

On the Interaction of Adaptive Video Streaming with Content-Centric Networking

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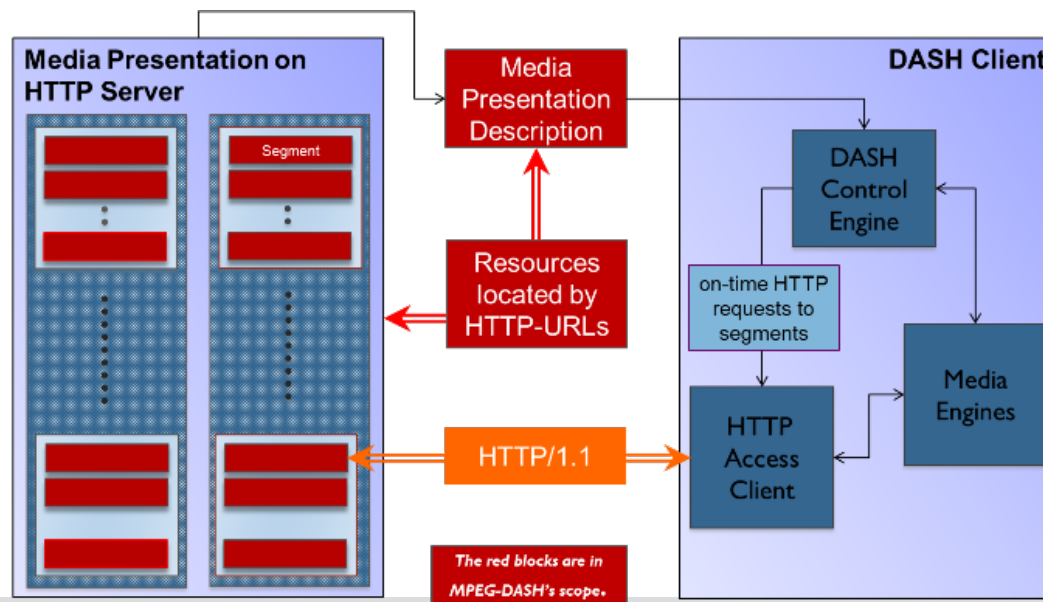


Video & Future Internet

- **Video streaming is an increasing share of Internet traffic**
 - 90% in 2017; Netflix + YouTube = half of Internet traffic
- **Information-Centric Networks: a new architecture for content delivery**
 - Video IS content
- **Both adaptive video streaming and ICN attempt to solve the bandwidth scarcity, but in different ways:**
 - Video streaming: By adapting demand to network conditions;
 - ICN: By making traffic demands local or P2P
- **Are these compatible?**

What do I mean by video streaming

- **Dynamic Adaptive Streaming over HTTP (DASH)**
- **A client-based rate adaptation mechanism (stateless at the server) which measures the effective bandwidth and selects a rate accordingly**



