iDASH: improved Dynamic Adaptive Streaming over HTTP using Scalable Video Coding

Yago Sánchez, Thomas Schierl, Cornelius Hellge, Thomas Wiegand - Fraunhofer HHI, Germany
Dohy Hong - N2N Soft, France
Danny De Vleeschauwer, Werner Van Leekwijck, Bell Labs - Alcatel Lucent, Belgium
Yannick Lelouedec - Orange Labs FT, France

Fraunhofer HHI

OUTLINE

Motivation

HTTP Streaming

SVC

Caching

Results

Conclusion

MOTIVATION

Service providers have resorted to use HTTP/TCP for Multimedia Delivery

- Relying on RTP/UDP may result in traversal problems with NATs and Firewalls
- HTTP/TCP allows re-useing existing HTTP cache infrastructures

Different type of users => poor cache performance

- Different equipment capabilities
- Different connectivity characteristics

Resources at the network limited

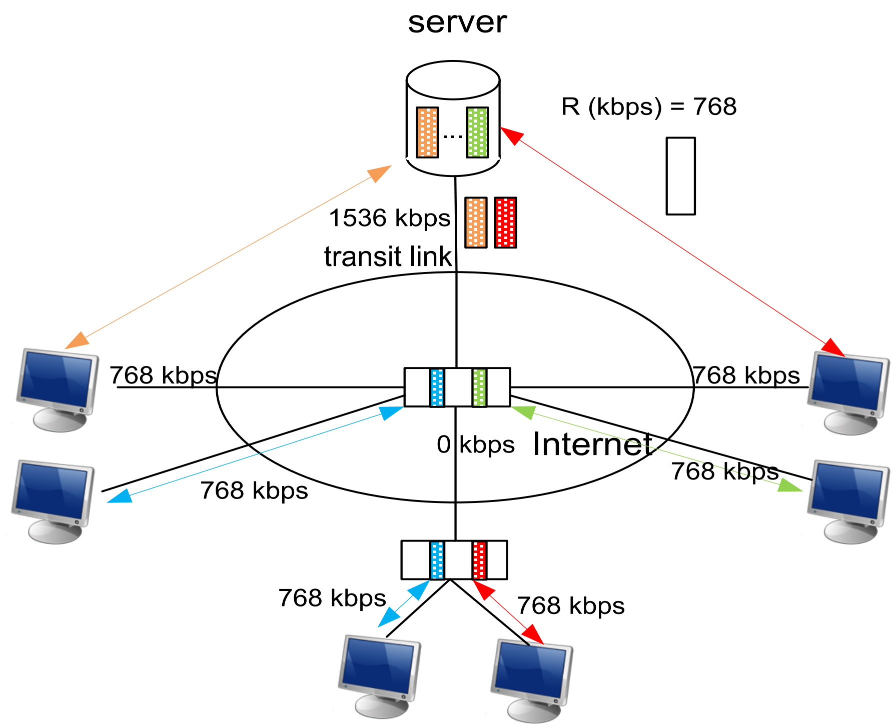
- Capacity on the links shared
- Storage in the HTTP cache not enough

HTTP STREAMING - INTRODUCTION

HTTP caches placed in the network reducing the load on the server and transit link

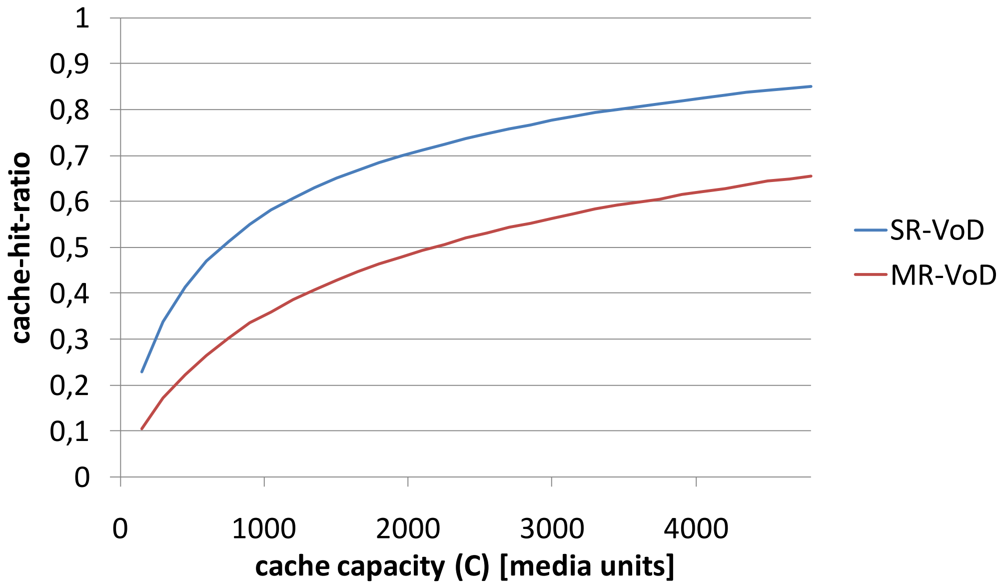
Video split in smaller segments/ chunks and transported over HTTP

Different representation of the video to allow the users to request the one that matches at best their capabilities



