Scalable Video Coding based DASH for efficient usage of network resources

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Abstract

Global Internet traffic shows an upward trend with annual growth rates as large as 50%. The share of video streaming and download services is growing and takes an increasingly large proportion of the total bandwidth. In addition, the success of mobile network technologies and the further spread of mobile Internet lead to an increased diversification of access data rates and internet terminals like smartphones, tablets, or laptops. In such a context, Content Delivery Networks (CDNs) are forced to offer all content in multiple versions for different resolutions and bitrates. Emerging adaptive streaming technologies will further increase the number of required representations due to additional adaptation points. The enormous proliferation of different versions of each content becomes a challenge for the efficiency of existing network and caching infrastructure.

This position paper provides a summary of the benefits of adopting the Dynamic Adaptive Streaming over HTTP (DASH) based on the Scalable Video Coding (SVC) as key technology for spreading video streaming over the Internet and making it a ubiquitous application. It describes how due to the adoption of SVC network resources are more efficiently used, which has a big importance for reducing costs of deployment of such a service.

Introduction

HTTP-based video streaming has been gaining popularity within the recent years due to its simplicity and other benefits, such as the usage of the widely deployed network caches to relieve video servers and the avoidance of problems with firewall and NAT traversal when RTP/UDP-based solutions are considered. Therefore, many service providers have resorted to adopt HTTP streaming as the basis for their services. Furthermore, as reported in [1] internet multimedia applications and especially video streaming is continuously growing and has become a very significant proportion of the global Internet traffic. This fact is even expected to be intensified by the success of mobile network technologies, which make internet ubiquitous and will lead to a sharp increase in the video streaming related traffic [2]. With such a forecast, means for reducing the streaming related Internet traffic are highly desired to allow service providers to cope with the increasing demand of streaming services, while keeping the infrastructure cost at an acceptable level.

Dynamic Adaptive Streaming over HTTP (DASH) is expected to be one of the killer applications of the following years. The growing interest of such a service is obvious. Proprietary adaptive streaming solutions are provided by major players like Adobe Systems [3], Apple [4], Microsoft (IIS Smooth

Streaming) [5]. And several standardization processes have been initiated recently in this domain, such as MPEG's Dynamic Adaptive Streaming over HTTP (DASH) [6], 3GPP Adaptive Streaming over HTTP [7] and OpenIPTV Forum HTTP Streaming specification [8].

Scalable Video Coding (SVC) and applicability to DASH

Scalable Video Coding (SVC) [10] allows representing video into different versions with different frame rates, spatial resolutions and/or quality levels (fidelity to the original video) by a single video stream. A SVC stream consists of a base layer and one or more enhancement layers. The base layer corresponds to the version with the lowest frame rate, spatial resolution and/or quality. By adding enhancement layers the resulting decoded video is enhanced in any of the aforementioned dimensions. SVC is a perfect candidate for adaptation, which is a main aspect in DASH [6].

In DASH clients are responsible for performing adaptation: it is a client-driven adaptation. Clients receive an XML document, the Media Presentation Description (MPD), where available media at the server is described. Media is arranged at the server into *Representations*, which users have to select to create an appropriate presentation. For more information, the reader is referred to [6].

When SVC is used in DASH, the different SVC layers can be split and distributed into different *Representations*. If users have enough throughput they can request all the representations with all the layers, but when their throughput is limited, they can omit request to data from the representations containing the highest layers.

Impact on caching efficiency by adaptive streaming

The efficiency of caching infrastructure in adaptive streaming has been studied thoroughly within the European Project OCEAN [11] and reported in [9].
Figure 1 shows a possible DASH architecture. Typically in a DASH environment HTTP caches are placed between the DASH server and the clients in order to reduce the outgoing traffic at the server.

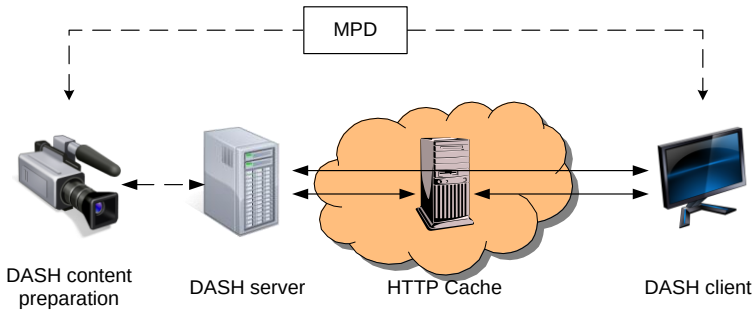

Figure 1: Example for DASH architecture

With AVC based DASH, clients interested in the same media content may request different versions of this content due to different equipment capabilities or connectivity characteristics. Therefore, cache performance is decreased, since first more files have to be stored in the cache and second there is a higher diversity in the client requests compared to the case where only one version for each media content is available. The cache performance comparison of the aforementioned cases has been studied in [9] and is shown in Figure 2, where a non-adaptive service with a unique *Representation* per content and DASH with four versions (*Representations*) of each media are compared. For DASH, for each media content the request distribution of the qualities is uniformly distributed. The request pattern of the users, i.e. which films are requested, are measured from a real deployment of a VoD service. For more information the reader is referred to [12].

