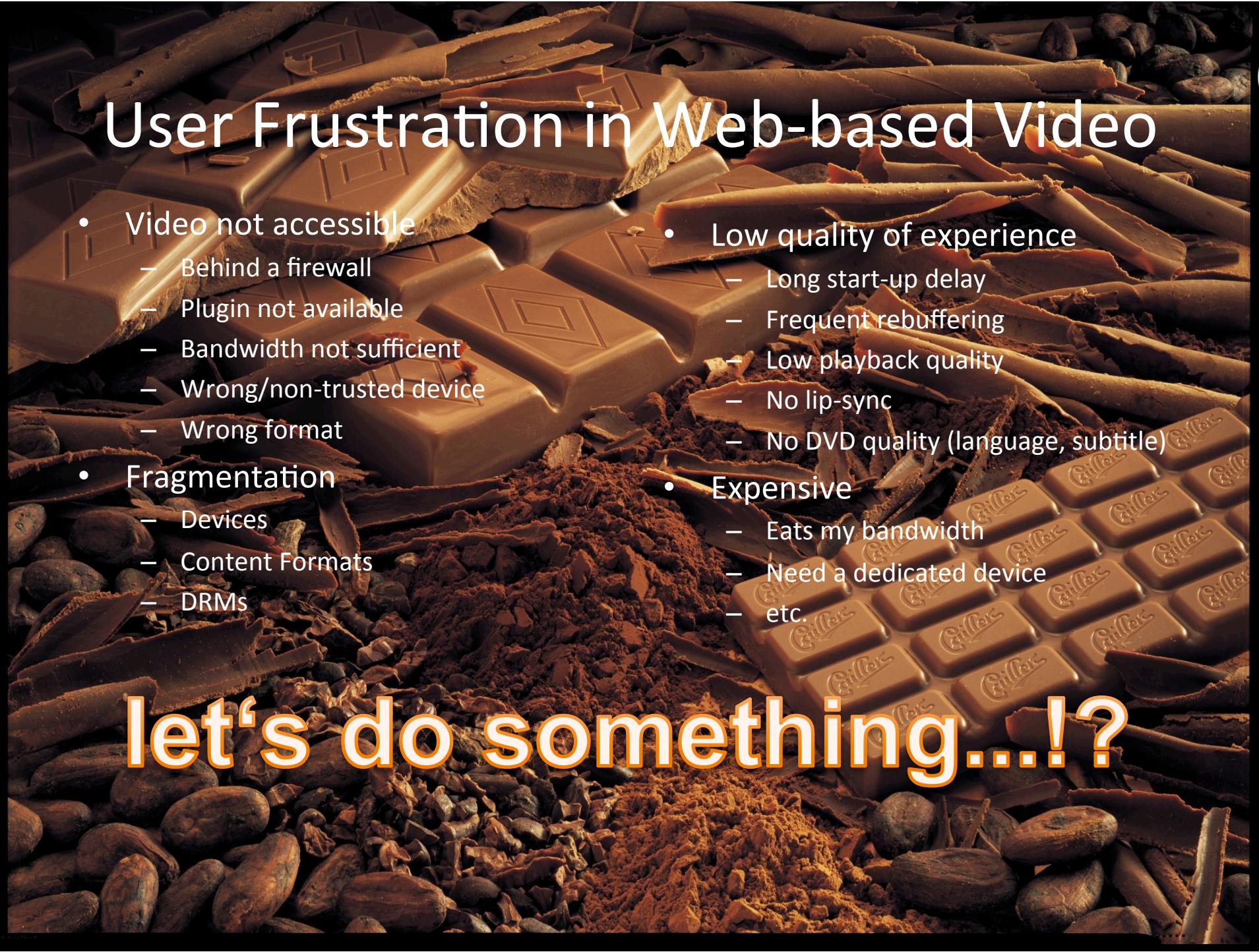


MPEG's Dynamic Adaptive Streaming over HTTP (DASH) - An Enabling Standard for Internet TV

Thomas Stockhammer
Qualcomm Incorporated



User Frustration in Web-based Video

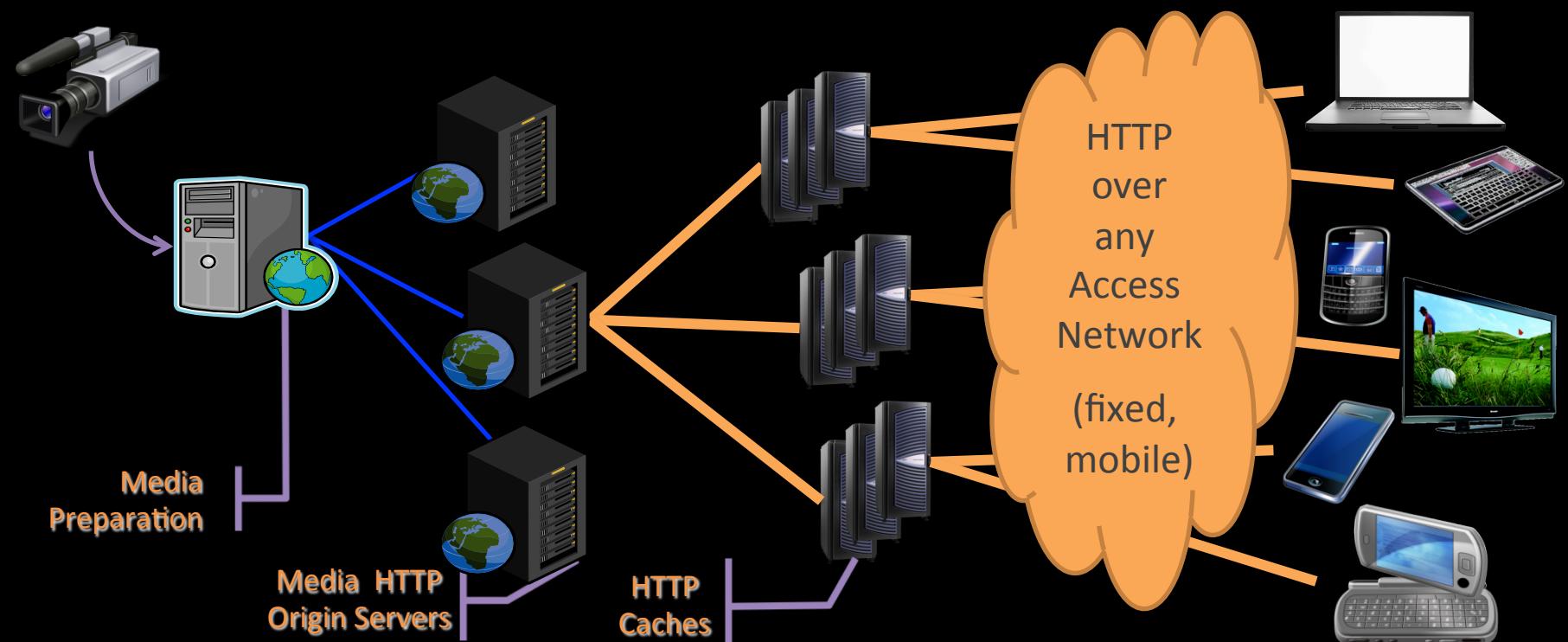
- Video not accessible
 - Behind a firewall
 - Plugin not available
 - Bandwidth not sufficient
 - Wrong/non-trusted device
 - Wrong format
- Fragmentation
 - Devices
 - Content Formats
 - DRMs
- Low quality of experience
 - Long start-up delay
 - Frequent rebuffering
 - Low playback quality
 - No lip-sync
 - No DVD quality (language, subtitle)
- Expensive
 - Eats my bandwidth
 - Need a dedicated device
 - etc.

let's do something...!?



