Dynamic Adaptive Streaming over HTTP: From Content Creation to Consumption

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ABSTRACT
In this tutorial we present dynamic adaptive streaming over HTTP ranging from content creation to consumption. It particular, it provides an overview of the recently ratified MPEG-DASH standard, how to create content to be delivered using DASH, its consumption, and the evaluation thereof with respect to competing industry solutions. The tutorial can be roughly clustered into three parts. In part I we will provide an introduction to DASH, part II covers content creation, delivery, and consumption, and, finally, part III deals with the evaluation of existing (open source) MPEG-DASH implementations compared to state-of-art deployed industry solutions.

Categories and Subject Descriptors
H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Video.*

General Terms
Algorithms, Design, Experimentation, Measurement, Performance, Standardization.

Keywords
Adaptation, DASH, Dynamic Adaptive HTTP Streaming, MPEG, Streaming.

1. INTRODUCTION
In recent years the Internet has become an important channel for the delivery of multimedia using HTTP as its primary protocol and a number of proprietary solutions are available. Several of these solutions implement dynamic adaptive streaming over HTTP which allows clients that receive a video to observe their own network throughput and use this information to choose from several levels of compression that are made available by servers. This quality switching can be done at predefined points in time of the video's playback schedule. The advantage of this approach is that it exploits existing and widely deployed infrastructures and a pragmatic division of concerns. However, dynamic adaptive streaming is far less understood than classical streaming approaches and much research is still required to identify how components interact with each other, how alternative compression techniques can be used, how it can be used in the context of applications, and how overall performance can be optimized.

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The aim of this tutorial is to provide an overview of the recently ratified MPEG-DASH standard [6][1], how to create content to be delivered using DASH, its consumption, and the evaluation thereof with respect to competing industry solutions. One of the essential differences between DASH and earlier streaming solutions is that the client is in charge of adapting its demands to the bandwidth share that is available for serving it. This client behavior is not standardized and differentiates players.

2. MPEG-DASH
In April 2012 ISO/IEC published the first part of DASH comprising media presentation description and segment formats. It addresses the industry needs of segmented delivery of multimedia assets in a dynamic adaptive way using individual HTTP (partial) GET requests. The relationship between the segments is described in a media presentation description (MPD) which is made available to the client prior to the actual streaming. Based on the MPD the client schedules HTTP requests for the individual segments encapsulated using either ISO base media file format (ISOBMFF) or MPEG-2 transport stream (M2TS). The MPD defines a hierarchical data model comprising periods, adaptation sets, representations, and the actual segments. While periods allow to separate multimedia assets along a timeline, adaptation sets and representation provide different encodings of the same content based on certain characteristics such as bitrate, resolution, frame rate, language, etc. The dynamic adaptive behavior is achieved by switching between representations of adaptation sets at predefined points in the presentation timeline. The way in which this is done is not defined in the standard and left open for industry competition.

3. CONTENT CREATION, DELIVERY, AND CONSUMPTION
For the actual deployment of DASH a couple of issues need to be discussed which are addressed in this tutorial as follows:

- How to create content for DASH? This includes issues regarding the appropriate coding format, bitrate, resolution, frame rate, segment length, and the actual quality. Additionally, content creation is concerned whether the different modalities (i.e., audio, video, text) are multiplexed or provided as individual streams.
- How to deliver content using DASH? As it is based on HTTP, it is naturally well-behaved in an Internet that is dominated by TCP traffic. DASH may even utilize existing infrastructures such as content delivery networks and proxy caches. However, the traffic patterns seen in DASH streaming differ

from known traffic, and the positive and negative effects are still to be evaluated.

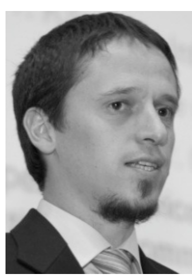
- How to consume content using DASH? In contrast to older streaming methods, this consideration is central in DASH because clients rather than servers make timing and adaptation decisions. They involve client implementation issues such as adaptation logic, bandwidth estimation, and segment request scheduling. Decisions are influenced by device capabilities, and must take user satisfaction into account.

Finally, we will present existing (open source) implementation efforts including VLC, GPAC, libdash, DASHEncoder, dataset, DASH-JS, and mobile platforms [2].

4. EVALUATION

As part of the evaluation we are going to present how current industry standard solutions, including Microsofts' Smooth Streaming, Netflixs' variant, Apples' HTTP Live Streaming, and Adobe's Dynamic HTTP Streaming perform [3]. In particular, we explain how this performance comes to pass and where each of the solutions is applicable. It may not be obvious, but widely different behavior is desirable for on-demand streaming to wireless devices, on-demand streaming to home cinemas, joining continuous live streams, or waiting for a live event. We present the differences and the best-known adaptation policies. Since a good adaptation is meant to create the best possible user experience, we provide insides into their connection based on user studies [4]. Obviously, the strategies matter only if network performance varies. We will therefore also explain how different bottlenecks in the network can be approached [5].

5. BIOGRAPHY OF PRESENTERS



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