Departamento de Engenharia Electrotécnica e de Computadores

Multimedia systems - M.EEC0057

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Multimedia streaming protocols Part 2: MPEG DASH

What will we learn?

- What are the lines of work endorsed by MPEG to address the challenges of multimedia streaming
- The concepts, technologies and tools supporting those lines of work
- The major characteristics and differentiating aspects of MPEG-DASH
- What are the steps involved in the operation of DASH client
- The DASH meta-information
- Tools for implementing a DASH service

Recent MPEG technology for media distribution in IP networks

- MPEG-H, MMT
  - ISO/IEC 23008-1:2014, Information technology - “High efficiency coding and media delivery in heterogeneous environments” - Part 1: MPEG media transport (MMT)
  - the “long term” MPEG solution
- MPEG-DASH
  - ISO/IEC 23009:2012. Information technology — Dynamic adaptive streaming over HTTP (DASH)
  - the “short term” MPEG solution

a little bit of history

- the MPEG-2 Transport Stream standard is one of the most successful technologies developed by MPEG
  - used for more than three decades in a great variety of audiovisual applications and services as the transport mechanism
  - in 2008 voices inside MPEG started to suggest that it was time to review it
    - the initiative called “Modern Media Transport" (MMT) was then launched
- but experts were divide in their intentions within this line of work
  - 1) adopting an approach focussed on unifying the fragmented market of video streaming on the Internet
  - 2) adopting a more wider scope approach to embrace both the challenges of the broadband world as well as those of more traditional broadcasters and promote their integration
    - namely to enable broadcasters to offer second screen applications

a little bit of history (2)

- two lines of action were therefore decided to set up within this initiative
  - one with shorter time frame objectives
    - aiming at rapidly unifying the streaming strategies on the Internet
      - Dynamic Adaptive Streaming over HHTP (DASH) stream
      - DASH is currently supported and promoted by the DASH Industry Forum
        - DASH-IF <http://dashif.org> is responsible for promoting market adoption of MPEG-DASH for interoperable streaming of multimedia content over Internet. It publishes implementation guidelines and facilitates interoperability testing
  - another one with longer time frame objectives
    - aiming to address particularly the challenges being face by traditional media broadcasters in a more and more broadcast-broadband converged world
      - MPEG Media Transport (MMT) stream

a little bit of history (3)

- DASH has subsequently evolved on its own, establishing its own path and delivering a standardised solution specified as recommendation ISO/IEC 23009
  - enabling efficient streaming of multimedia data on shared IP networks using existing HTTP infra-structure
    - servers, CDNs, proxies, caches, etc.
- DASH re-uses existing technology and specifies new auxiliary formats, both binary and textual XML-based to
  - assist the transfer of multimedia content between servers and standard HTTP clients
- it adopts the “metadata plus segmented media” paradigm of HLS
  - defines a Media Presentation Description (MPD) file, as the metadata structure to describe characteristics of versions of the same media
  - defines segments to encapsulate media content, used as the fundamental unit in HTTP GET requests to transfer content