DASH in a Nutshell

- **What:** Video streaming solution where small pieces of video streams/files are requested with HTTP and spliced together by the client. Client entirely controls delivery.
- **Why:** reuse widely deployed standard HTTP servers/caches for scalable delivery, e.g. existing Internet CDNs; traverse NAT/Firewalls; simple rate adaptation; fixed-mobile convergence; convergence of services, etc.
- **Use case:** Accessing OTT video streaming services over any access network to any device



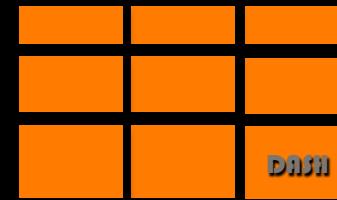
MPEG DASH ISO/IEC 23009-1

- MPEG DASH ISO/IEC 23009-1 technically frozen in August 2011
- Timeline and Activities
 - Draft International Standard (DIS) 23009-1 publicly available
 - 2 months balloting period until October 2011
 - Parallel approval process for extensions to
 - ISO base media FF to support DASH 14496-12/AMD 3
 - Common Encryption 23001-7
 - Continuous coordination with 3GPP and other SDOs (DECE, OIPF, etc.)
 - Conformance and Reference Software activities kicked off (see WD 23009-2)
 - Licensing and promotional efforts ongoing – see last slide
- Good news: Converging standard for adaptive streaming on the way

Convergence = Confidence

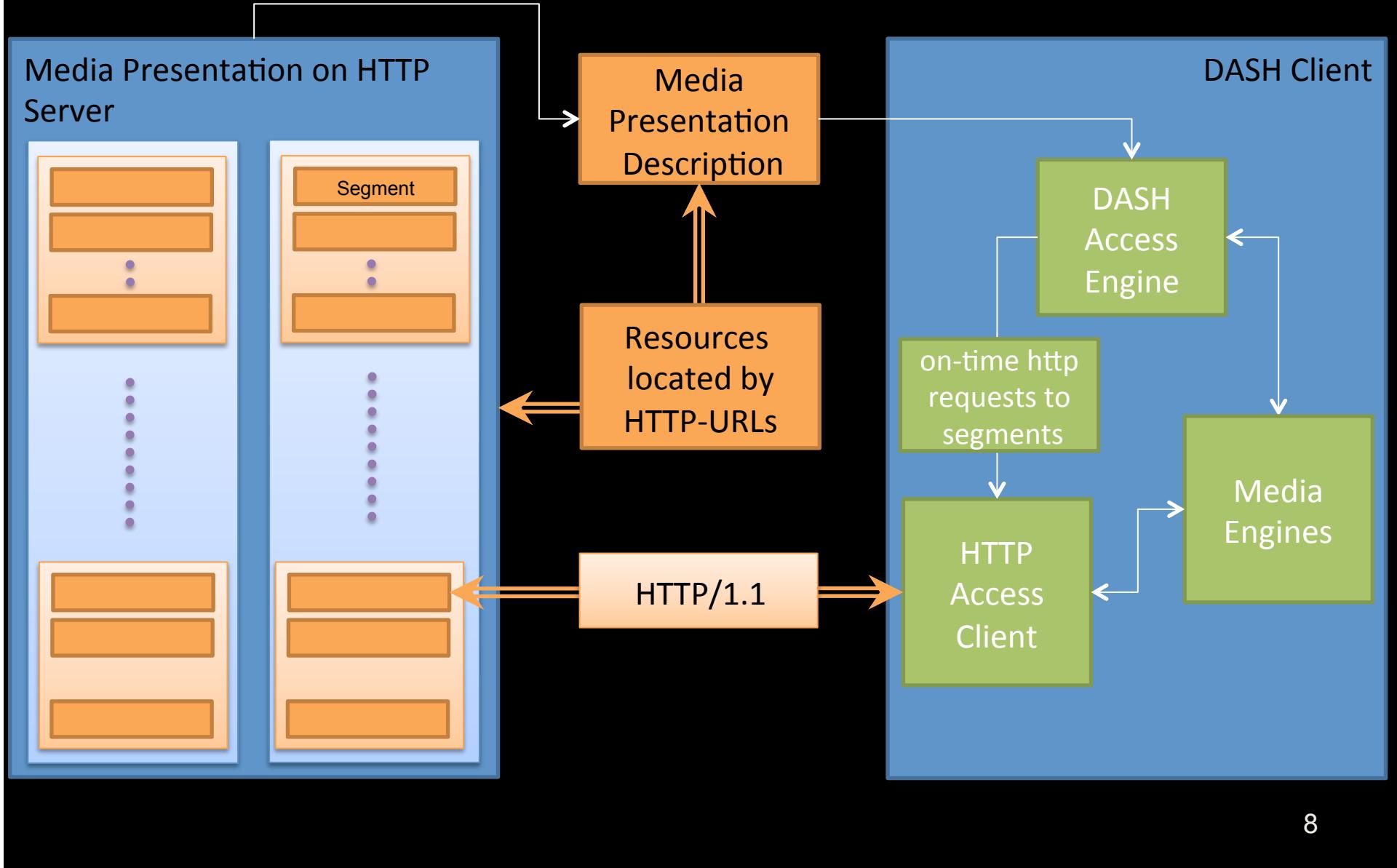
(Some) DASH Design Principles

- DASH is not:
 - system, protocol, presentation, codec, middleware, client specification
- DASH is an **enabler**
 - provides **formats** to enable efficient and high-quality delivery of streaming services over the Internet considered as one component in an e2e service
 - System definition left to other organizations (SDOs, Fora, Companies, etc.)
- It attempts to be very good in what is to be addressed by the standard
 - Enables reuse of existing technologies (containers, codecs, DRM etc.)
 - Enables deployment on top of HTTP-CDNs (Web Infrastructures, caching)
 - Enables very high user-experience (low start-up, no rebuffering, trick modes)
 - Enables selection based on network and device capability, user preferences
 - Enables seamless switching
 - Enables live and DVD-kind of experiences
 - addresses global and regulatory deployment issues
 - Moves intelligence from network to client, enables client differentiation
 - Enables deployment flexibility (e.g., live, on-demand, time-shift viewing)
 - Provide simple interoperability points (profiles)
 - provides convergence with existing proprietary technologies in this space