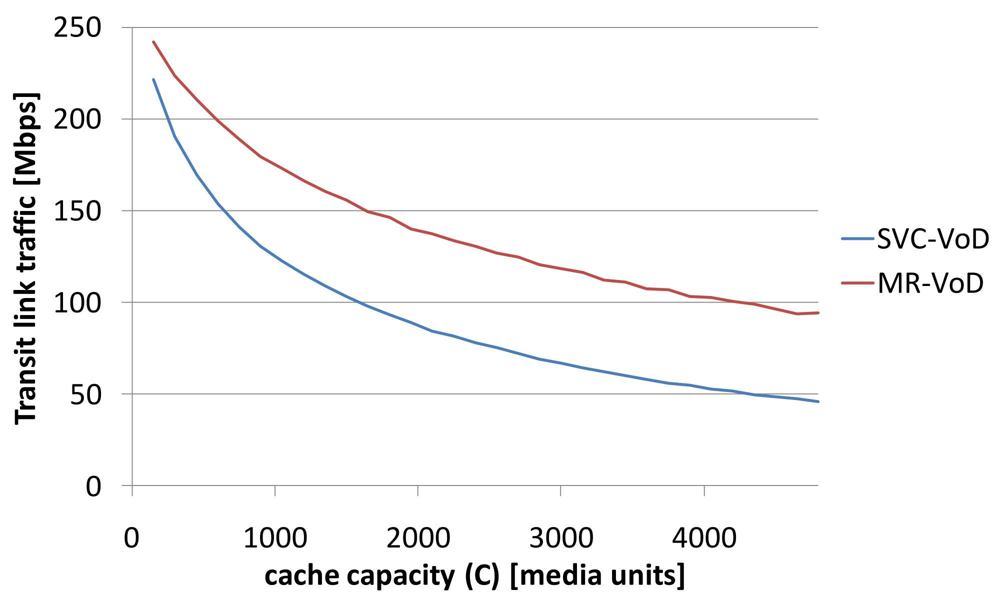
HTTP STREAMING – EFFECT OF MULTIPLE REPRESENTATIONS

Multiple Representations Video on Demand (MR-VoD) is less effective for caches performance than Single Representation Video on Demand (SR-VoD)



HTTP STREAMING – EFFECT OF MULTIPLE REPRESENTATIONS

With MR-VoD more data has to be sent from the server (though the transit link) than with SR-VoD



Proposed solution:

- USE SCALABLE VIDEO CODING (SVC) TO IMPROVE CACHE PERFORMANCE

SVC (SCALABLE VIDEO CODING)

This works focuses on SNR Scalability

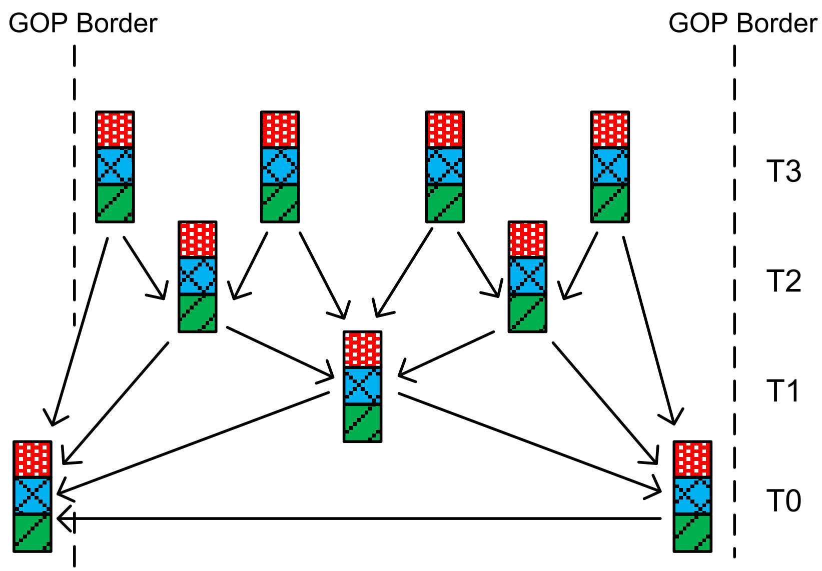
Representations are created from sub-streams of the whole SVC stream

Different representations mapped to Operation Points (OP)

- OPs based on complete Layers => If many it may increase the SVC overhead
- OPs also based on smaller parts of layers.

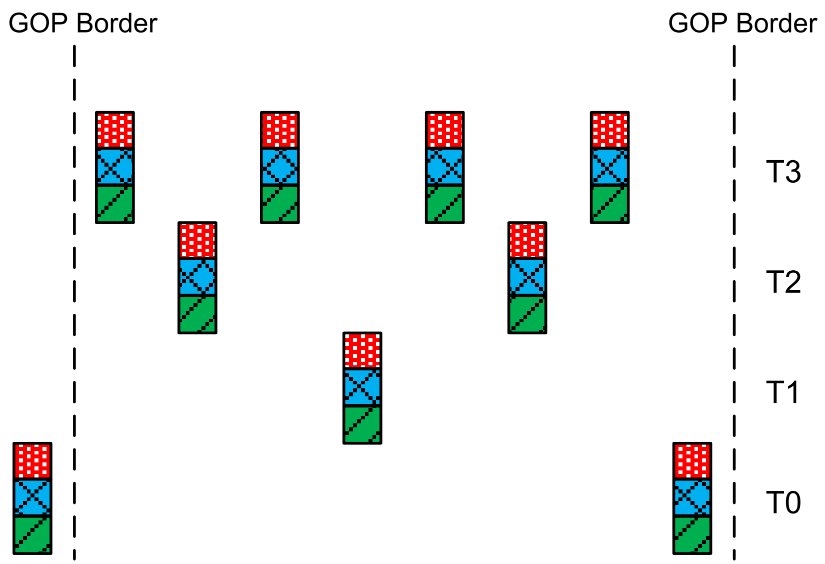
Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.



Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.