What do I mean by Future Internet

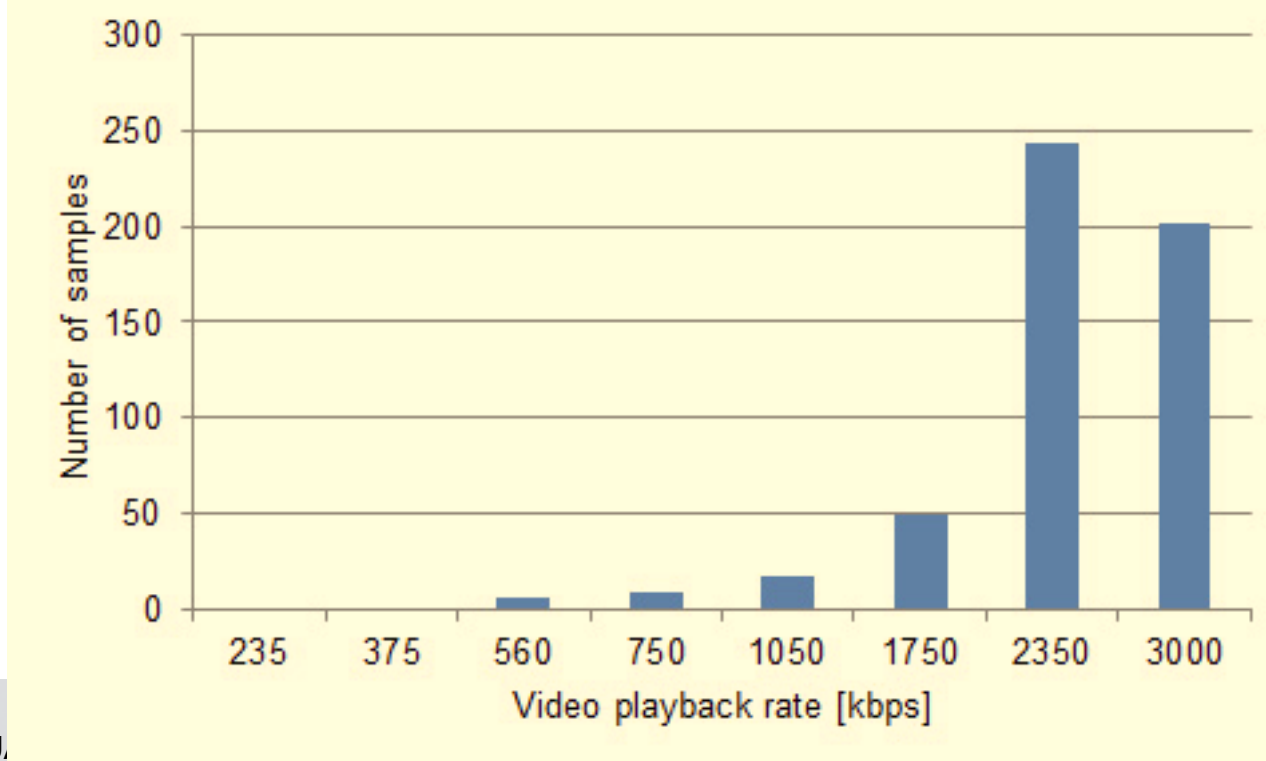
- **Here: Information Centric Network**
- **Architecture organized around requesting and routing content by name, independently of host location**
- **Key features:**