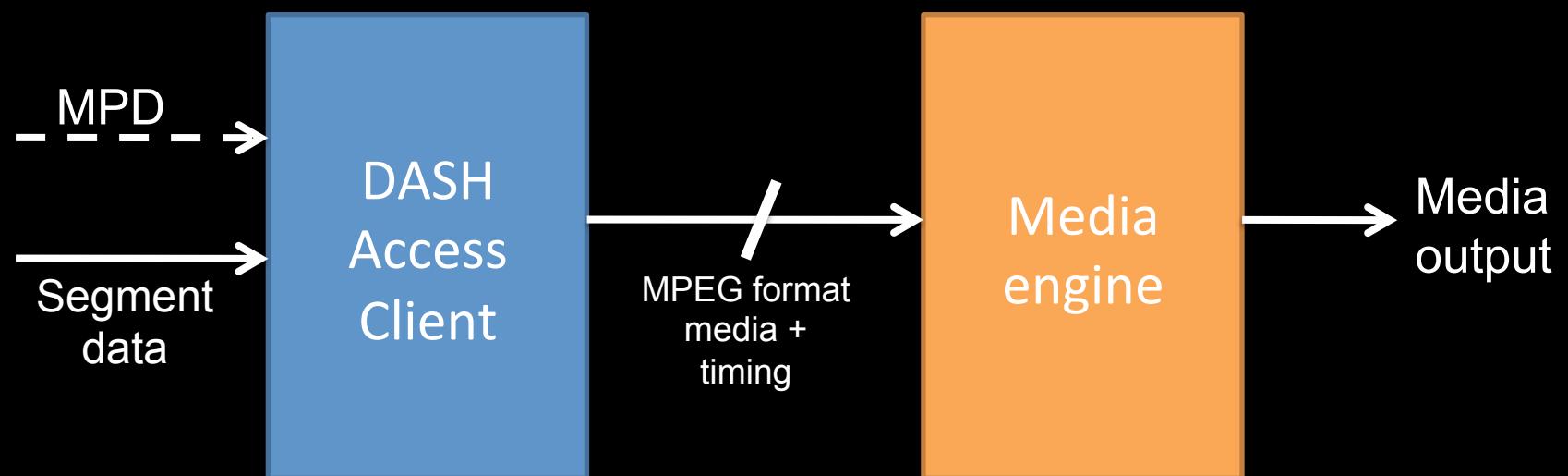
MPEG DASH SPECIFICATION INSIGHTS

What is specified – and what is not?



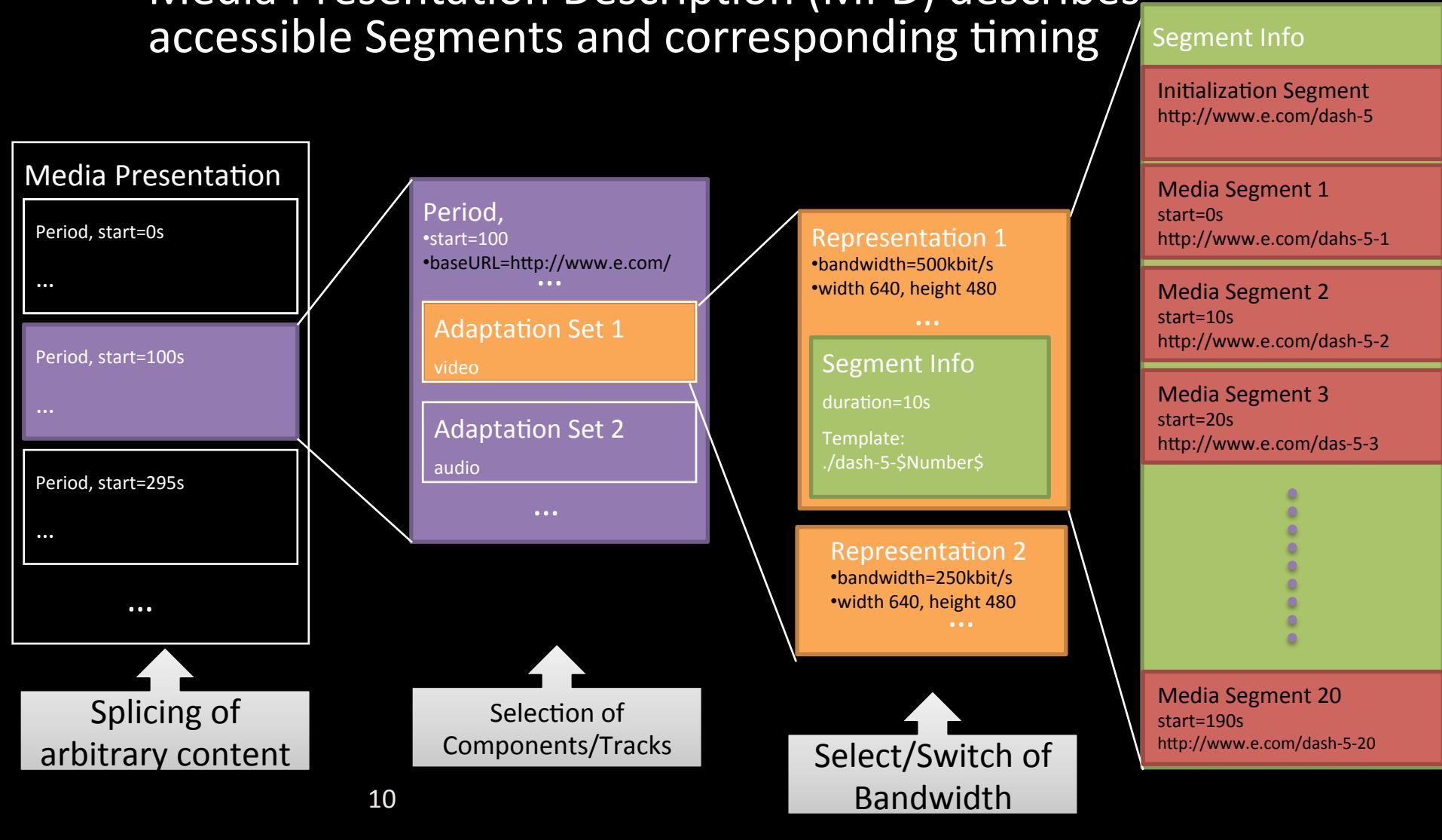
Information Classification

- MPD and Index Information for DASH Access client
 - Core specification aspects of DASH
- Initialisation and Media Segments for Media engine
 - Reuse of existing container formats and easy conversion
 - Small adaptations may be necessary for usage in DASH



