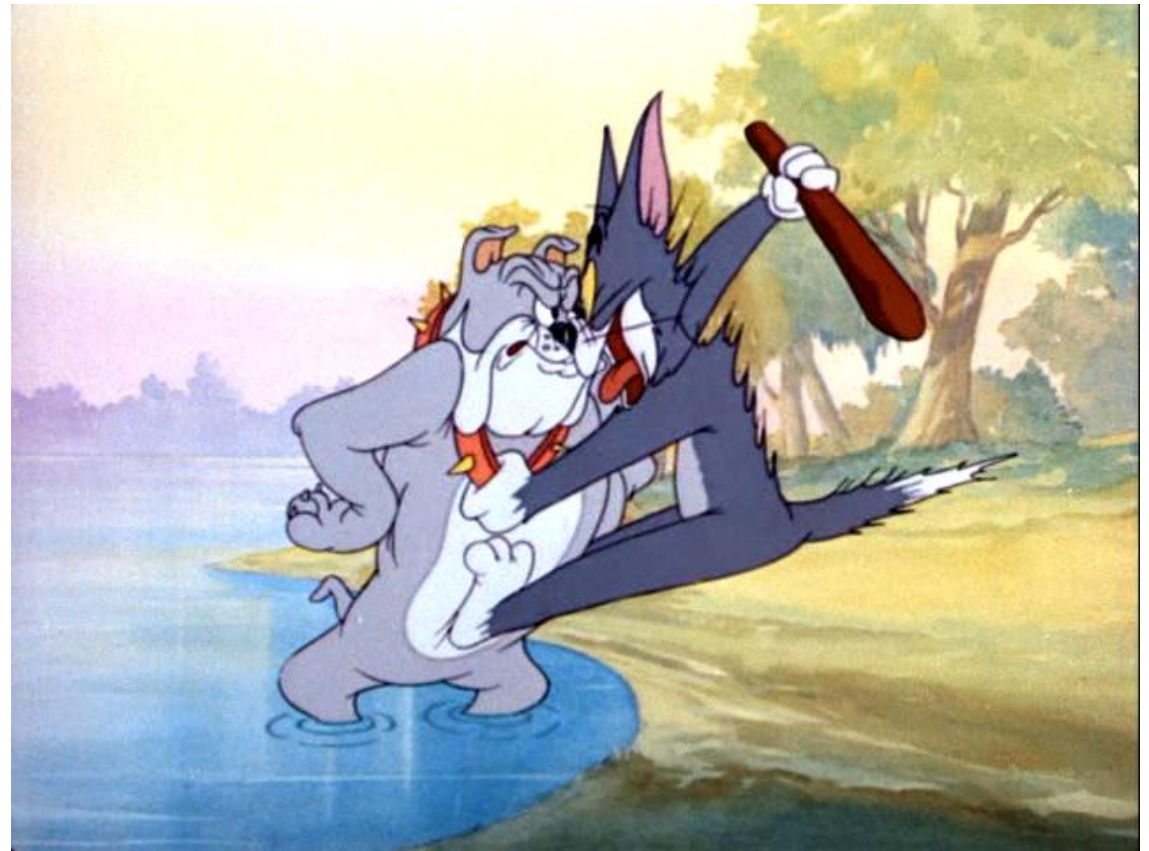
Now, lets look at his opponent Jerry

Likes:



Now, lets look at his opponent Jerry

Likes:



Now, lets look at his opponent Jerry

Dislikes:





Jerry's video

THE VIDEO HAS BEEN REMOVED FROM THIS VERSION OF THE PERSENTATION TO LIMIT THE FILE SIZE. PLEASE USE THE OTHER VERSION ON MY SITE TO WATCH THE VIDEO