 - Inherent mobility support (at least: location independence)
 - Content uniquely identified by name
 - Content can be cached by operators/users as well as CDNs

Adaptive streaming and ICN: will it blend?



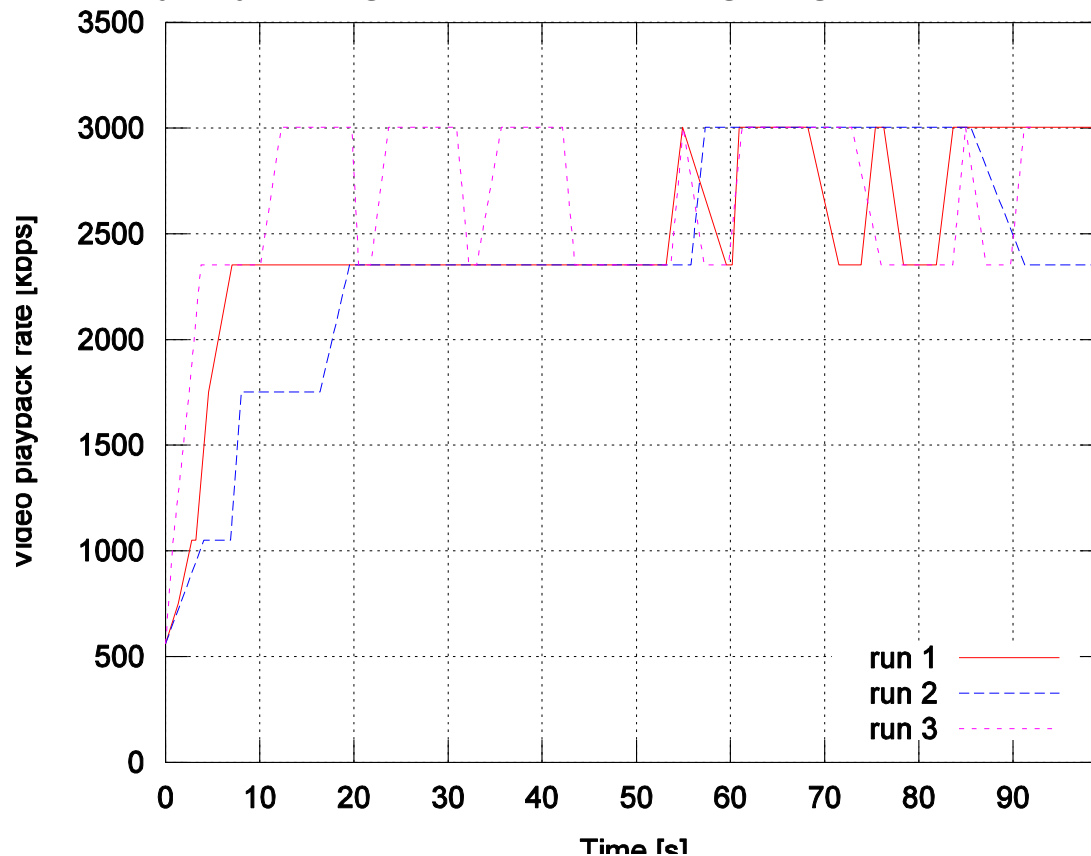
Empirical Study of Adaptive Video Streaming