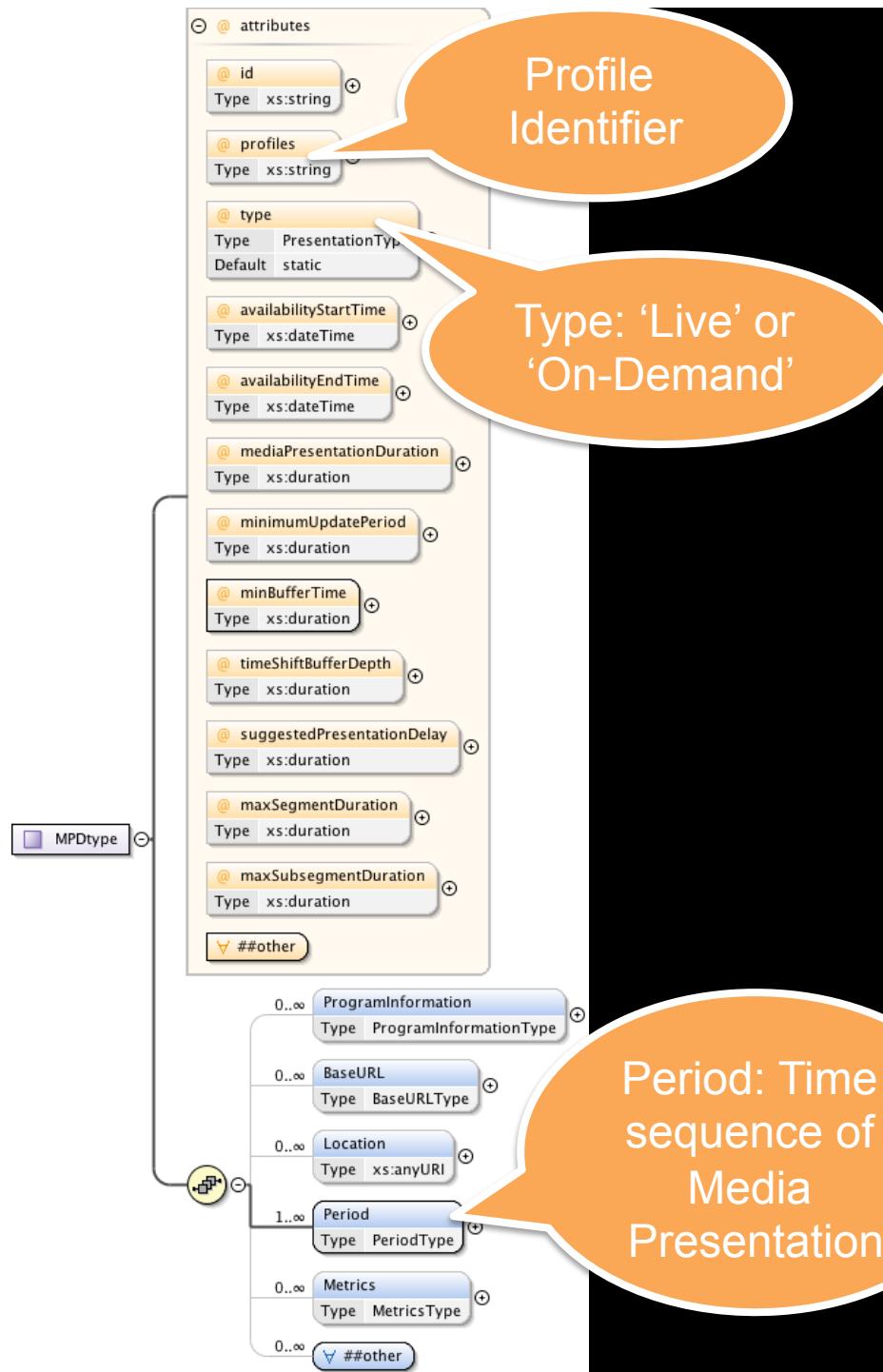
Media Presentation Data Model

- Media Presentation Description (MPD) describes accessible Segments and corresponding timing



Key feature – Common Timeline

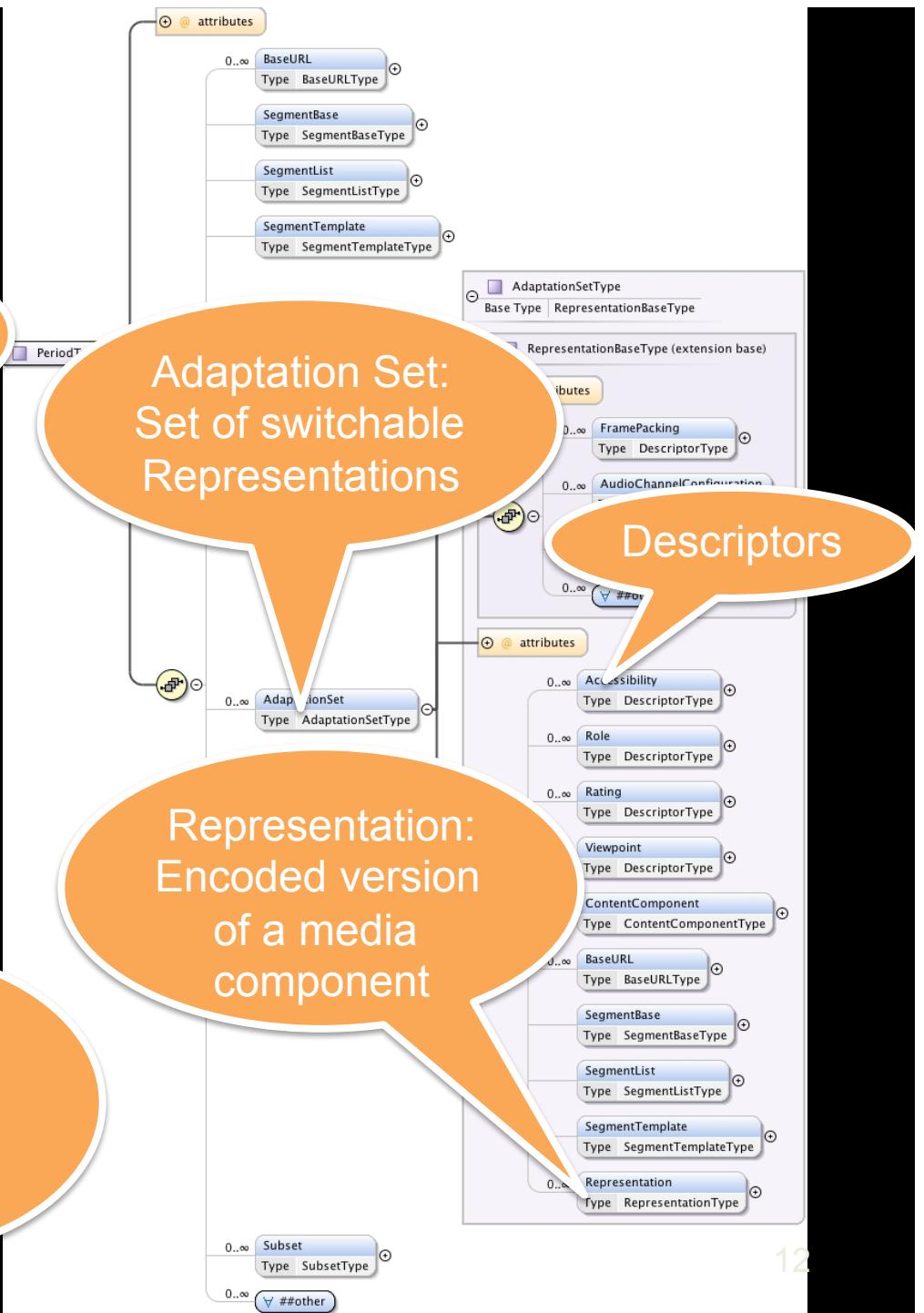
- Representations in one Period share common presentation timeline
 - presentation time of access unit within the media streams is mapped to **the global common presentation timeline**
 - enables **synchronization** of different media components and **seamless switching** of different coded versions of the same media components
- Other timelines
 - segment availability times (mapped to UTC clock)
 - internal media decode time (not exposed on DASH level)