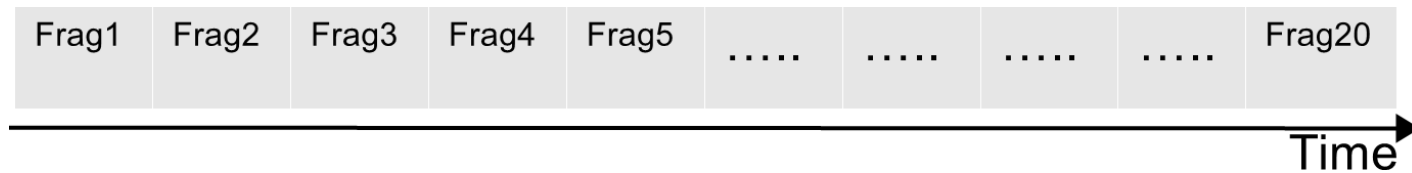


Contributions

- 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

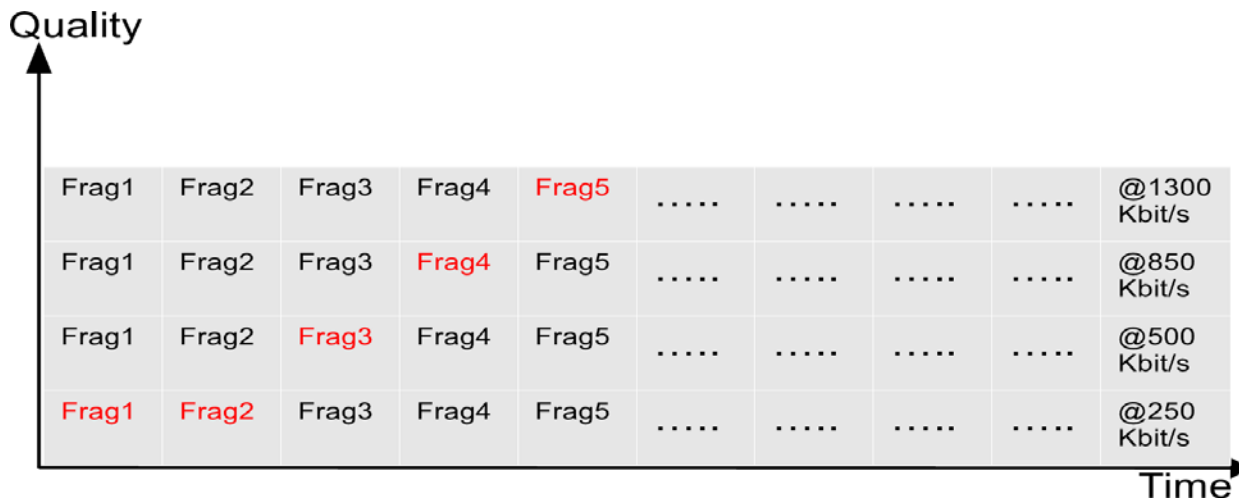


HTTP-based streaming



- 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

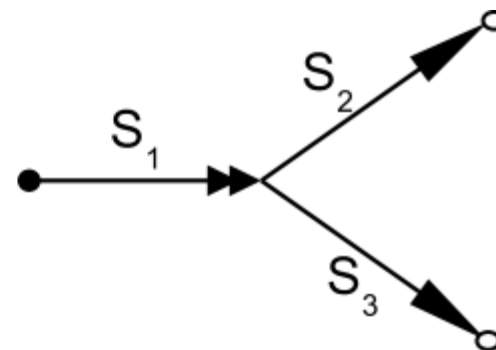
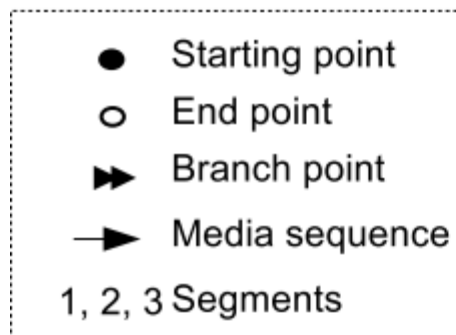
Nonlinear multi-path video