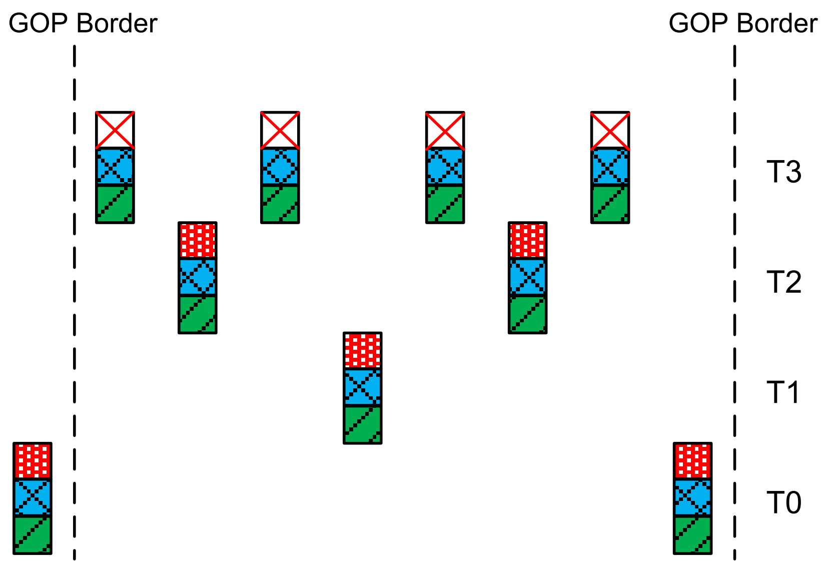


OP 0

SVC (SCALABLE VIDEO CODING) - EXAMPLE

Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.

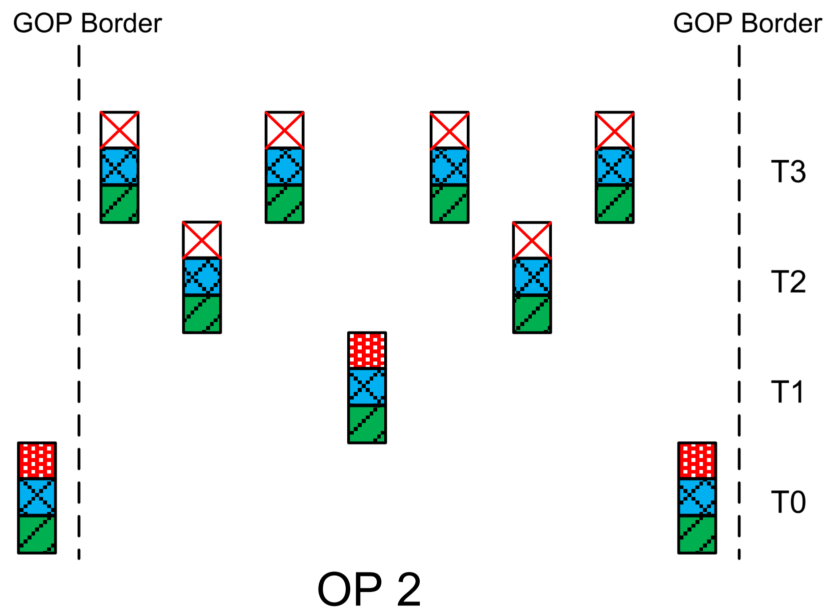


OP 1

SVC (SCALABLE VIDEO CODING) - EXAMPLE

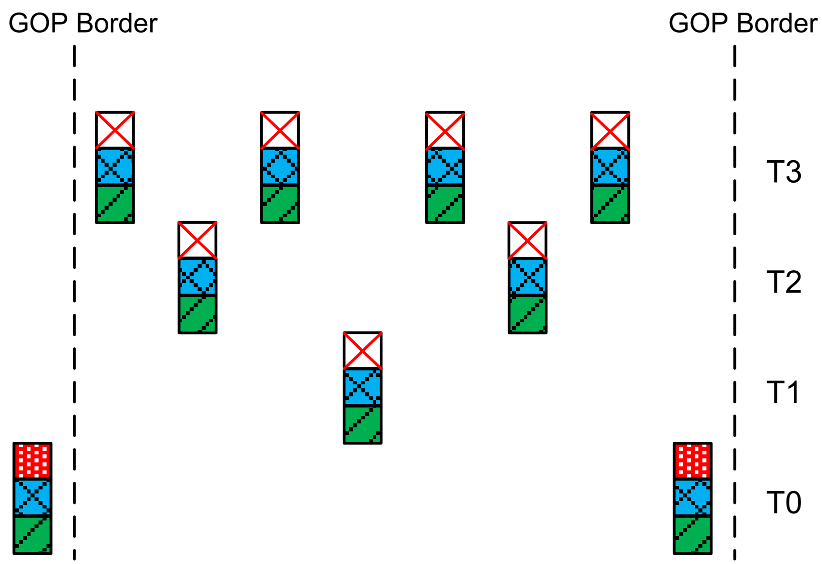
Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.



Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.

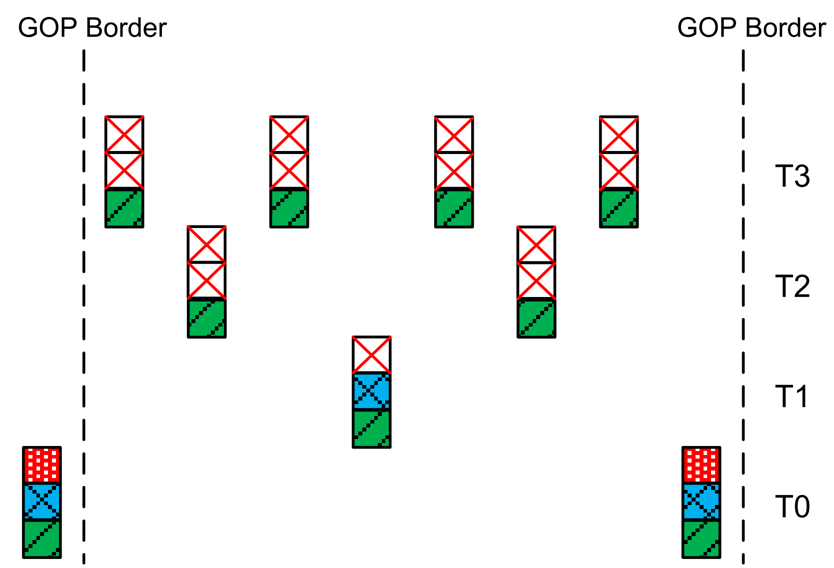


OP 3

SVC (SCALABLE VIDEO CODING) - EXAMPLE

Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.