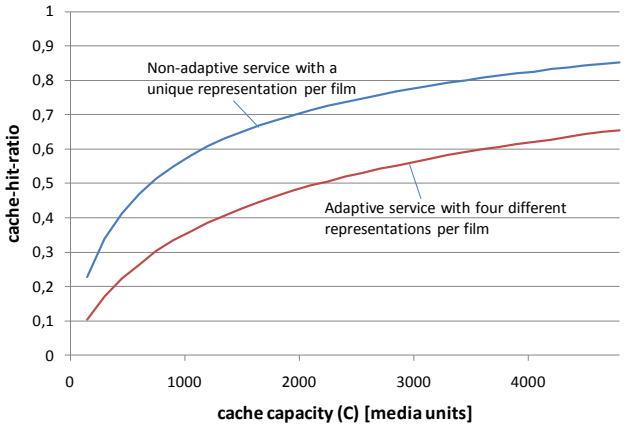

Figure 2: Cache-hit ratio for a non-adaptive and an adaptive service

As shown in the figure, the cache performs quite poorly due to the increased diversity of files for allowing adaptation to the network conditions.

Improved caching efficiency with SVC based DASH

As already stated, our proposal to cope with this drawback is to use SVC. In the case of SVC different qualities are directly mapped to a different number of layers downloaded. However, clients requesting the same video content at different qualities share some common *Representations*, corresponding to the lowest layer, e.g. the base layer, which all clients download always. This leads to a better performance of the cache. A comparison to the AVC based DASH is shown in Figure 3.

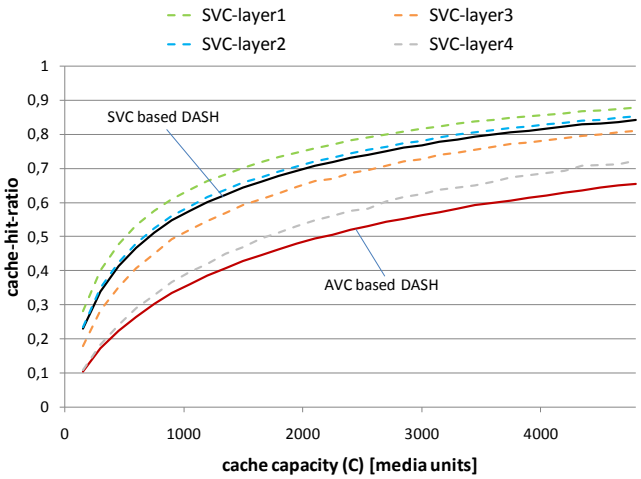

Figure 3: Cache-hit ratio comparison for SVC and AVC

As shown in the figure the SVC approach outperforms the AVC approach. Also, for the SVC approach, the cache-hit ratio for each layer separately is shown, where the base layer corresponds to *SVC-layer1* and the highest enhancement layer corresponds to *SVC-layer4*. As expected, the cache hit ratio for the base layer is the highest one. For more information the reader is referred to [9].

Figure 3 shows that the average cache-hit-ratio with SVC based DASH is significantly higher than with AVC based DASH. Furthermore, the difference in caching efficiency increases with a higher number of representations as it can be expected for future CDNs, which will serve mobile and fixed receivers.

Conclusion and Statements

DASH is expected to be a very successful technology. However, W3C is going to play a very important role in the spread of video streaming to a big mass of the population by its development of HTML5. If DASH is as successful as it is foreseen, the multimedia related traffic will increase tremendously. However, this has to happen in the most network-friendly way as possible to ensure its applicability and low cost for content providers.

Since W3C plays this important role and SVC has shown to be a valuable mean to reduce the streaming traffic within the network. W3C is encouraged to take into account SVC based DASH as a key solution for ubiquitous video streaming over the internet.

Considering the current situation and results described in this position paper, we can summarize the following statements.

- The entire Internet traffic is increasing significantly and video distribution will have a large proportion of this.
- Diversification of devices is forcing CDNs to offer several versions of each content with different bit rates and qualities.
- Adaptive HTTP streaming technologies (DASH) introduce several representations per content, which leads to reduced cache efficiency and thus to further increase of traffic on the network.
- Scalable Video Coding (SVC) is a key technology in order to align with the requirements of future video delivery to mobile and stationary internet users.

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