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



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



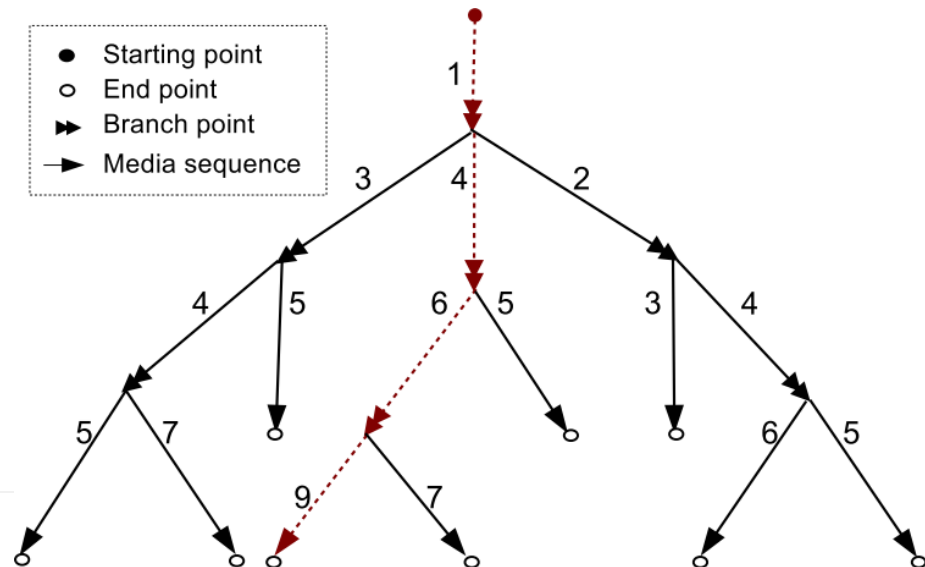


A separate flexible and personalizable metafile

- 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

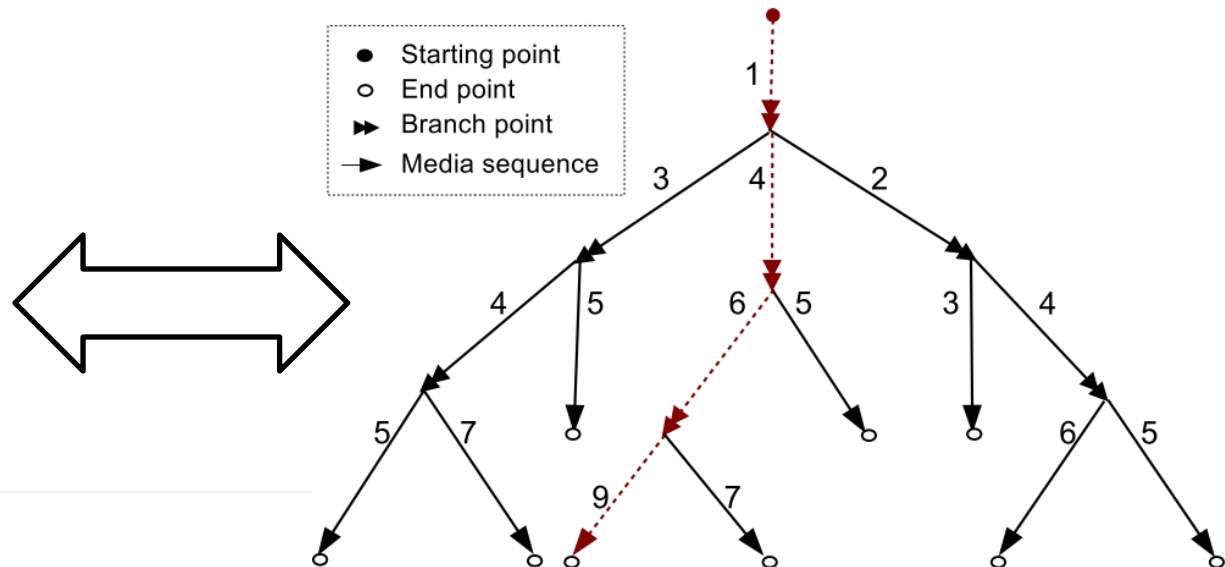
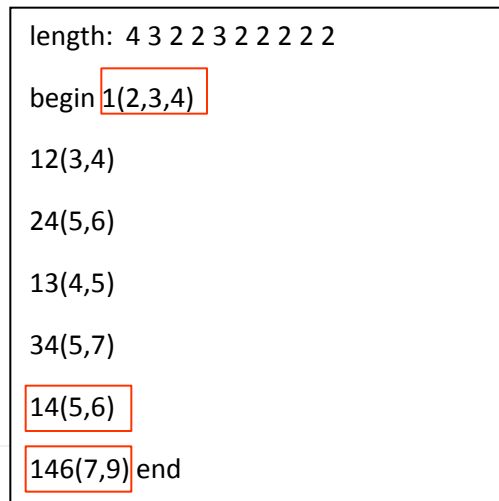
A separate flexible and personalizable metafile

