Client Starvation: A Shortcoming of Client-driven Adaptive Streaming in Named Data Networking

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1. Motivation: Adaptive Streaming in NDN

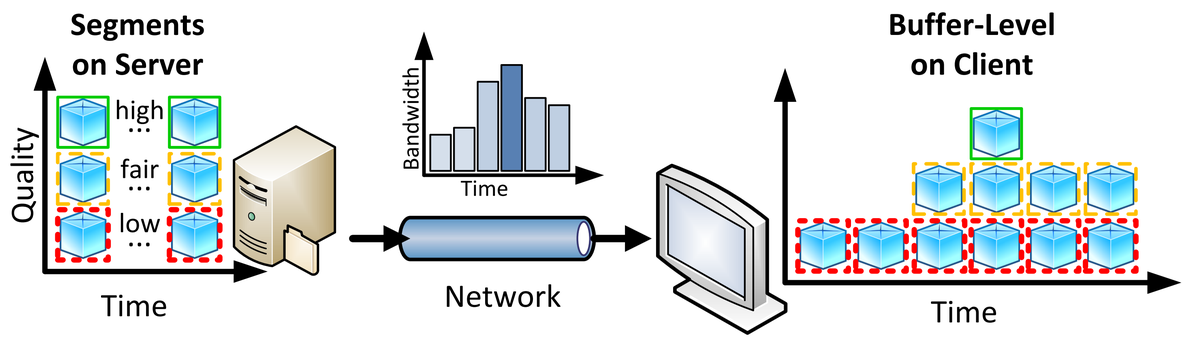
- The prevalence of multimedia traffic in today's Internet requires efficient support of audio and video consumption in Named Data Networking (NDN).

Multimedia Traffic at Peak Times [1]		
Continent / Access	Fixed	Mobile
North America	*59.09%*	*36.07%*
Asia	*47.06%*	*43.87%*
Europa	*39.38%*	*32.74%*

- NDN's inherent caching and multipath transmission capabilities can increase the effectiveness of audio-visual content dissemination compared to classical IP-based networks.
- Varying consumer demands, e.g., heterogeneous end-devices, and fluctuating network conditions require adaptive mechanisms to sustain acceptable Quality of Experience (QoE) for consumers.

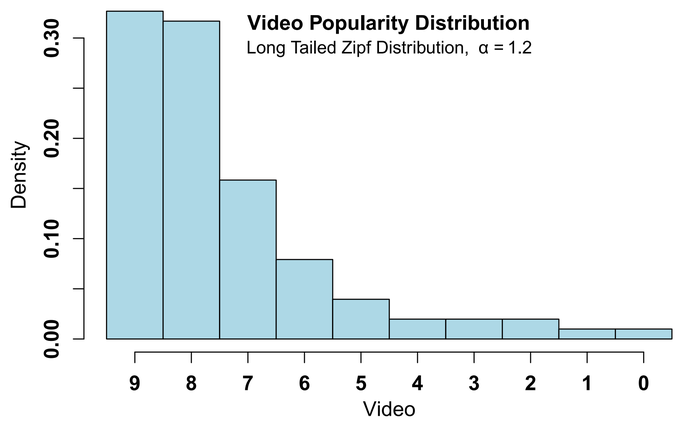
2. MPEG-DASH: Pure Client-driven Adaptive Streaming

- Due to its effectiveness in IP-based networks, the integration of MPEG-DASH (ISO/IEC 23009-1) in NDN has been investigated [2].
- MPEG-DASH enables adaptive streaming by splitting content into segments, which are encoded into various quality levels. Clients are responsible to select the appropriate segment(s) at each point in time.
- The MPEG-DASH adaptation process considers only local parameters, e.g., network throughput or video buffer level. NDN specifics are disregarded, causing negative side-effects.



