HTTP Streaming of MPEG Media

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Abstract—MPEG has developed various technologies for multimedia transport, such as MPEG-2 Transport Stream (TS) and ISO Media Base File Format. These technologies have been widely accepted and heavily used by various industries and applications, such as digital broadcasting, audio and video transport over the Internet, mobile phones, etc.

In recent years, the Internet has become an important channel for the delivery of multimedia. As HTTP is widely used on the Internet, it has recently been used extensively for the delivery of multimedia content. However, there is no standard for HTTP-based streaming of MPEG media. MPEG intends to standardize a solution that addresses this need.

This paper provides an overview of the recent Call of Proposals (CfP) for HTTP Streaming of MPEG Media, a new work item within ISO/IEC MPEG. In particular, it will provide an overview of existing systems and the outcome of the evaluation of the aforementioned CfP which has been conducted during the 93rd MPEG meeting in July 2010.

I. INTRODUCTION

HTTP streaming is referred to as the delivery of continuous media such as audio or video using the Hypertext Transfer Protocol (HTTP) enabling the end user to consume the media without the need to download the entire content prior to consumption. The media distribution method has become a de-facto standard on the Internet for two reasons. First, reasonable Internet connectivity (i.e., in terms of bandwidth for media content) is nowadays available anywhere, anytime, and almost on any device. Second, the usage of HTTP does not cause any NAT/firewall issues as it is the case with other media transport protocols like RTP/RTSP. However, there is no standard for the HTTP streaming of (MPEG) media and, thus, MPEG intends to produce a standard which shall address this need. In this paper we provide an overview of the recent call for proposals on the HTTP streaming of MPEG media [1]. In particular we will review the requirements, context and objectives, and scope for this new standard. Furthermore, we will provide first insights to the outcome of the evaluation conducted during the 93rd MPEG meeting in July 2010 [2] resulting in a new work item called Dynamic Adaptive Streaming over HTTP (DASH). Finally, we present our prototype implementation based on the VideoLan Client (VLC) [3].

The remainder of this paper is organized as follows. Section II provides an overview of related work in this area. The requirements for HTTP streaming of MPEG media are summarized in Section III. The outcome of the CfP is described in Section IV as Dynamic Adaptive Streaming over HTTP (DASH) and Section V presents our prototype implementation. Finally, the paper is concluded in Section VI.

II. RELATED WORK

This section provides an overview of related work in the area of HTTP streaming in alphabetic order. Recently, 3GPP already specified Adaptive HTTP Streaming (AHS) [1] which defines a Media Presentation Description (MDP) and extensions to the well-known ISO Base Media File Format (ISOBMFF) [5]. The former is an XML document providing a manifest/session description which enables the client to request individual media segments via HTTP. The media segments are compliant to a delivery format that has been derived from the ISOBMFF.

Adobes' Dynamic HTTP Streaming [6] is based on their own Flash media manifest and F4F file format. The former is an XML document similar to 3GPPs' MPD and the latter are MP4 fragment files, i.e., also based on ISOBMFF. However, the solution is proprietary and not compliant to 3GPP AHS.

Apples' HTTP live streaming [7] is well known for quite some time and implemented on the iPhone and similar devices. It makes use of a M3U playlist file which serves as the manifest and each media file must be formatted as an MPEG-2 Transport Stream (M2TS) [8].

Finally, Microsofts' Smooth Streaming [9] is also around for a while which utilizes a server manifest file (i.e., SMIL document) and a client manifest file (i.e., proprietary XML document). Furthermore, this approach defines a smooth streaming format (ISMV) as an extension of the ISOBMFF. Additionally, they have also provided a comparison with the solutions provided by Apple and Adobe [10].