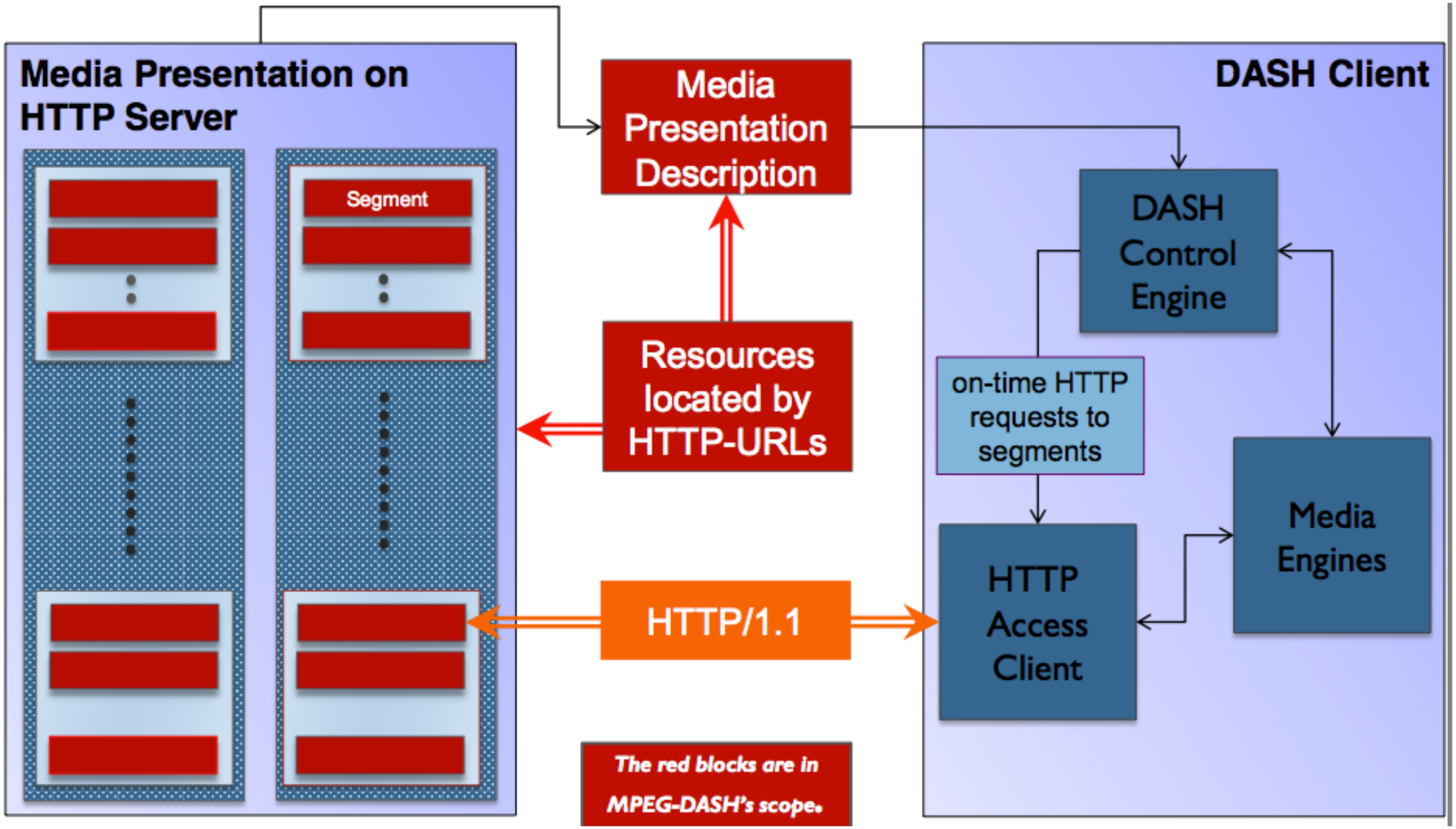
Recalling HAS

- the HAS approach is the one of
  - generating multiple variations of the content
  - fragmenting it in segments
  - assign to the client the freedom of independently download, rearrange, and decode such segments
- it enables the distribution of the same content among several sources to support scalability, error resilience, bandwidth congestion
- it enables to providing dynamic adaptation of the multimedia presentation according to various transmission parameters

DASH - concept and objectives

- DASH is a technology, not a protocol
  - meant for the implementation of adaptive multimedia streaming
- it is not associated a any particular encoding format
  - it is codec-agnostic
- it bases on the concept of creating several versions of the same content with different bit rates
  - corresponding to different qualities and/or resolutions
- and on segmenting each of those versions in relatively short chunks
  - enabling to send segments from different versions sequentially during the same session
  - at each instant, the selection of one among the available segments is under the client's responsibility
    - based on information on the network conditions or other context of usage information (from the terminal, the user, natural environment, etc.)