Profile Identifier

Type: 'Live' or
'On-Demand'

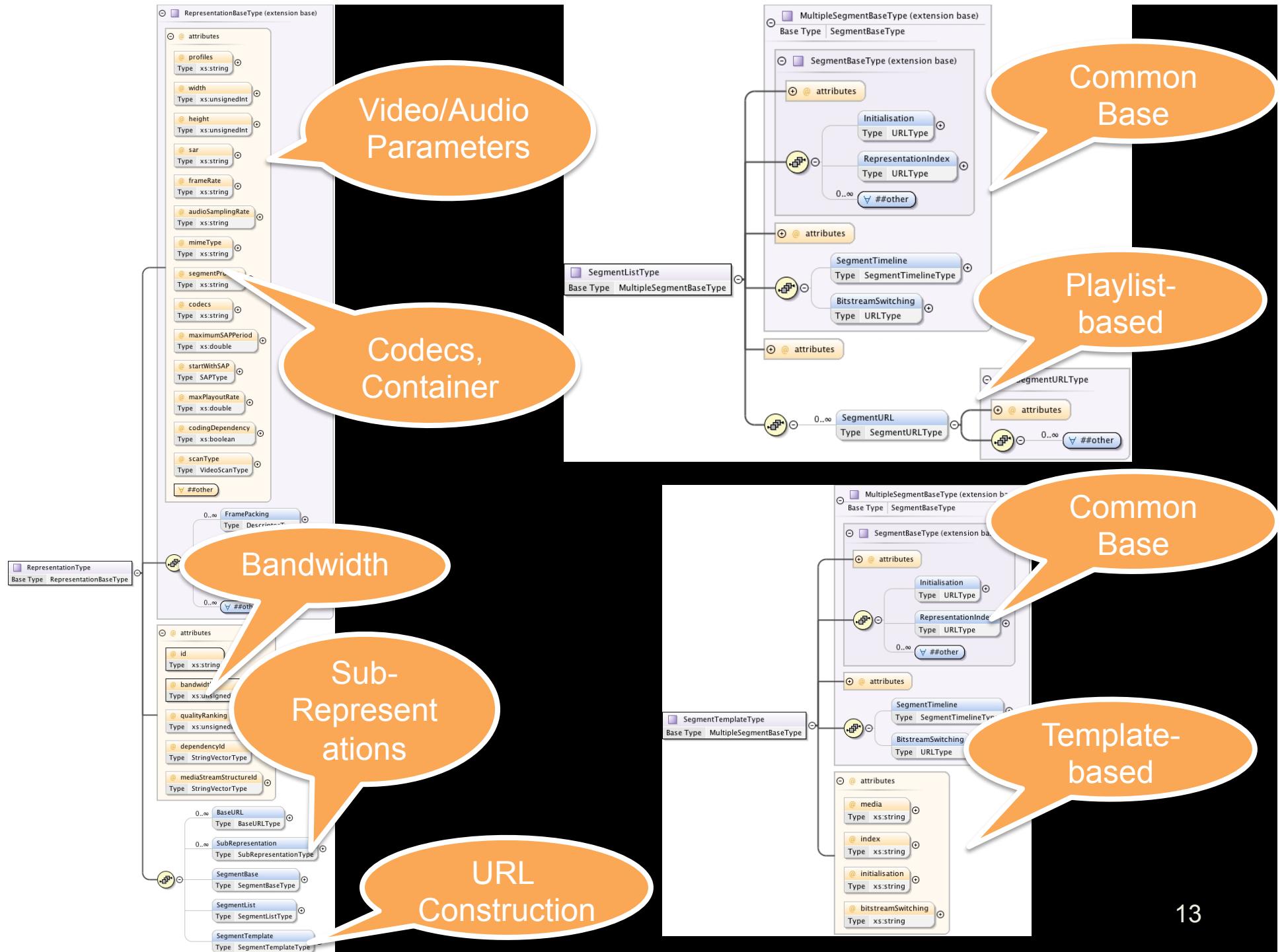
Period: Time sequence of
Media Presentation



Adaptation Set:
Set of switchable
Representations

Descriptors

Representation:
Encoded version
of a media
component



MPD Information

- Redundant information of Media Streams for the purpose to initially select or reject Adaptation Sets/Representations
 - Examples: Role, Codec, DRM, language, resolution, bandwidth
- Access and Timing Information
 - the HTTP-URL(s) and byte range for each accessible Segment
 - the earliest next update of the MPD on the server
 - the segment availability start and end time in wall-clock time
 - the approximated presentation start time and duration of a Media Segment in the media presentation timeline
 - for live service, playout start instructions such that segments will be available in time for fluent playout in the future
- Switching and splicing relationships across Representations
- not much more ...