- **Netflix based, as Netflix uses a DASH-like mechanism**
 - other adaptive streaming flavor exists (adobe, apple, microsoft)
- **Looked at the rate selection of a single client over a good connection (most stable scenario) -> bimodal distribution**

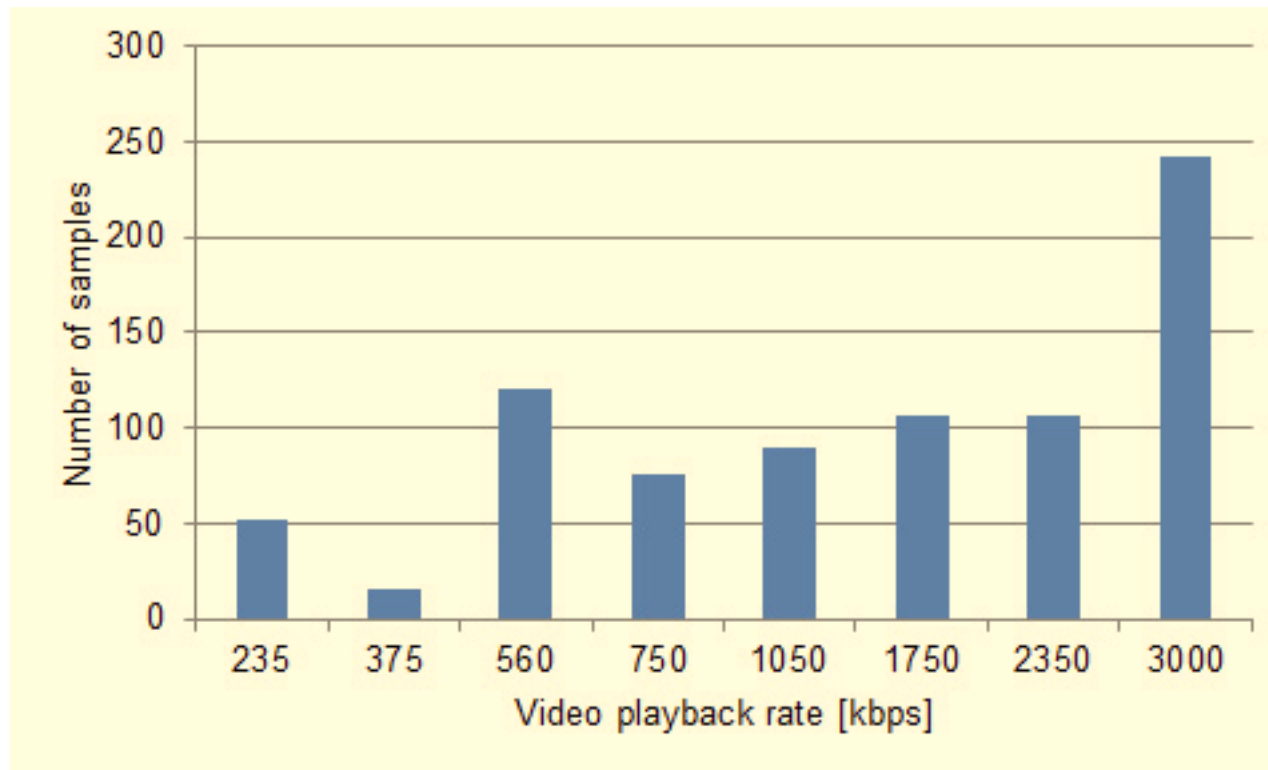


Empirical Study of Adaptive Video Streaming

- **Overlap of consecutive runs? Nope**
 - Actually, by design, to avoid rate going up and down synchronously



Rate Adaptation in a Mobile Scenario

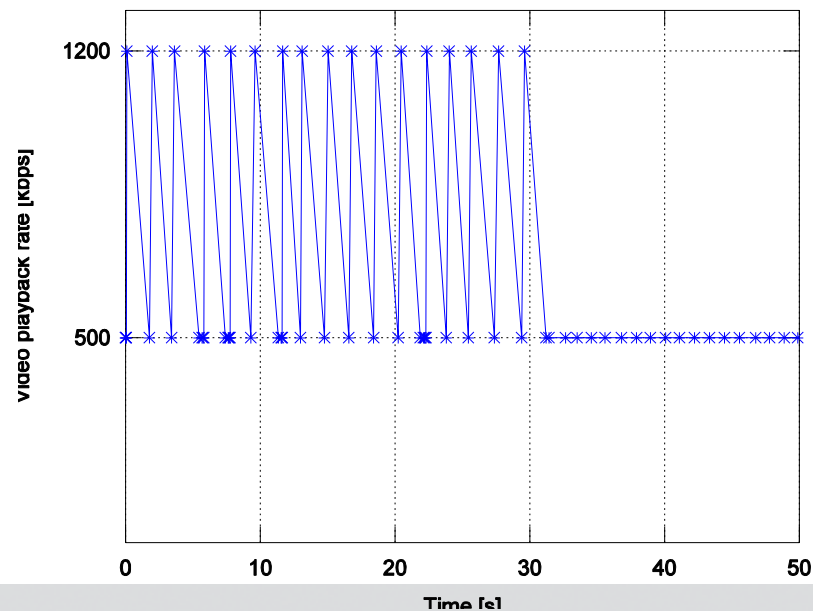


Impact on ICN: Caching Hit rate

- **Caching and rate adaptation are not pulling in the same direction**
- **Rate adaptation decreases the efficiency of caching**
- **In the best scenario (stable conditions), it divides the caching capacity by a factor almost $\frac{1}{2}$ therefore reducing the hit rate at the cache**
- **Formulation using Che's approximation for LRU given in the paper**
 - We can actually compute the hit rate penalty of having multiple descriptions