Interestingly, all of them utilize some kind of manifest file and extend the ISOBMFF. The manifest file does not follow any (metadata) standard such as MPEG-7 [11] or MPEG-21 [12] which in our view could be used for defining the manifest with probably some (minor) extensions. In any case, this manifest file looks like an interesting use case for the concept of the Digital Item introduced by MPEG-21 [13]. Furthermore, it seems there is a need to extend the ISOBMFF in order to support HTTP (live) streaming. Note that MPEG is currently defining an amendment for part 12 of MPEG-4 – the home of the ISO Base Media File format – which is called "AMENDMENT 2: Support for sub-track selection & switching, post-decoder requirements, and color information" [14]. Finally, Riiser et.at. defined a low overhead container format for adaptive streaming [15] that proposes an alternative to the MPEG family of delivery formats (i.e., M2TS, ISOBMFF, and derivations thereof) for the streaming over HTTP.
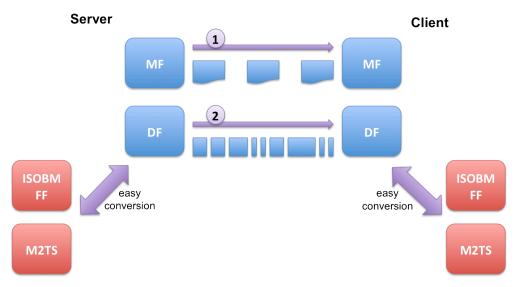
Figure 1. DASH System Architecture.

III. REQUIREMENTS FOR HTTP STREAMING OF MPEG MEDIA

A. Use Cases

The use cases for which requirements have been defined can be clustered into the following domains [16]:

- **Emerging applications and contents** such as Ultra-HD (UHD) content, 3D video, and interactive 3D.
- **Adaptivity** concerning different network and device capabilities and conditions.
- **Delivery** in terms of progressive download, peer-to-peer (P2P), multi-channel (multi-pipe) delivery, and relaying of content.
- **Convergence** with respect to the network and the service. The latter can be further divided into content plus e-commerce and content plus widget respectively.
- **Transparency** to content protection and rights management.

B. Objectives and Scope

The main objectives of HTTP streaming of MPEG media are as follows [17]:

- efficient delivery of MPEG media over HTTP in an adaptive, progressive, download/streaming fashion;
- support of live streaming of multimedia content;
- efficient and ease of use of existing content distribution infrastructure components such as CDNs, proxies, caches, NATs and firewalls;
- support of integrated services with multiple components;
- support for signaling, delivery, utilization of multiple content protection and rights management schemes; and
- support for efficient content forwarding and relay.

The scope can be divided into three functional areas [17]:

- **Encapsulation and storage** is defined as data formats, either stored on some storage device, or carried as a payload using the HTTP protocol. It includes M2TS, ISOBMFF, and their possible derivations and extensions.
- **Delivery** for which the target protocol is HTTP.
- **Control** is defined as an interactive protocol allowing service discovery, session initialization, remote control, and management.

C. Requirements

The actual requirements are organized into the following categories: *content*, *delivery*, *decoding and presentation support*, *service control*, *adaptation*, and *content protection* [18].

Requirements for content are further subdivided into the aggregation of content and its components and the type of content. The former is asking to support a flexible combination of content components including convenient conversion between delivery and storage formats. The latter refers to which type of content shall be support by this standard, namely any type of MPEG media (and possibly other non-MPEG media), including current and future MPEG codecs, in protected or unprotected form.

The requirements on delivery obviously make a reference to HTTP and to the usage of existing infrastructures for caching in Content Distribution Networks (CDNs). Additionally, they request for random access, trick modes, and the like.

Decoding and presentation support mainly addresses synchronization issues of content components. Service control is referred to as service discovery and initialization. Adaptation in the context of HTTP streaming may include an initial selection as well as dynamic changes during the session along axes such as bit-rate, temporal resolution, spatial resolution, quality/fidelity, or view perspective. Finally, the standard shall support content protection but shall be independent of any particular rights management system.
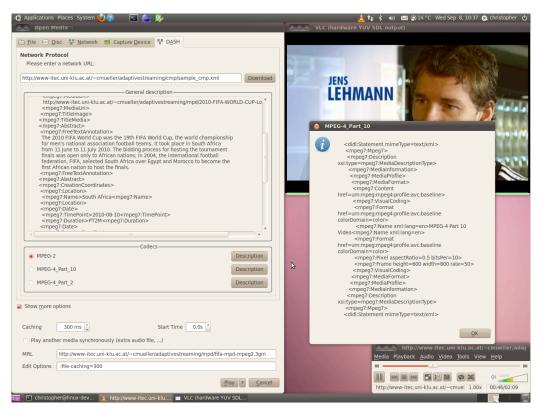
For details the interested reader is referred to [18].

Figure 2. Screenshot for the CMP Processing as an Extension of the VLC.