Accessing Segments

- Multiple Base URLs
 - same information can be accessed at multiple locations
 - Redundancy, client-side load balancing, parallel download
- Byte range access with regular GETs
 - mapping to byte ranges needs to be done in CDNs
 - includes environments for which direct access to HTTP stack is not possible (browser-plugins)

Descriptors

- Content Protection (2 schemes defined)
- Role (1 scheme defined)
 - caption, subtitle, main, alternate, supplementary, commentary, dub
- Accessibility (Role scheme may be used)
- Rating
- Viewpoint
- Frame Packing (2 schemes defined)
- Audio Channel Configuration (1 scheme defined)

Example for Role and Viewpoint

```
<MPD>
  <Period>
    <AdaptationSet mimeType="video/mp4" group="1">
      <Role schemeIdUri="urn:mpeg:DASH:role:2011" value="main"/>
      <Viewpoint schemeIdUri="urn:mpeg:DASH:viewpoint:2011" value="vp1"/>
      <Representation id="11" bandwidth="1024000">...</Representation>
      <Representation id="12" bandwidth="512000">...</Representation>
      ...
    </AdaptationSet>

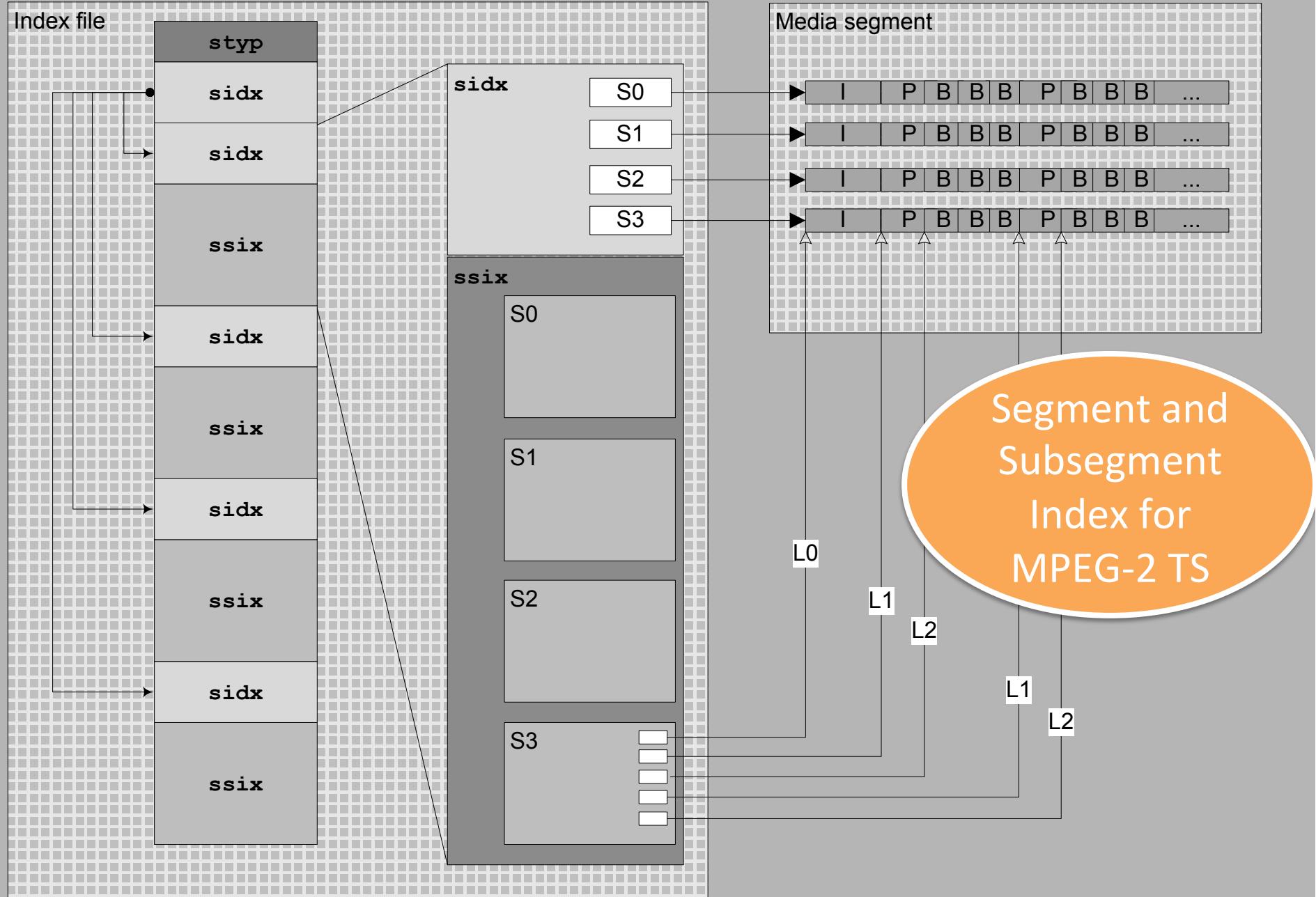
    <AdaptationSet mimeType="video/mp4" group="1">
      <Role schemeIdUri="urn:mpeg:DASH:role:2011" value="alternate"/>
      <Viewpoint schemeIdUri="urn:mpeg:DASH:viewpoint:2011" value="vp2"/>
      <Representation id="21" bandwidth="1024000">...</Representation>
      <Representation id="22" bandwidth="512000">...</Representation>
      ...
    </AdaptationSet>

    <AdaptationSet mimeType="audio/mp4" group="2">
      <Role schemeIdUri="urn:mpeg:DASH:role:2011" value="main"/>
      <Role schemeIdUri="urn:mpeg:DASH:role:2011" value="supplementary"/>
      <Viewpoint schemeIdUri="urn:mpeg:DASH:viewpoint:2011" value="vp1"/>
      <Representation id="31" bandwidth="128000">...</Representation>
      <Representation id="32" bandwidth="64000">...</Representation>
      ...
    </AdaptationSet>

    <AdaptationSet mimeType="audio/mp4" group="2">
      <Role schemeIdUri="urn:mpeg:DASH:role:2011" value="alternate"/>
      <Role schemeIdUri="urn:mpeg:DASH:role:2011" value="supplementary"/>
      <Viewpoint schemeIdUri="urn:mpeg:DASH:viewpoint:2011" value="vp2"/>
      <Representation id="41" bandwidth="128000">...</Representation>
      <Representation id="42" bandwidth="64000">...</Representation>
      ...
    </AdaptationSet>
  </Period>
  ...
</MPD>
```

Segment Indexing

- Provides binary information in ISO box structure on
 - Accessible units of data in a media segment
 - Each unit is described by
 - Byte range in the segments (easy access through HTTP partial GET)
 - Accurate presentation duration (seamless switching)
 - Presence of representation access positions, e.g. IDR frames
- Provides a compact bitrate-over-time profile to client
 - Can be used for intelligent request scheduling
- Generic Data Structure usable for any media segment format, e.g. ISO BMFF, MPEG-2 TS, etc.
- Hierarchical structuring for efficient access
- May be combined with media segment or may be separate



Media Segments

- Contains the actual segmented media streams
- additional information to map segment into media presentation timeline for switching and synchronous presentation with other Representations
- For ISO BMFF, contains one or more movie fragments
- Can be short (\approx 1-10 sec) and long (\approx 10sec – 2h)