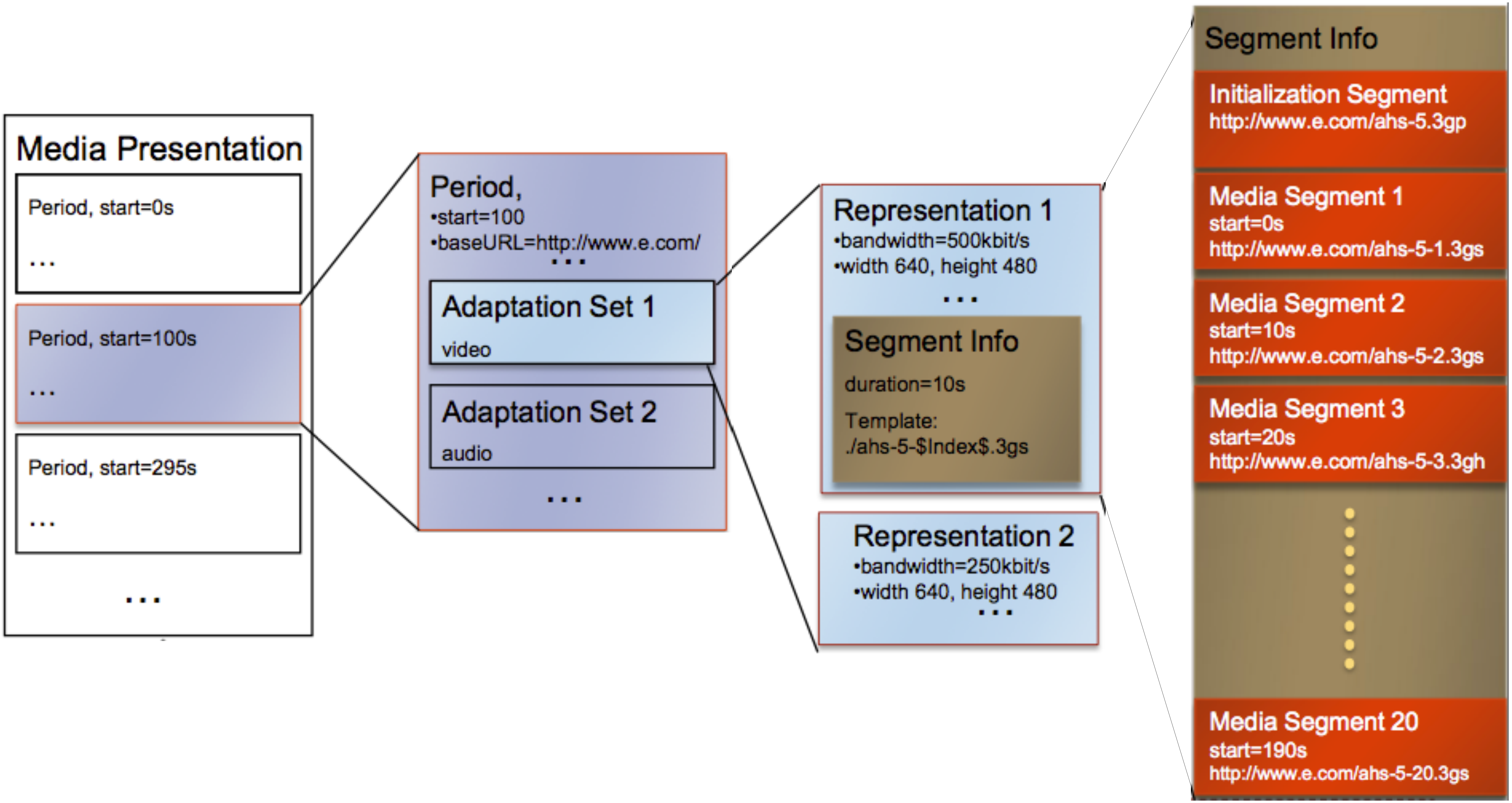
DASH architecture


Media Presentation on HTTP Server
Segment
Media Presentation Description
Resources located by HTTP-URLs
HTTP/1.1
The red blocks are in MPEG-DASH's scope.
DASH Client
DASH Control Engine
on-time HTTP requests to segments
HTTP Access Client
Media Engines

note: figure extracted from "MPEG's Dynamic Adaptive Streaming over HTTP (DASH) — An Enabling Standard for Internet TV". Thomas Stockhammer, Qualcomm Incorporated (talk given at the W3D workshop on DASH)

The DASH meta information

- Media Presentation Description, MPD



note: figure extracted from "MPEG's Dynamic Adaptive Streaming over HTTP (DASH) — An Enabling Standard for Internet TV". Thomas Stockhammer, Qualcomm Incorporated (talk given at the W3D workshop on DASH)

What's in the MPD?

- high level information concerning the media streams to enable the receiver th accept or reject certain representations beforehand
  - encoding type, IPR/DRM, language, resolution, bit rate, etc.
- data to access segments and to temporally stamp the segments
  - URL(s) and location with a resolution at the byte level
  - available time length of the segment
  - start instant and duration of the segment
  - in case it is a live content, being encoded and streamed in real-time, instructions concerning the instant to initiate the streaming to ensure that there will be continuity in the service/playout
    - to ensure that all segments will be readily available (on time) to ensure continuous transmission and playout
  - relation between segments of different versions to ensure transparent switching between versions

what does the receiver need to do?