- 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



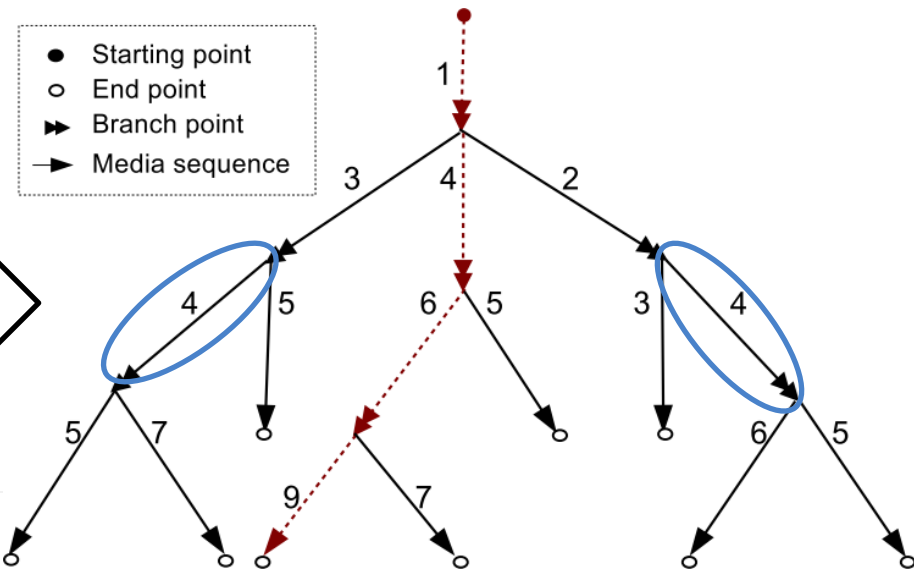
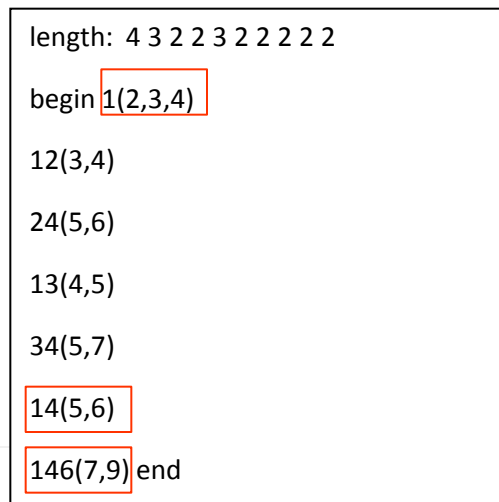
A separate flexible and personalizable metafile

- 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



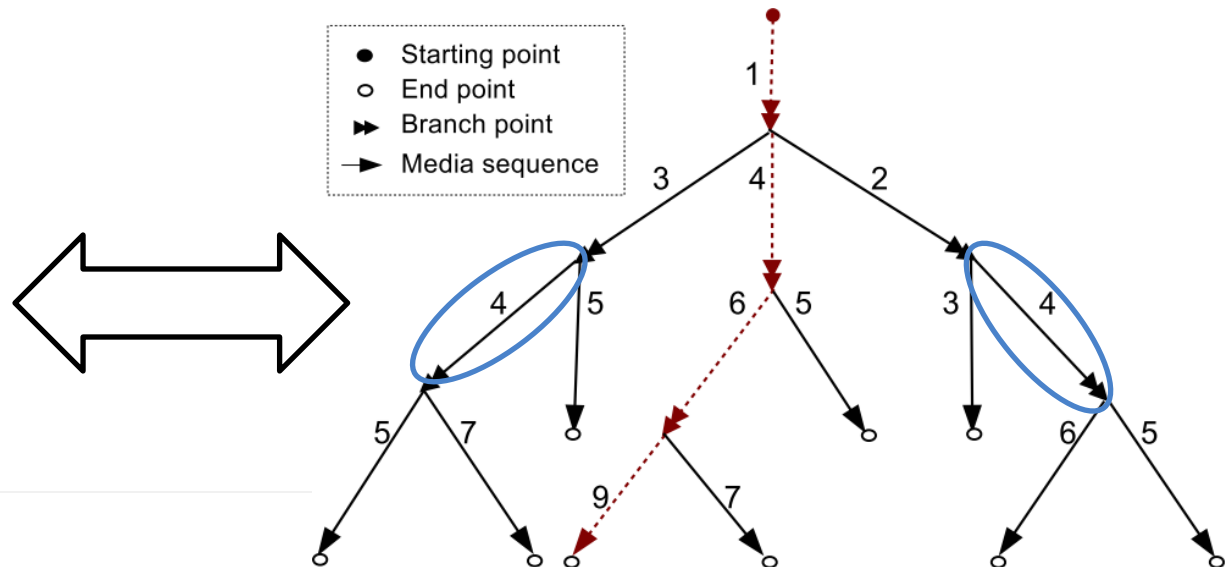
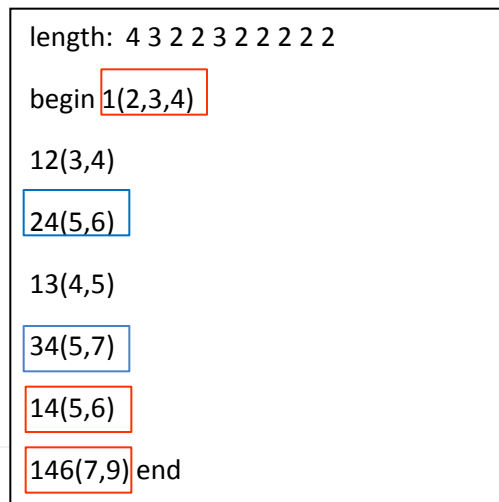
A separate flexible and personalizable metafile