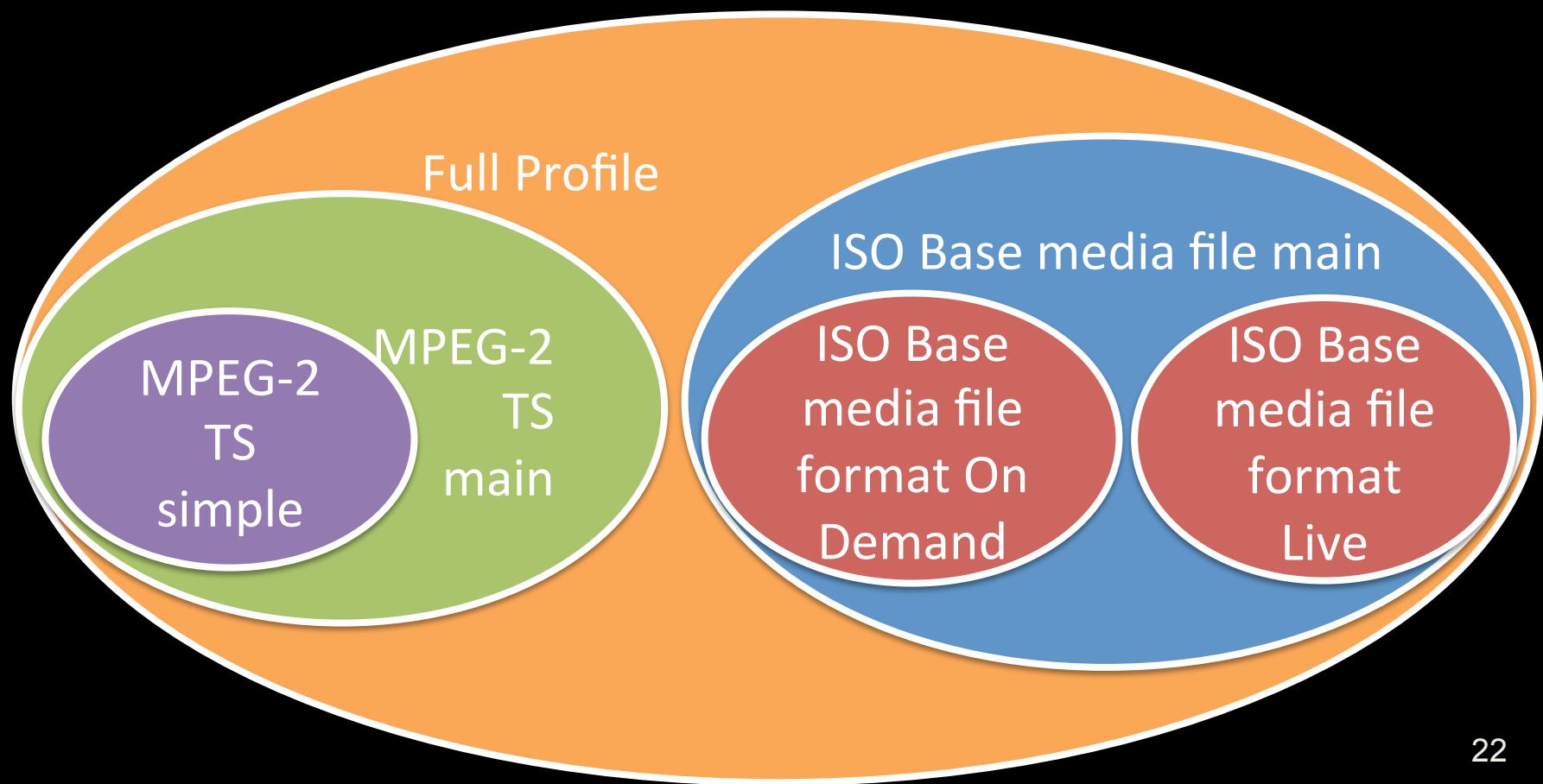
Segment duration	Advantages	Disadvantages
Short	<ul style="list-style-type: none">• Suitable for live• commonality with live• High switching granularity on segment level	<ul style="list-style-type: none">• Large number of files• Large number of URLs• Fixed request size• switching granularity on segment level
Long	<ul style="list-style-type: none">• Small number of files• Small number of URLs• High switching granularity• Flexible request sizes• Improved cache performance	<ul style="list-style-type: none">• Need for Segment Index• Difference from Live

Live Presentation

- Live Services enabled
 - Generation of Segments on-the-fly
 - Access of only a subset of the Segments within a time window
 - Server/Network may offer Segments only for a certain time window
 - Update of MPD to describe new Segments and/or new Periods, such that the updated MPD is compatible with the previous MPD to ensure that
 - clients may immediately begin using the new MPD without synchronisation with the old MPD, since it is compatible with the old MPD before the update time; and
 - the update time needs not be synchronised with the time at which the actual change to the MPD takes place: i.e. changes to the MPD may be advertised in advance
 - Media Presentation is described by the initial MPD and all updates.
 - With URL templates, updating of MPD generally not necessary
 - Client and server are expected to be synchronized to UTC time.
- Time-shift viewing and network PVR functionality seamlessly enabled
 - Segments may be accessible on the network over a long time.

Profiles

- Set of restrictions on the offered Media Presentation (MPD & Segments)
- can also be understood as permission for DASH clients that only implement the features required by the profile to process the Media Presentation
- Profiles defined in ISO/IEC 23009 (as below). More restrictions may be added



ISO Base media file format On Demand

```
<?xml version="1.0" encoding="UTF-8"?>
<MPD
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="urn:mpeg:DASH:schema:MPD:2011"
  xsi:schemaLocation="urn:mpeg:DASH:schema:MPD:2011"
  type="static"
  mediaPresentationDuration="PT3256S"
  minBufferTime="PT1.2S"
  profiles="urn:mpeg:dash:profile:isoff-on-demand:2011">

  <BaseURL>http://cdn1.example.com/</BaseURL>
  <BaseURL>http://cdn2.example.com/</BaseURL>

  <Period>
    <!-- English Audio -->
    <AdaptationSet mimeType="audio/mp4" codecs="mp4a">
      <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-656164657221"/>
      <Representation id="1" bandwidth="64000">
        <BaseURL>7657412348.mp4</BaseURL>
      </Representation>
      <Representation id="2" bandwidth="32000">
        <BaseURL>3463646346.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
    <!-- French Audio -->
    <AdaptationSet mimeType="audio/mp4" codecs="mp4a.40.2" lang="fr" subsegmentAlignment="true">
      <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-656164657221"/>
      <Role schemeIdUri="urn:mpeg:dash:role" value="dub"/>
      <Representation id="3" bandwidth="64000">
        <BaseURL>3463275477.mp4</BaseURL>
      </Representation>
      <Representation id="4" bandwidth="32000">
        <BaseURL>5685763463.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
    <!-- Timed text -->
    <AdaptationSet mimeType="application/ttml+xml" lang="de">
      <Role schemeIdUri="urn:mpeg:dash:role" value="subtitle"/>
      <Representation id="5" bandwidth="256">
        <BaseURL>796735657.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
    <!-- Video -->
    <AdaptationSet mimeType="video/mp4" codecs="avc1.4d0228" subsegmentAlignment="true">
      <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-656164657221"/>
      <Representation id="6" bandwidth="256000" width="320" height="240">
        <BaseURL>8563456473.mp4</BaseURL>
      </Representation>
      <Representation id="7" bandwidth="512000" width="320" height="240">
        <BaseURL>56363634.mp4</BaseURL>
      </Representation>
      <Representation id="8" bandwidth="1024000" width="640" height="480">
        <BaseURL>562465736.mp4</BaseURL>
      </Representation>
      <Representation id="9" bandwidth="1384000" width="640" height="480">
        <BaseURL>41325645.mp4</BaseURL>
      </Representation>
      <Representation id="A" bandwidth="1536000" width="1280" height="720">
        <BaseURL>89045625.mp4</BaseURL>
      </Representation>
      <Representation id="B" bandwidth="2048000" width="1280" height="720">
        <BaseURL>23536745734.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
  </Period>
</MPD>
```