Impact on ICN: cache Oscillations

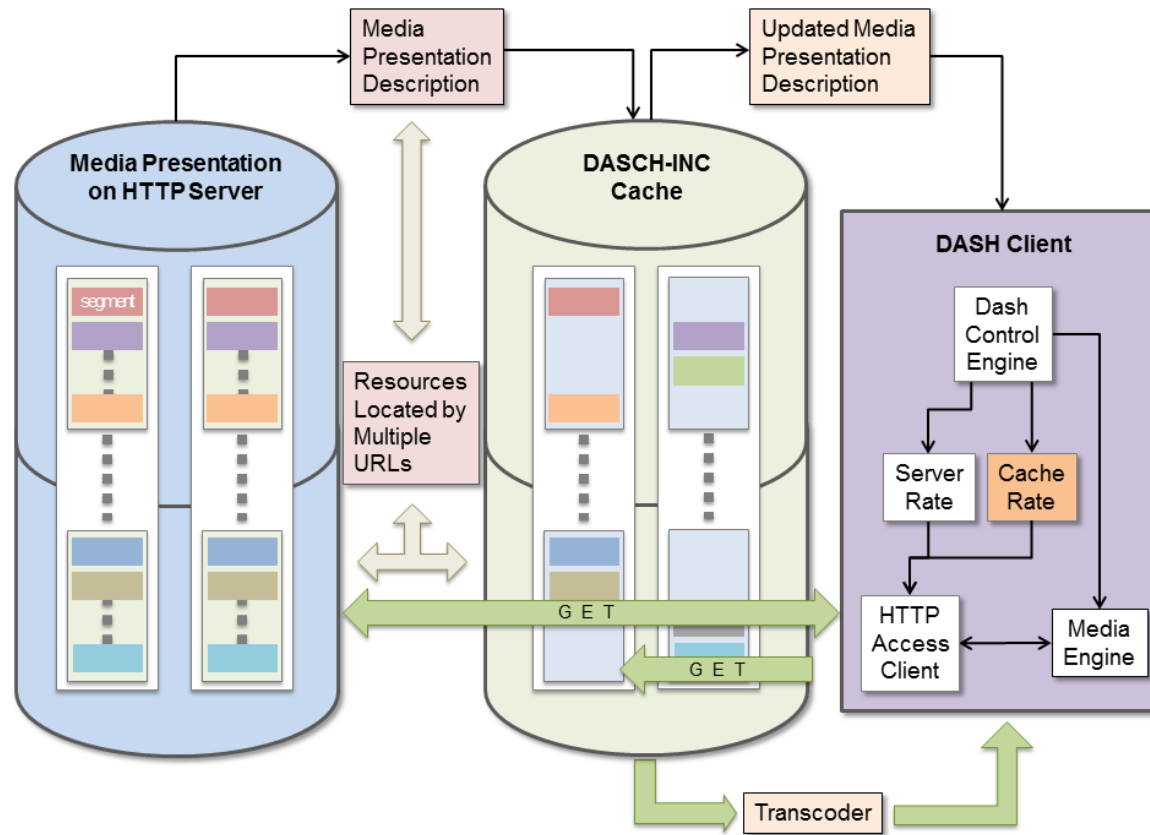
- Client measures the performance of the network
- In ICN (specifically CCN), client doesn't know it's getting the content from a cache or the origin server
 - Can't tell if network condition has changed (therefore must adapt rate) or if content location has changed (therefore must not adapt rate)



Some suggestions for cohabitation

- **For oscillations: Make the client aware of the content location**
 - So it can tell apart network variations from server location
- **For cache capacity:**
 - Allow cache to respond with available rate rather than requested rate
 - Allow cache to keep only the highest rate and transcode to get lower rates
 - Allow client to specify a request *by parameters* instead of by name: GET(movie file f , segment time t , bandwidth $< b$)
 - Allow cache to modify MPD to let client know of what it holds

Some suggestions for cohabitation



Conclusions: Compatible?

- **the client-initiated pull approach;**
- **the content being dealt with in pieces (or chunks);**
- **the support of efficient replication and distribution of content pieces within the network;**
- **the session-free nature of the exchange between the client and the server at the streaming layer: the client is free to request any chunk from any location;**
- **the support for potentially multiple sources.**

Conclusions: Compatible or Not?

- **Naming of the data in DASH does not necessarily follow the ICN convention of any of the ICN proposals.**
- **While chunks can be retrieved from any server, the rate adaptation mechanism attempts to estimate the available network bandwidth so as to select the proper playback rate**
- **The typical issue of access control and accounting happens in this context, where chunks can be cached in the network outside of the administrative control of the content publisher**
- **Dynamic streaming multiplies the representations of a given video stream, therefore diminishing the effectiveness of caching:**
- **Caching introduces oscillatory dynamics as it may modify the estimation of the available bandwidth between the end user and the repository where it is getting the chunks from.**
- **The ICN transport mechanism needs to be compatible to some extent with DASH.**

Conclusions: Work to be done!

- Potential for integration, but...
- DASH/adaptive streaming needs to be modified if it were to be deployed over ICN.
- Suggested work item for ICNRG IRTF WG
- <http://users.soe.ucsc.edu/~cedric/papers/draft-video-streaming-over-ICN-00.txt>
- Packet Video workshop Paper at <http://arxiv.org/abs/1307.0794>

Thank you

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