- 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



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



The player



Strobe Media Playback

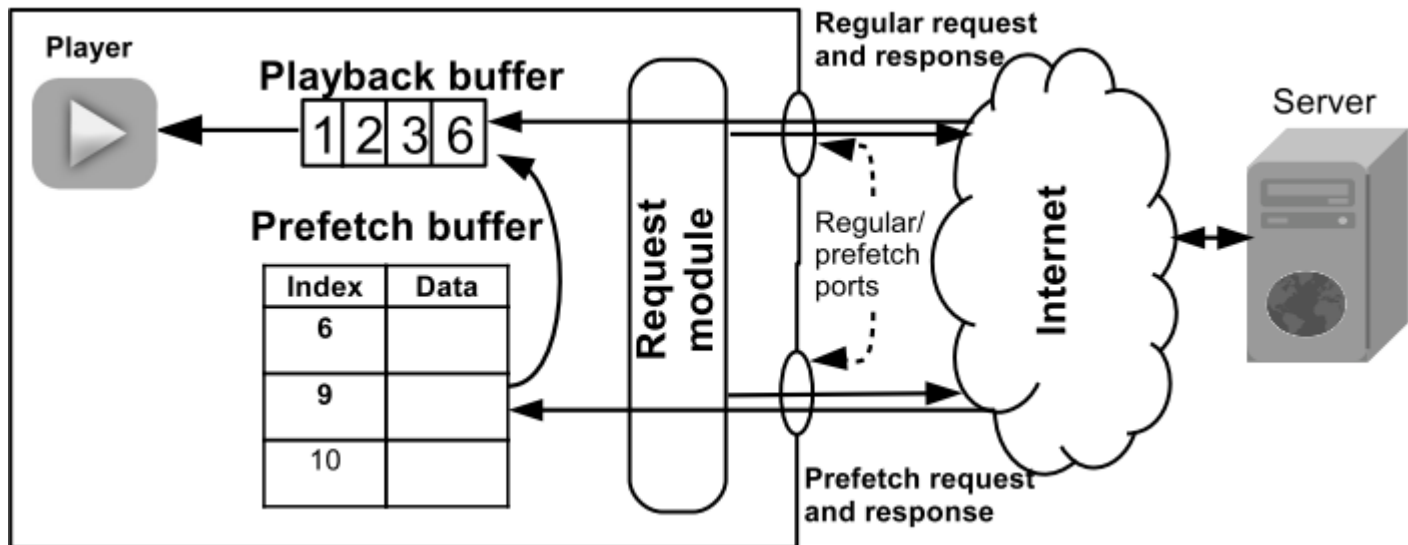


open source
media framework



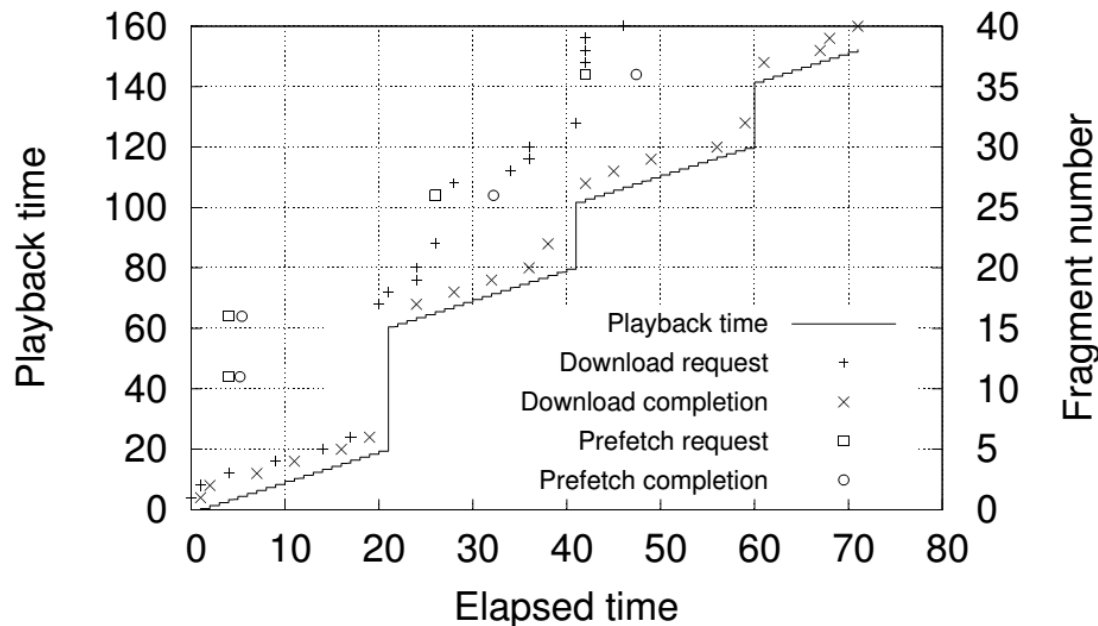
Prefetching and rate adaptation

- 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



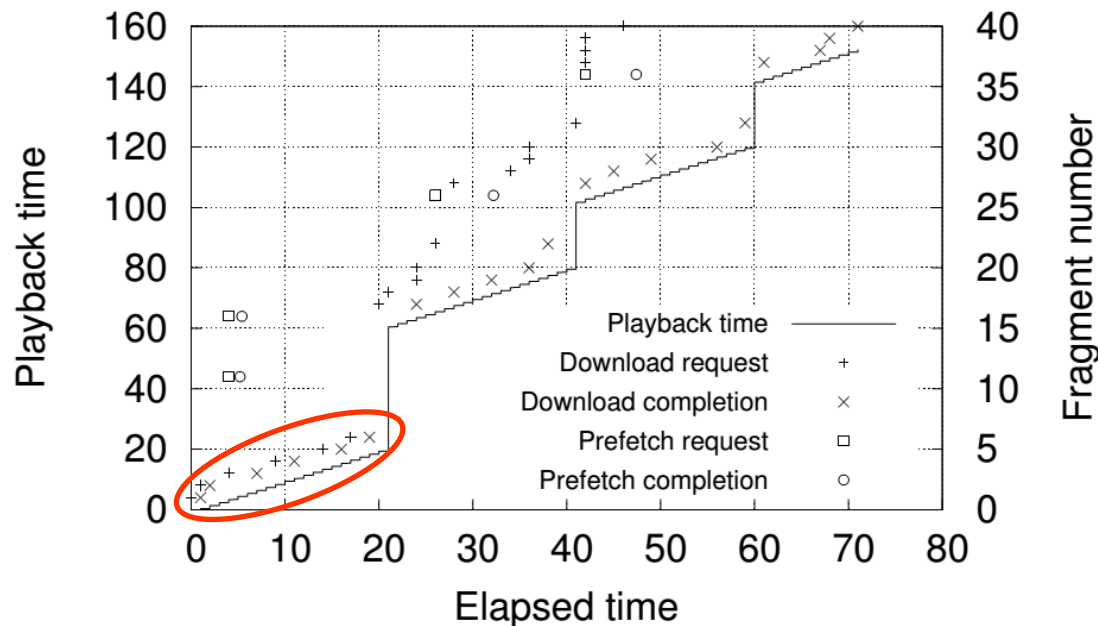
Proof-of-concept evaluation