- connect to the server and select the desired media content
    - as in a VoD service, by inspecting the catalog of available movies
- download the MPD associated to that media content and analyse the high-level information provided in it
    - depending on the terminal capability and user preferences it may reject some of the versions
        - e.g., original sound track vs translated sound track; sub-titles vs no sub-titles; high definition vs standard definition; etc.)
- evaluate other consumption restrictions such as available bandwidth connection
- send an HTTP GET command using the URL retrieved from the MPD, requesting a segment of a version that satisfies the identified restrictions
    - Need to annotate continuously the reproduction time instants of the last request made
    - Need to continuously evaluate the network conditions
        - if there are changes, look into the MPD for a new version that satisfies the new context restrictions and use the url of the next sequential segment in the next HTTP GET request
        - if there are no changes, uses the URL of the next segment of the same version to issue the next HTTP request

DASH-IF support for implementation

- to help developers validate the compliance of their DASH-enabled solutions, DASH-IF has published some additional documents
  - “Guidelines for Implementation: DASH-AVC/264 Test Cases and Vectors”
    - it provides the definition of “Interoperability Points” that are translated into a set of test cases, such as
      - DASH-AVC/264: supporting H.264/AVC Progressive High Profile up to 720p
      - DASH-AVC/264 HD (with support for video up to 1080p)
      - DASH-HEVC/265 1080p 8bit extension (HEVC Main Profile Main Tier at level 4.1)
    - it offers resources such as
      - a repository of data sets to be used for testing purposes by developers of DASH-compliant players <dashif.org/data sets/>
      - a DASH MPD validator <http://dashif.org/conformance.html>, to check for MPD and segment conformance
      - the dash.js javascript framework, which is a reference player implementation using Media Source Extensions (MSE) and Encrypted Media Extensions (EME) browser specifications

implementation approach

- Using MPEG-DASH on network adaptive multimedia applications requires the use of several software components
  - Content encoder
  - Web server
  - Client-side applications
- the content encoding phase, includes in fact two individual processing steps:
  - 1) encode the video source material into for example the H.264/AVC format with multiple bit rates / quality / resolutions
    - in a practical implementation this can be done using FFMPEG encoding software
  - 2) generate the MPEG-DASH compatible format, this is, the MPD manifest and the segments from the several media versions
    - in a practical implementation this can be done by using the MP4Box encoding software, which is part of the GPAC framework

implementation approach (2)

- example to create several compressed versions of the media content using FFMPEG (repeat with different bitrates and output filenames)

```
$ ffmpeg -i "video.mp4" -b:v "bitrate"k “outputVideo4dash_1.mp4"
(e.g. ffmpeg -i cars.mp4 -b:v 1500k cars4dash_1.mp4)
```

- having multiple compressed media files with multiple bitrate/view variations, MP4Box is then used to translate them into the MPEG-DASH format, using for example the following command:

```
    $ mp4box -profile main -dash 1 -frag 1 -out
"video1_dash.mpd" “outputVideo4dash_1.mp4" "outputVideo4dash_2.mp4"
"outputVideo4dash_3.mp4" ... “outputVideo4dash_N.mp4”
```

  - creation of a manifest file (“video1_dash.mpd”) that describes all of the previously encoded versions of a video (in the example given, outputVideo4dash_1.mp4 to outputVideo4dash_N.mp4)
  - and to segment each version into 1 second files
    - for maximum compatibility, MPEG-DASH Main profile is used

implementation approach (3)

- alternative FFMPEG commands to create alternative versions
  - manipulating the quality and not the bit rate directly

```
$ ffmpeg -i video.y4m -c:v libx264 -preset ultrafast -qp 40 output40.mp4
```

- instead of specifying a target bit rate, the quality factor is specified
  - qp = 0 best quality
  - qp = 51 worse quality
- the `-preset ultrafast` setting is used to speeding up the compression
  - but the process will not be as efficient in terms of compression, so the file size will be bigger than setting it to `veryslow`

- manipulating the spatial resolution

```
$ ffmpeg -i video.y4m -c:v libx264 -qp 20 -s 640x480 output480p.mp4
```

- manipulating the temporal resolution

```
$ ffmpeg -i video.y4m -c:v libx264 -qp 20 -r 12 output12fps.mp4
```

implementation approach (3)

- on the client side a DASH-enabled client will be necessary
  - to correctly interpret the MPD and sequentially issue HTTP request to the server
  - it may be used the MP4Client from the GPAC framework, which implements a DASH client
- on the server side, given that HTTP streaming is used to retrieve specific segments to be played in the client
  - a common Web server can be used to store the multiple versions of the media data
    - for example an Apache server

    - FFMPEG. https://ffmpeg.org/
    - GPAC Multimedia Open Source Project. https://gpac.wp.imt.fr/

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