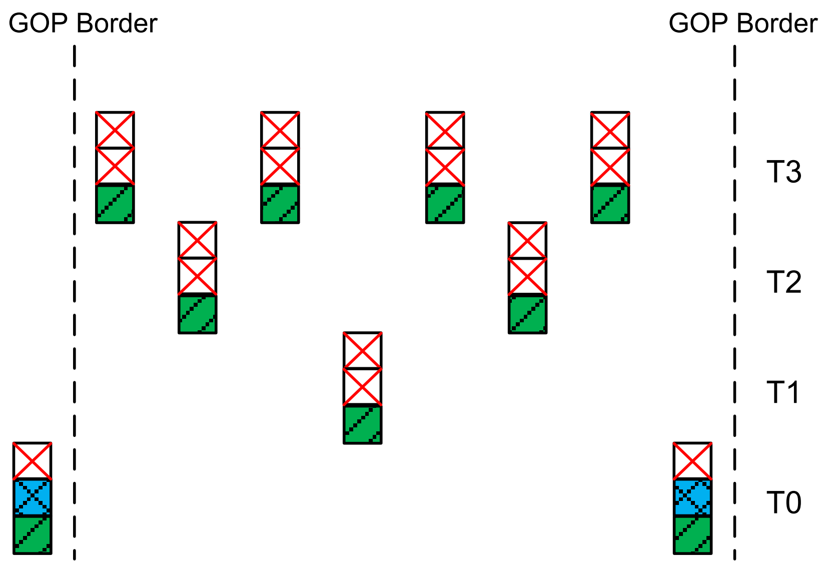


OP 5

SVC (SCALABLE VIDEO CODING) - EXAMPLE

Different representations/Operation Points (OP)

- OPs also based on smaller parts of layers.



OP 7

CACHING - I

Caches store data supposed to be asked in the future to relieve the server from having to send directly the data

There are many different cache replacement algorithms that improve the cache performance based on some especial criteria/metric

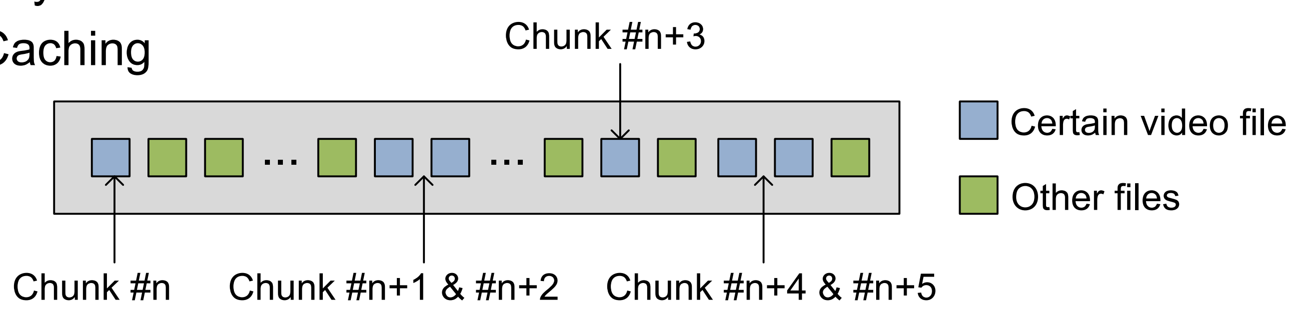
- LRU: Least Recently used
- LFU: Least Frequently used
- CC: Chunk-based Caching
- …

CACHING - I

Caches store data supposed to be asked in the future to relieve the server from having to send directly the data

There are many different cache replacement algorithms that improve the cache performance based on some especial criteria/metric

- LRU: Least Recently used
- LFU: Least Frequently used
- CC: Chunk-based Caching
- …