- 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



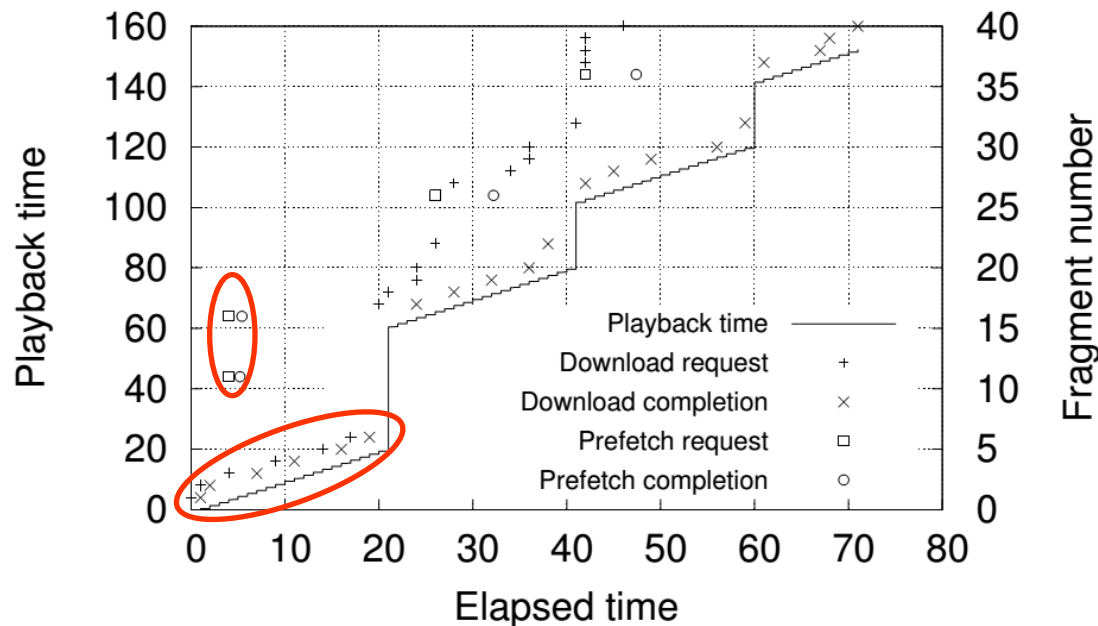
Proof-of-concept evaluation

- 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



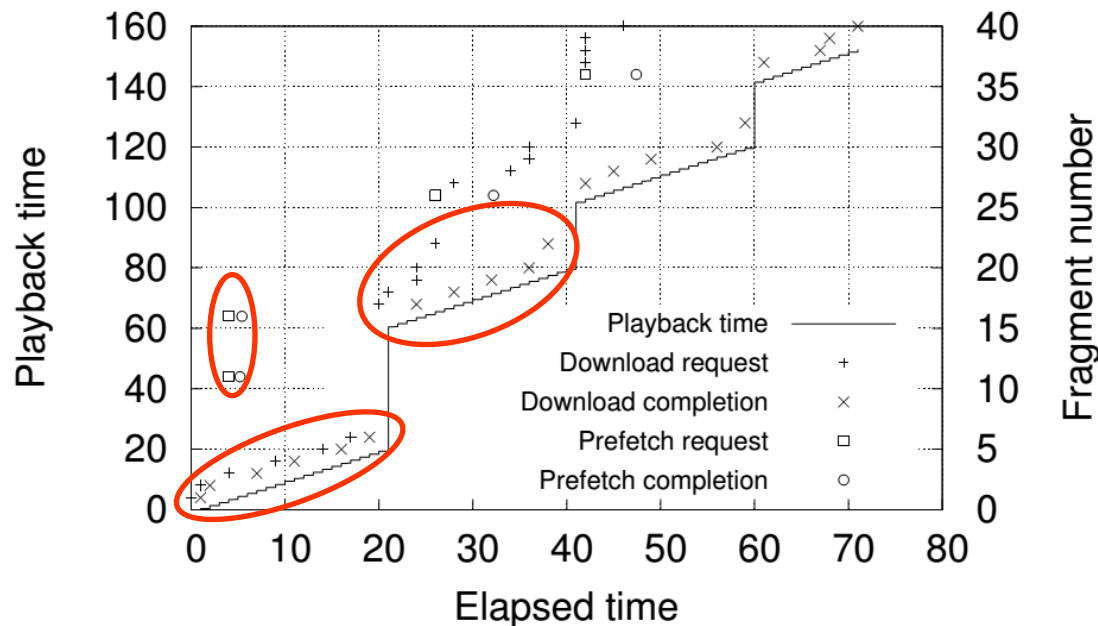
Proof-of-concept evaluation

- 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



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



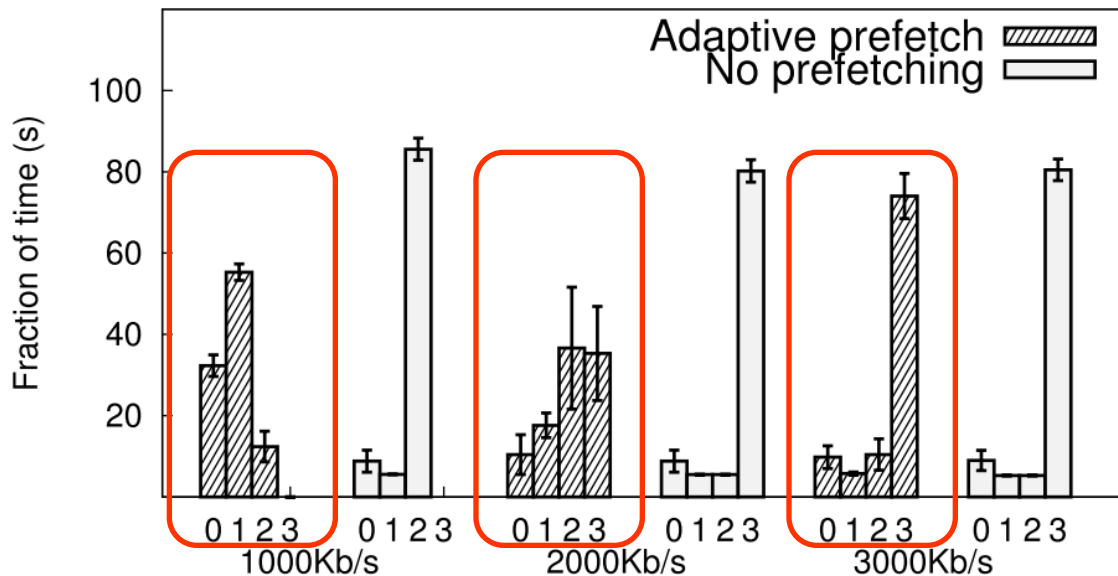