IV. DYNAMIC ADAPTIVE STREAMING OVER HTTP (DASH)

During its 93rd meeting, MPEG evaluated 15 submissions from 20 organizations (including companies, research institutions, and universities). The submissions provided technologies for the HTTP streaming of MPEG media in the following areas:

- Manifest File (MF), i.e., playlist, media presentation description, etc. which is mostly based on XML.
- Delivery Format (DF) as extensions/specializations of ISOBMFF and M2TS.

The system architecture is depicted in Figure 1 and based on that MPEG started a new work item called Dynamic Adaptive Streaming over HTTP (DASH) which will be Part 6 of MPEG-B (i.e., ISO/IEC 23001-6).

On request, the manifest file will be provided to the client in order to initiate the session (cf. step-1 in Figure 1). The client will parse the manifest file and request individual segments compliant to the delivery format using HTTP and according to the information found in the manifest file (cf. step-2 in Figure 1). For the manifest file, DASH adopted the Media Presentation Description (MPD) as defined by 3GPP AHS [4] as a starting point. The MPD follows a data model comprising a sequence of one or more consecutive non-overlapping *periods* for which one or more *representations* may be available. A single representation refers to a specific media following certain characteristics such as bit-rate, frame rate, resolution etc. Furthermore, each representation consists of one ore more *segments* that actually describe the media

and/or metadata to decode and present the included media content.

The delivery format defines the format of the segments to be delivered to the client upon the HTTP requests based on the MPD. In the case of 3GPP AHS the delivery format has been derived from ISOBMFF but M2TS is not supported. However, the OpenIPTV Forum (OIPF) has also adopted 3GPP AHS and defined the usage of M2TS [19] which is currently studied in the course of the DASH standardization.

Finally, as the delivery format shall be compatible to existing MPEG formats (i.e., ISOBMFF and M2TS), it shall be also possible to provide easy conversion from and to these formats. For example, easy conversion on the server would ease the usage of legacy content encoded in existing formats such as MP4 and its derivations. On the other hand, client-side easy conversion would facilitate repurposing of content received via DASH, e.g., in order to support legacy infrastructures.

V. A PROTOTYPE IMPLEMENTATION OF DASH

In this section we present a prototype implementation of DASH based on the VideoLan Client (VLC) [3]. In particular, we have added another layer on top of the MPD which allows for the composition of media presentations (CMP) that is currently discussed within one of the evaluation experiments of DASH. The CMP provides means for the selection of a specific configuration (e.g., codec selection, subtitles, different views, etc.) prior to the delivery of the actual MPD. After the client has chosen the configuration which fulfils its needs, the client requests the actual MPD. This MPD may

contain various representations used for dynamic adaptive streaming over HTTP. As a data model for the CMP we have adopted MPEG-21 Digital Item Declaration (DID) [13]. Digital Items are configurable through the so-called choice/selection mechanism. A *Choice* describes a set of related *Selections* which can affect the configuration of an item. As such it provides a generic and flexible way for multimedia content selection based on certain criteria defined by the Digital Item author. Such criteria may include rights expressions, usage environment constraints, or even different options for the end user.

A screenshot of a first version for the CMP processing as an extension of the VLC is depicted in Figure 2. The left window shows the "Open Media" dialog of VLC where the CMP manifest is provided. After download of the CMP manifest, the user (or the terminal) can (automatically) select the choice/selection based on the given description (i.e., different codecs in this scenario). In this screenshot general information is provided at the top (i.e., still in XML due to the early alpha status of the code) and additional information about the codec is given via a popup window on the right side. The actual MPD URL is automatically extracted from the CMP manifest and displayed at the bottom of the "Open Media" dialog. Once the appropriate choice is selected, the streaming/playback is initiated after the "Play" button is selected. We will improve this prototype as part of our future work.

VI. CONCLUSIONS

In this paper we have provided an overview of Dynamic Adaptive Streaming over HTTP (DASH), a new work item within MPEG. We have presented the outcome of the evaluation of 15 submissions from 20 organizations as well as our own prototype implementation based on VLC. The current timeline for the DASH standard development is as follows:

- Committee Draft (CD): 2010/10
- Final Committee Draft (FCD): 2011/01
- Final Draft International Standard (FDIS): 2011/07

Currently, several evaluation experiments are conducted, one including means for the composition of media presentation which has been already considered by our prototype implementation introduced above.

ACKNOWLEDGMENT

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