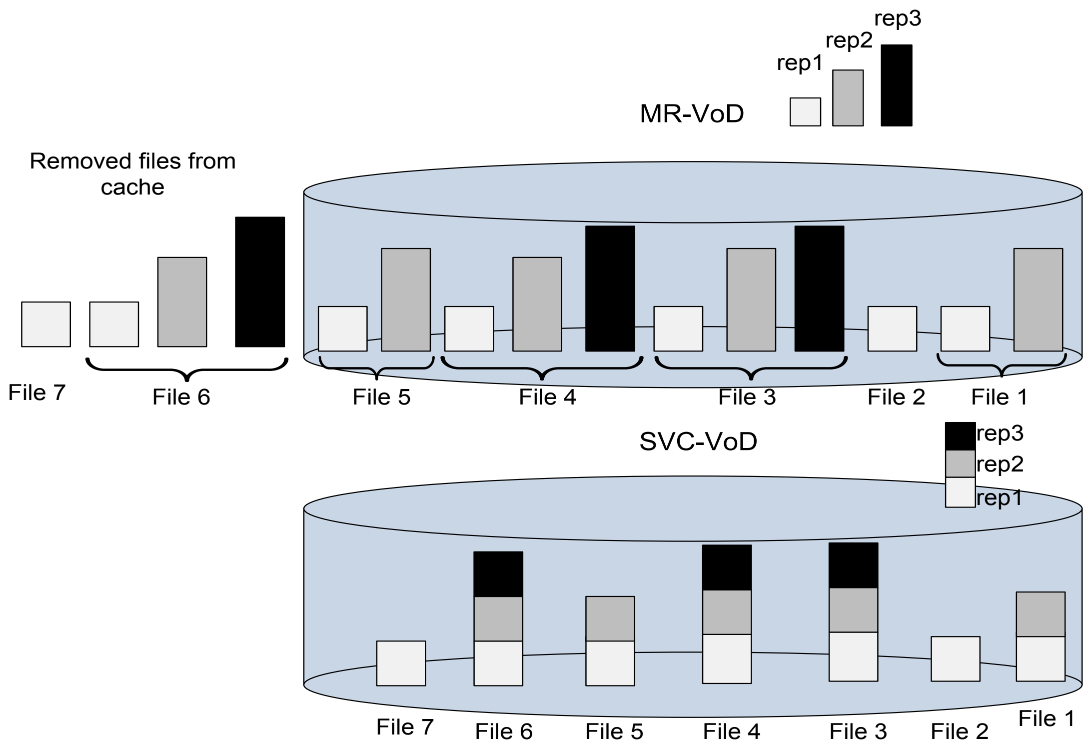


CACHING - II

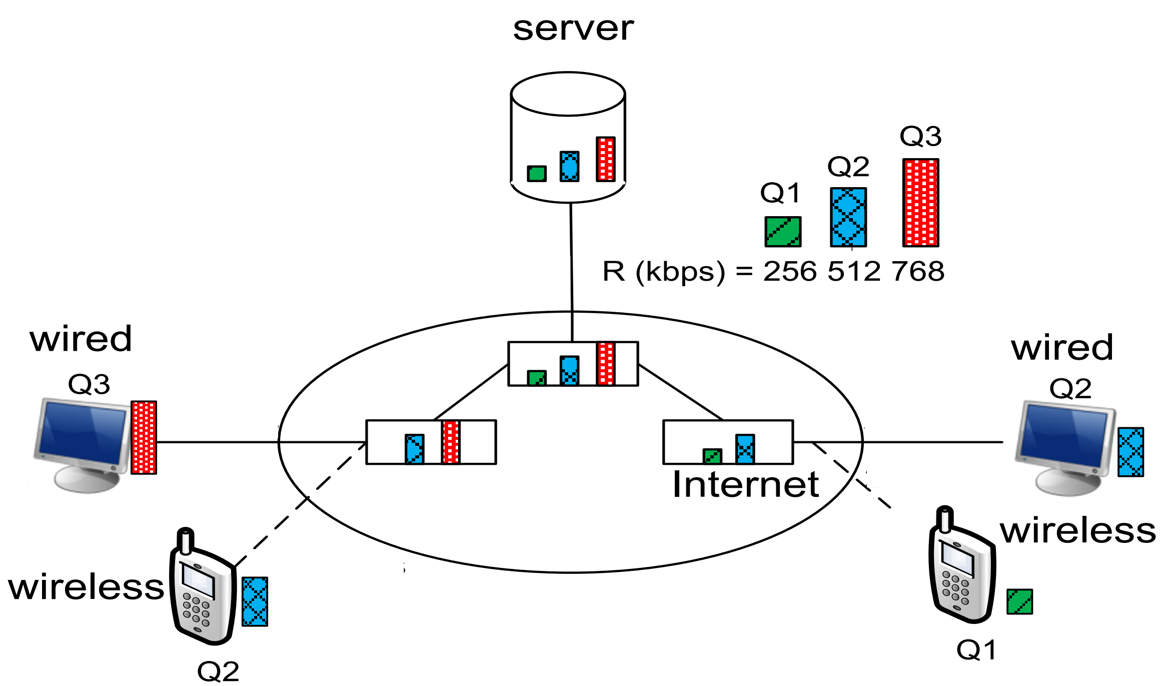
Cache performance can be easily improved by using SVC

- Cache storage better used than with MR-VoD
- Uneven distribution of request = more pronounced