Proof-of-concept evaluation

- 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

Scenario	Policy	Late data (stall events)	Branch time (seconds)
3Mb/s	No prefetching	100%	3.39 (0.94)
	Adaptive prefetch	0%	0.49 (0.10)
2Mb/s	No prefetching	100%	4.96 (1.08)
	Adaptive prefetch	0%	0.64 (0.19)
1Mb/s	No prefetching	100%	4.14 (1.10)
	Adaptive prefetch	0%	0.68 (0.17)

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**





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

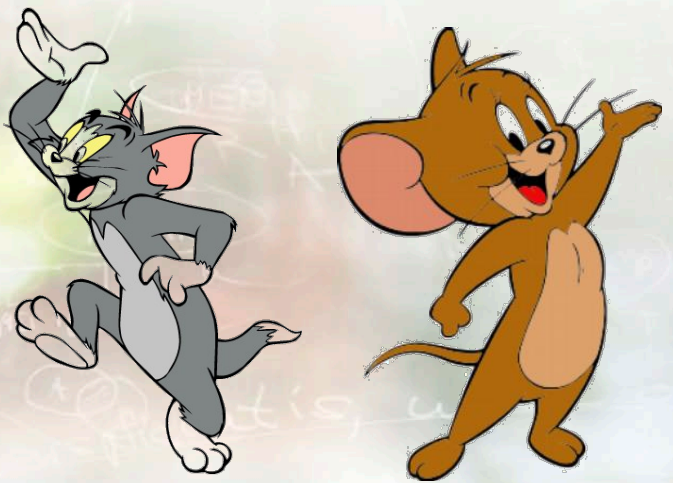
- Future work

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



Empowering the Creative User:

Personalized HTTP-based Adaptive Streaming of Multi-path Nonlinear Video



Linköping University

expanding reality

Contact: **Vengatanathan (Vengat) Krishnamoorthi**

vengatanathan.krishnamoorthi@liu.se

www.liu.se