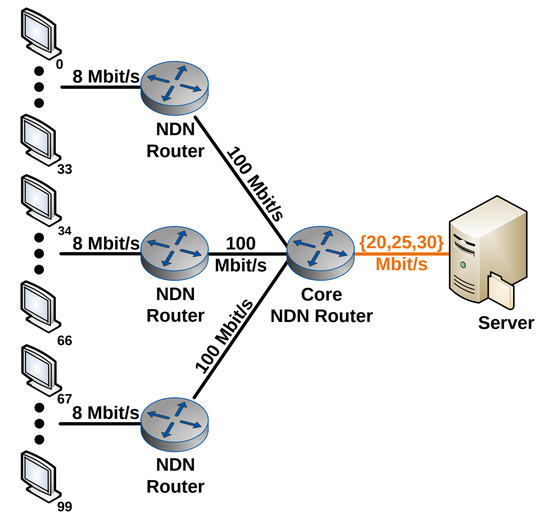
3. Content – Dataset and Popularity

- Video content is encoded according to the Scalable Video Coding (SVC) extension of H.264/AVC [3] using SNR-scalability.
- Six different quality levels (1290 – 3200 kbit/s) are provided.
- SVC-based encoding is chosen since NDN caches can be used more efficiently compared to non-scalable content encodings.
- Content popularity is modelled by a Zipf-like distribution.



Video Distribution	
Video	*Streamed by X Clients*
0,1	*1*
2,3,4	*2*
5	*4*
6	*8*
7	*16*
8	*32*
9	*33*