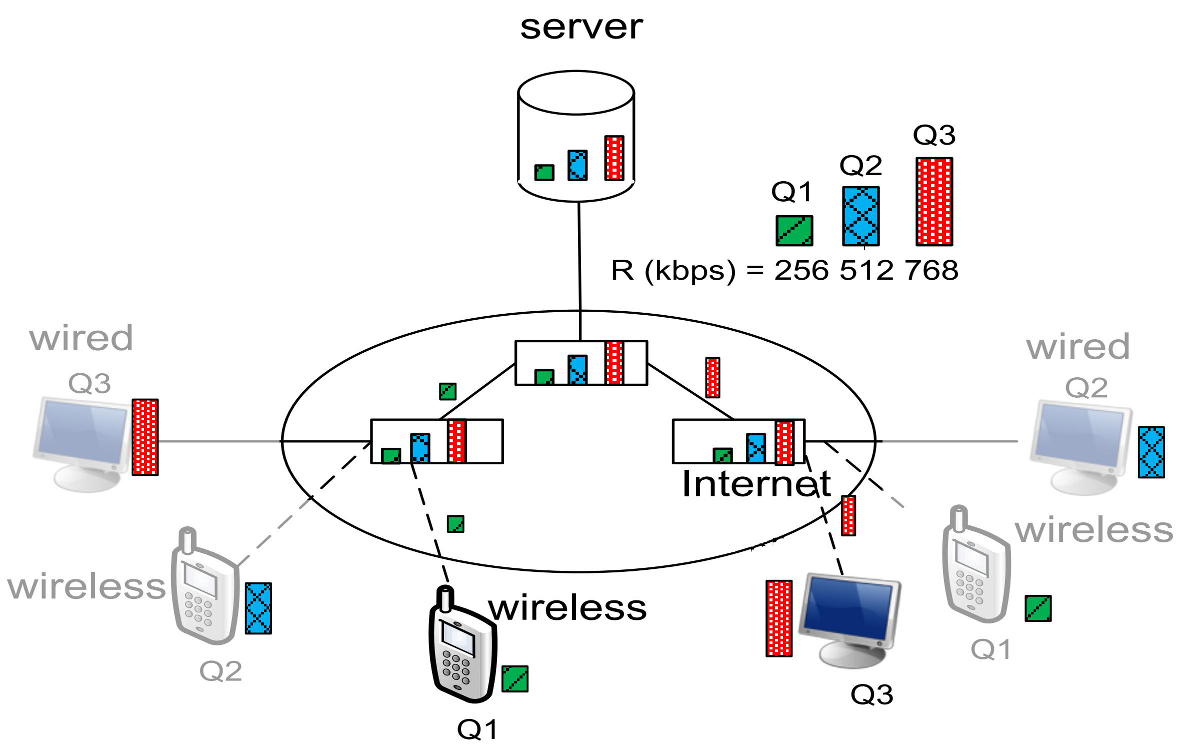
CACHING - CAPACITY USAGE COMPARISON



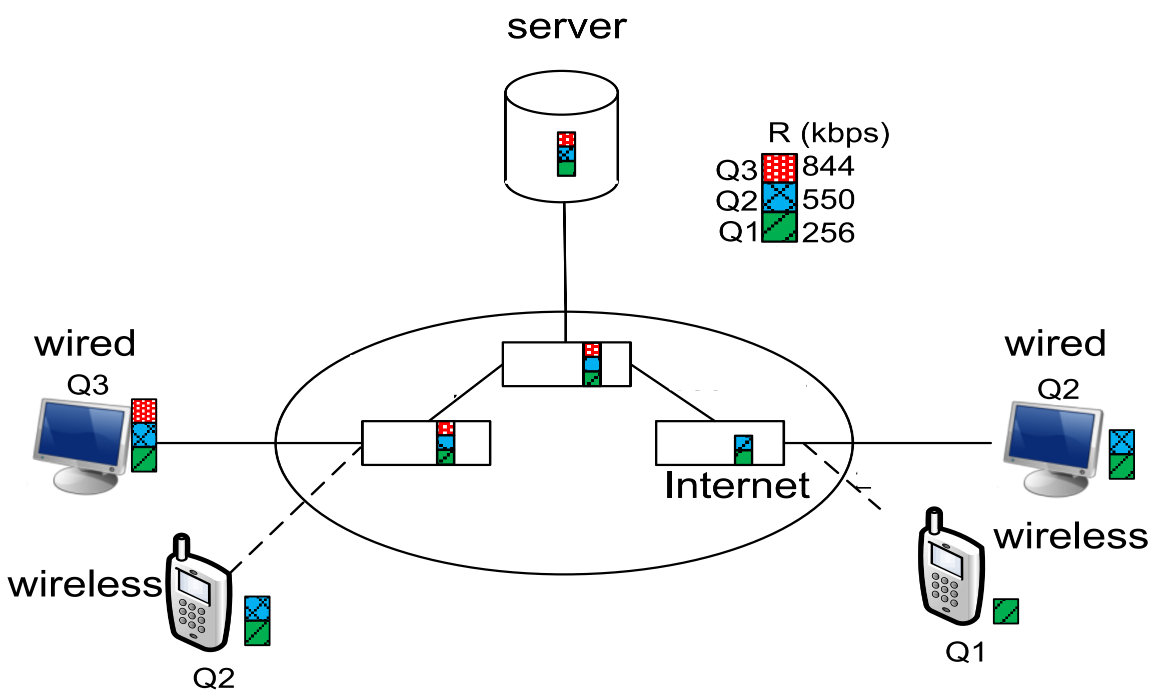
CACHING – EXAMPLE MR-VoD



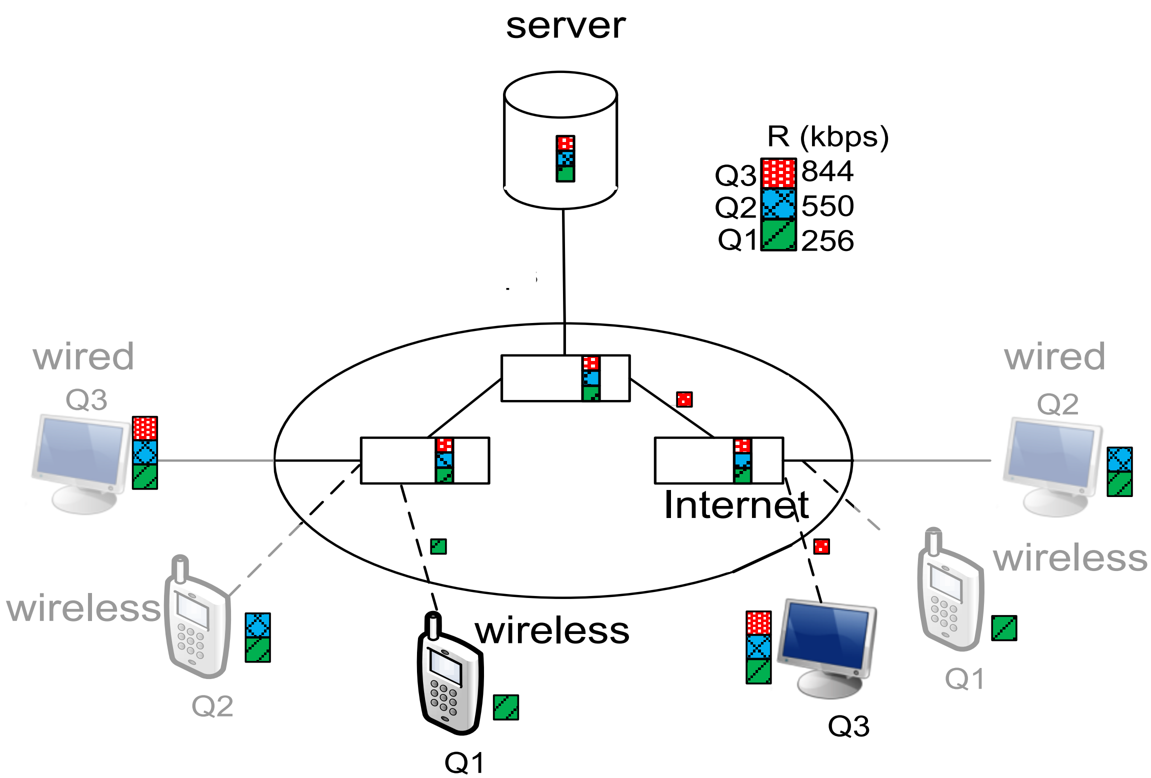
CACHING – EXAMPLE MR-VoD



CACHING – EXAMPLE SVC-VoD



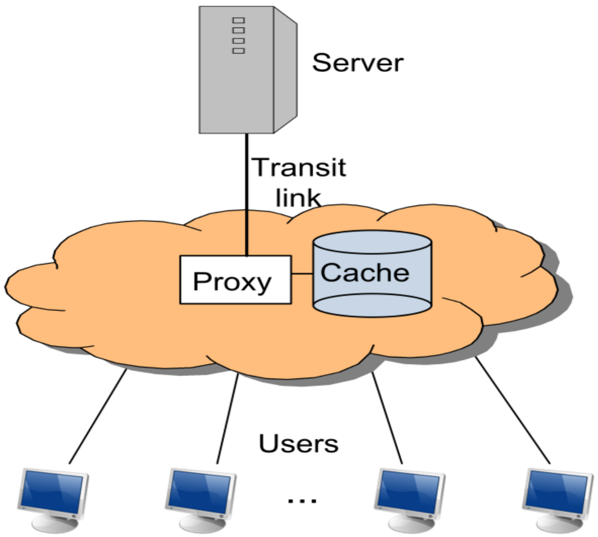
CACHING – EXAMPLE SVC-VoD



SIMULATIONS – SIMULATED SCENARIO

Statistics for users requests extracted from a deployed system

- Measured during a month
- More than 5000 files among which the users can choose
- 3400 requests per day on average
- This real system is SR-VoD



Cross traffic in access links

- 2 scenarios considered
  - Heavy cross traffic in Access link
  - Light cross traffic in Access link

SIMULATIONS – AVAILABLE REPRESENTATIONS

4 representations for each video to allow adaptation

SVC overhead of 10% compared to AVC

Rate Distribution of the representations

Codec	Rep. 1	Rep.2	Rep.3	Rep. 4
AVC	500 kbps	1000 kbps	1500 kbps	2000 kbps
SVC	500 kbps	1066 kbps	1633 kbps	2200 kbps

SIMULATIONS – AVAILABLE REPRESENTATIONS

Needed throughput in transit link and capacity in caches for all reps

AVC = 5000 kbps per video = (video of 90 min) **3375 MB**