MPEG-2 TS simple

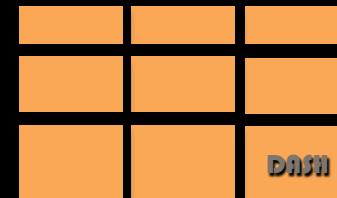
```
<?xml version="1.0" encoding="UTF-8"?>
<MPD
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="urn:mpeg:DASH:schema:MPD:2011"
  xsi:schemaLocation="urn:mpeg:DASH:schema:MPD:2011"
  type="static"
  mediaPresentationDuration="PT6158S"
  availabilityStartTime="2011-05-10T06:16:42"
  minBufferTime="PT1.4S"
  profiles="urn:mpeg:profile:dash:m2ts-simple"
  maxSegmentDuration="PT4S">

  <BaseURL>http://cdn1.example.com/</BaseURL>
  <BaseURL>http://cdn2.example.com/</BaseURL>

  <Period id="42" duration="PT6158S">
    <AdaptationSet
      mimeType="video/mp2t"
      codecs="avc1.4D401F,mp4a"
      frameRate="24000/1001"
      segmentAlignment="true"
      subsegmentAlignment="true"
      bitstreamSwitching="true"
      startWithSAP="2"
      subsegmentStartsWithSAP="2">
      <ContentComponent contentType="video" id="481"/>
      <ContentComponent contentType="audio" id="482" lang="en"/>
      <ContentComponent contentType="audio" id="483" lang="es"/>
      <BaseURL>SomeMovie</BaseURL>
    <SegmentTemplate
      media="$RepresentationID$_$Number%05$.ts"
      index="$RepresentationID$.sidx"
      initialisation="$RepresentationID$.init.ts"
      bitstreamSwitching="$RepresentationID$.bssw.ts"
      duration="4"
      startNumber="1"/>
      <Representation id="720kbps" bandwidth="792000" width="640" height="368"/>
      <Representation id="1130kbps" bandwidth="1243000" width="704" height="400"/>
      <Representation id="1400kbps" bandwidth="1540000" width="960" height="544"/>
      <Representation id="2100kbps" bandwidth="2310000" width="1120" height="640"/>
      <Representation id="2700kbps" bandwidth="2970000" width="1280" height="720"/>
      <Representation id="3400kbps" bandwidth="3740000" width="1280" height="720"/>
    </SegmentTemplate>
  </AdaptationSet>
  </Period>
</MPD>
```

Summary: DASH Selected Feature List

- Live, On-Demand and Time-shift services
- Independency of request size and segment size (byte range requests)
- Segment formats
 - ISO base media FF and MPEG-2 TS
 - guidelines for integrating any other format
 - Are codec independent
- Support for server and client-side component synchronization (e.g., separate and multiplexed audio and video)
- Support for efficient trick mode
- Simple splicing and (targeted) ad insertion
- Multiple base URLs for the same content
- Clock drift control for live sessions
- DASH metrics for reporting the session experience
- Profile: restriction of DASH and system features (claim & permission)
- Content Descriptors for Protection, Accessibility, Rating, etc.
 - Enables common encryption, but different DRM (DECE-like)



DEPLOYMENT CONSIDERATIONS

Common Uses Cases

- MPEG-DASH supports simple and advanced use cases:
 - On-Demand, Live and time-shift (nPVR) streaming
 - Dynamic ad-insertion
 - Dynamic update of program
 - Delivery of same content on three screens
 - Delivery of any multimedia content (2D, 3D, animation, graphics, multiview, subtitles, text, etc.), not just AV
 - Support of multiple languages and different audio configuration
 - etc.
- Simple use cases can be gradually extended to more complex and advanced ones

Migration Scenarios

- Most generated content/production equipment for legacy Adaptive Bitrate Streaming systems can be used for MPEG-DASH:
 - generic encoders can be reused, DASH adds descriptive metadata for better client operations
 - HLS Content suitable for DASH M2TS Main profile.
 - Smooth Streaming Content suitable for DASH ISOBMFF Live profile.
- Manifest files can be easily converted to MPD format
 - XML conversion from m3u8 and Smooth Streaming manifests.
 - Deployment of two manifest files (legacy and DASH MPD) in parallel (low overhead)
- Documentation in preparation ...
- It's not a competition

Next steps

- Complete standardization work
 - Formal approval of all specifications
 - Conformance, interoperability and reference software
- Towards deployments
 - Generate end-to-end system specs based on DASH including codecs, DRM, profiles, etc. (OIPF, 3GPP, HbbTV, HD Forum, etc.)
 - Generate guidelines, white papers, test content and software
 - Promotional efforts: Licensing, interoperability, plug-fests, etc.
 - Combine it with browsers, the web and HTML-5
- Everyone is invited to contribute

More Information

- Draft Specifications
 - 14496-12:2008/FDAM-3:
http://www.3gpp.org/ftp/Inbox/LSs_from_external_bodies/ISO_IEC_JTC1_SG29_WG11/29n12310.zip
 - 23001-7: http://www.3gpp.org/ftp/Inbox/LSs_from_external_bodies/ISO_IEC_JTC1_SG29_WG11/29n12313.zip
 - 23009-1: http://www.3gpp.org/ftp/Inbox/LSs_from_external_bodies/ISO_IEC_JTC1_SG29_WG11/29n12316.zip
- More information from Qualcomm including Qualcomm's licensing position
 - <http://www.qualcomm.com/blog/2011/08/16/dash-toward-better-mobile-video-user-experience>
- Several other companies have declared or expressed willingness to declare favorable licensing conditions



Comments – Questions - Feedback

THANK YOU