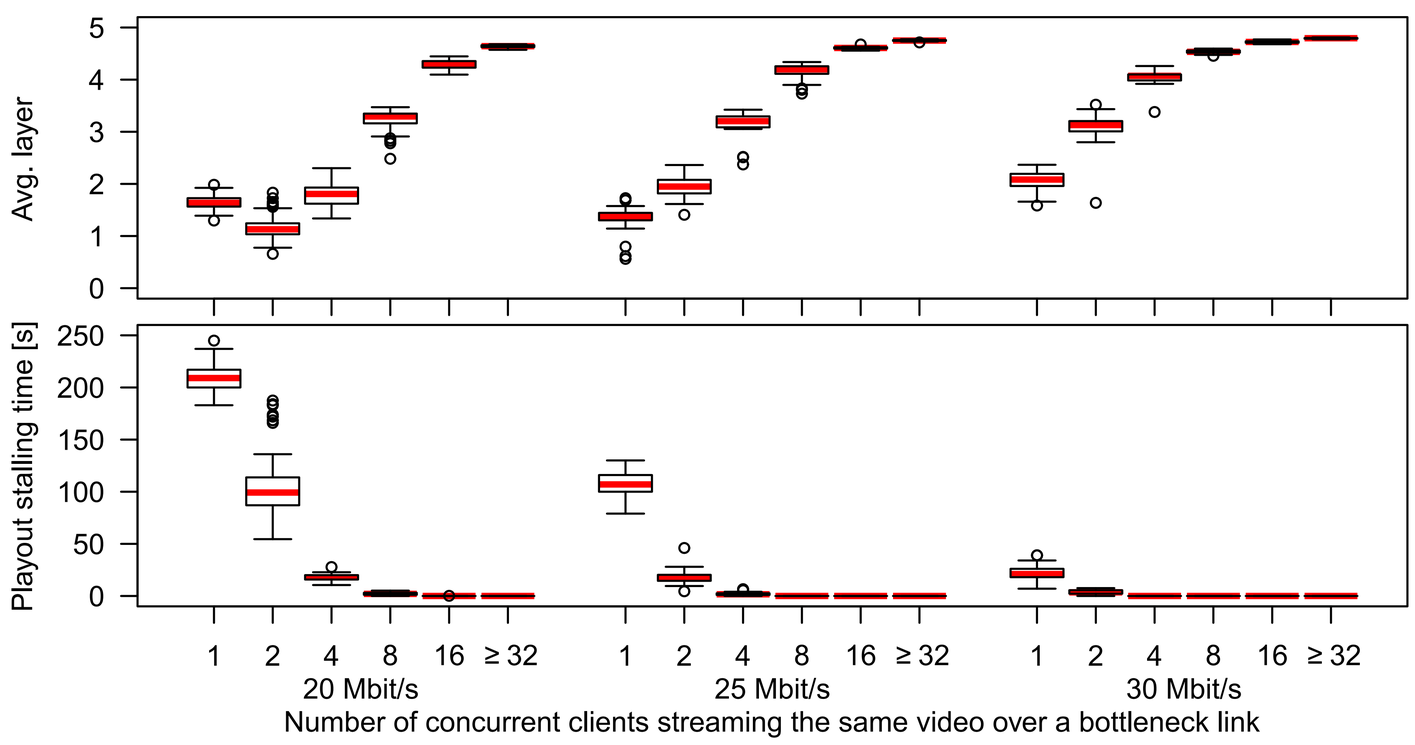
4. Experimental and Network Setup



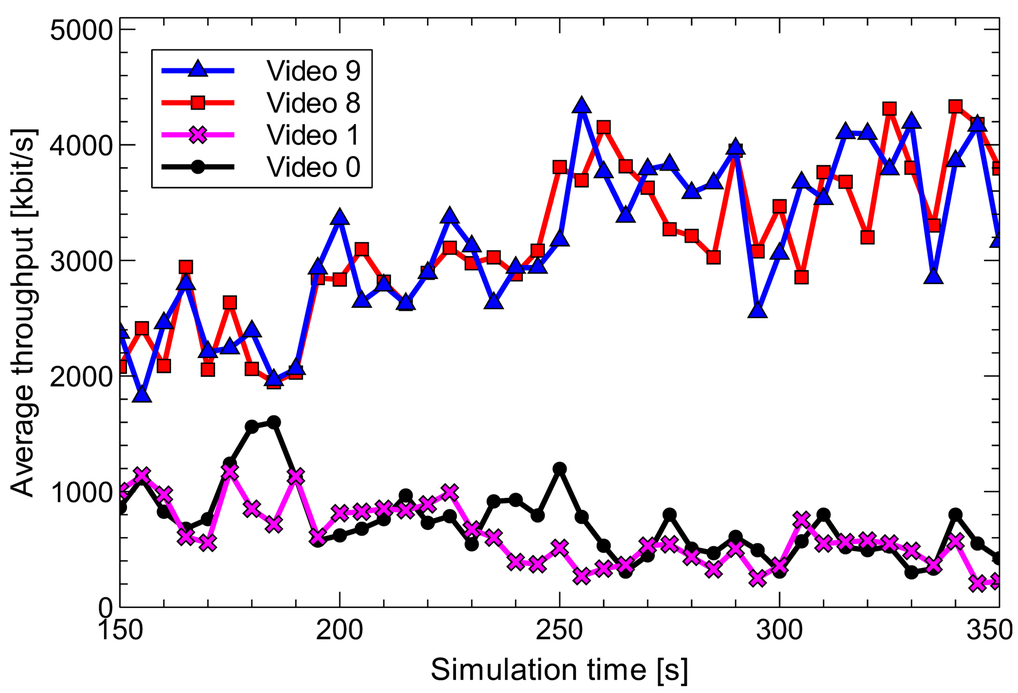
- 100 MPEG-DASH clients are streaming ten different videos over a bottleneck link (20, 25, 30 Mbit/s).
- For each evaluated bottleneck-speed 30 simulation runs are performed using the ns-3/ndnSIM simulator [4].
- For each run the video streamed by a client is randomly assigned based on the given popularity.

5. Results Showing the Issue of Client Starvation: Clients Streaming Unpopular Content Suffer from Unacceptable QoE

Average received layer and stalling time versus video popularity:



Average bandwidth share on the bottleneck link per video:



6. Conclusion and Future Work

- As clients are not aware of other concurrent consumers, the issue of Client Starvation cannot be resolved by pure client-driven adaptation.
- Client Starvation emerges within the network. Therefore the most effective place to approach this problem is within the network.
- We propose In-Network Adaptation (INA) to tackle Client Starvation. Readily available data in NDN nodes, e.g., information about the content and its dissemination, can be used to guide adaptation.
- We are going to investigate how INA can be enabled in the NDN context. Layered content encodings such as SVC [3] look promising, since they enable INA despite NDN's content-based security model.

References

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[3] H. Schwarz, D. Marpe, and T. Wiegand. Overview of the Scalable Video Coding Extension of the H.264/ AVC Standard. *IEEE Transactions on Circuits and Systems for Video Technology, 17(9):1103-1120*, 2007.
[4] A. Afanasyev, I. Moiseenko, and L. Zhang. ndnSIM: NDN Simulator for NS-3, *Technical Report NDN-0005*, 2012. Online: http://ndnsim.net/

Acknowledgements

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