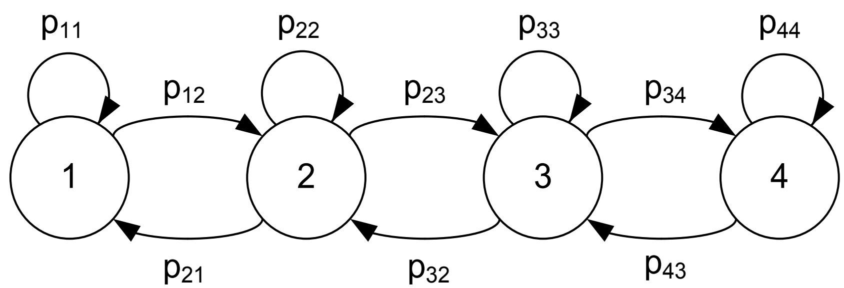
SVC = 2200 kbps per video = (video of 90 min) **1485 MB**

Rate Distribution of the representations

Codec	Rep. 1	Rep.2	Rep.3	Rep. 4
AVC	500 kbps	1000 kbps	1500 kbps	2000 kbps
SVC	500 kbps	1066 kbps	1633 kbps	2200 kbps

CROSS TRAFFIC

Four state Markov-chain simulated



$P=[p_{ij}]$

Cross traffic characterization:

- Mean state sojourn time

$$E[t_i]=\sum_{t_i=0}^{\infty}(t_i+1)*p_{ii}^{t_i}*(1-p_{ii})=\frac{1}{1-p_{ii}}$$

- Average percentage of time in each state

$$p_i:\pi*P=\pi$$

HEAVY CROSS TRAFFIC

Transition matrix

$$P = \begin{bmatrix} 0.996 & 0.004 & 0 & 0 \\ 0.004 & 0.992 & 0.004 & 0 \\ 0 & 0.004 & 0.992 & 0.004 \\ 0 & 0 & 0.004 & 0.996 \end{bmatrix}$$

Mean state sojourn time

$E[t_i]$ = 40 min (for segment of 10 sec length)

Average percentage of time in each state

25% of the time in each state

LIGHT CROSS TRAFFIC

Transition matrix

$$P = \begin{bmatrix} 0.9 & 0.1 & 0 & 0 \\ 0.096 & 0.9 & 0.004 & 0 \\ 0 & 0.002 & 0.985 & 0.013 \\ 0 & 0 & 0.004 & 0.996 \end{bmatrix}$$

Mean state sojourn time

$E[t_i]$=(approx.){2min, 2min, 10min, 40min}(for segment of 10 sec length)

Average percentage of time in each state

p={9.1%, 9.5%, 19.1%, 62.3%}

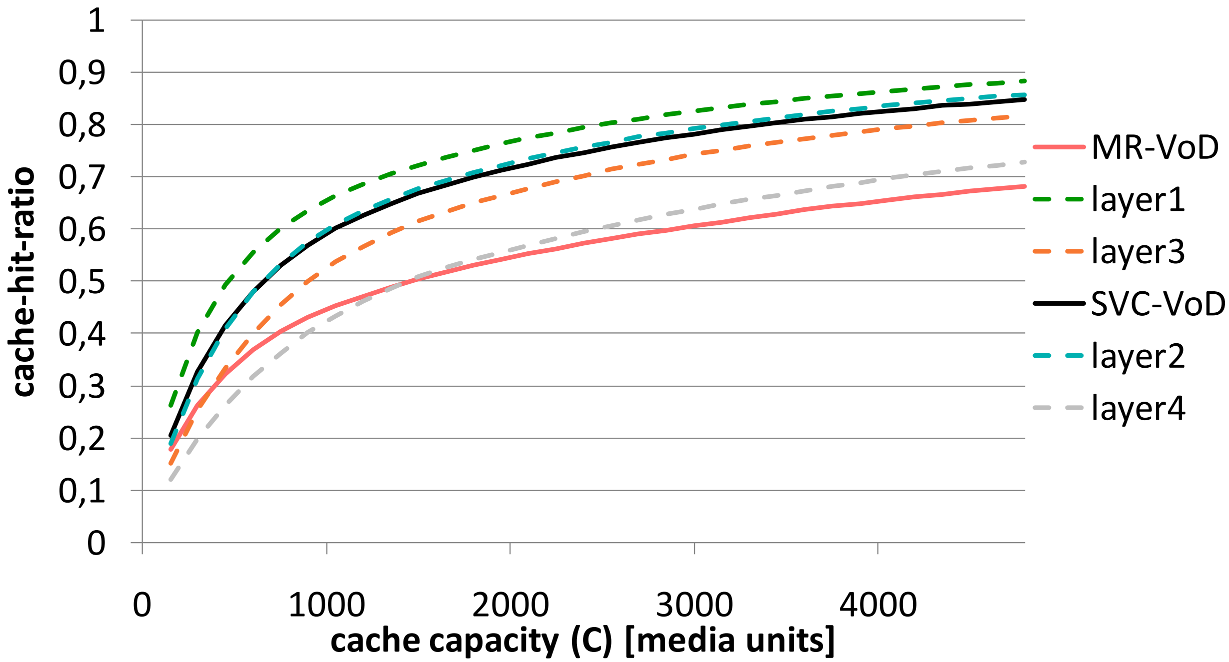
RESULTS-HEAVY CROSS TRAFFIC

Comparison of cache efficiency with MR-VoD and SVC-VoD

Cache capacity (media units)	LRU		CC	
	MR-VoD	SVC-VoD	MR-VoD	SVC-VoD
500	30.9 %	45.6 %	42.9 %	56.6 %
1000	42.1 %	58.2 %	52.0 %	64.5 %
2000	54.6%	69.0%	61.5%	72.0%

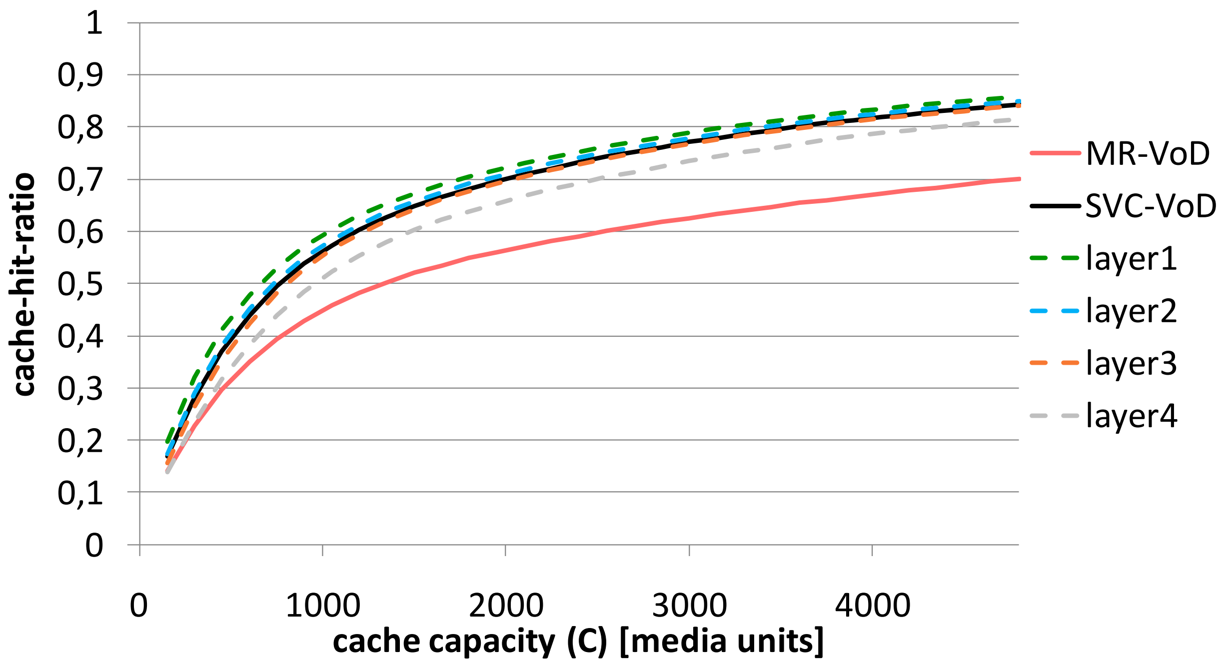
RESULTS-HEAVY CROSS TRAFFIC

Comparison of cache efficiency with MR-VoD and SVC-VoD



RESULTS-LIGHT CROSS TRAFFIC

Comparison of cache efficiency with MR-VoD and SVC-VoD



CONCLUSIONS

SVC can be efficiently encoded to get a high enough number of representations

HTTP-based VoD service can be easily improved by only using SVC

SVC-VoD results in a higher cache-hit-ratio and consequently in a lower traffic transmitted across the transit link between the server and the cache

Further work:

- Study the enhanced adaptability, faster response times with SVC
- Advantages of using SVC in DASH for Live Streaming

THANKS FOR YOUR ATTENTION!!!

Acknowledgments:

- The research leading to these results has received funding from the European Union's Seventh Framework Programme ([FP7/2007-2013]) under grant agreement n° 248775