Qualcomm Research

An Introduction to DASH (Dynamic Adaptive Streaming over HTTP)

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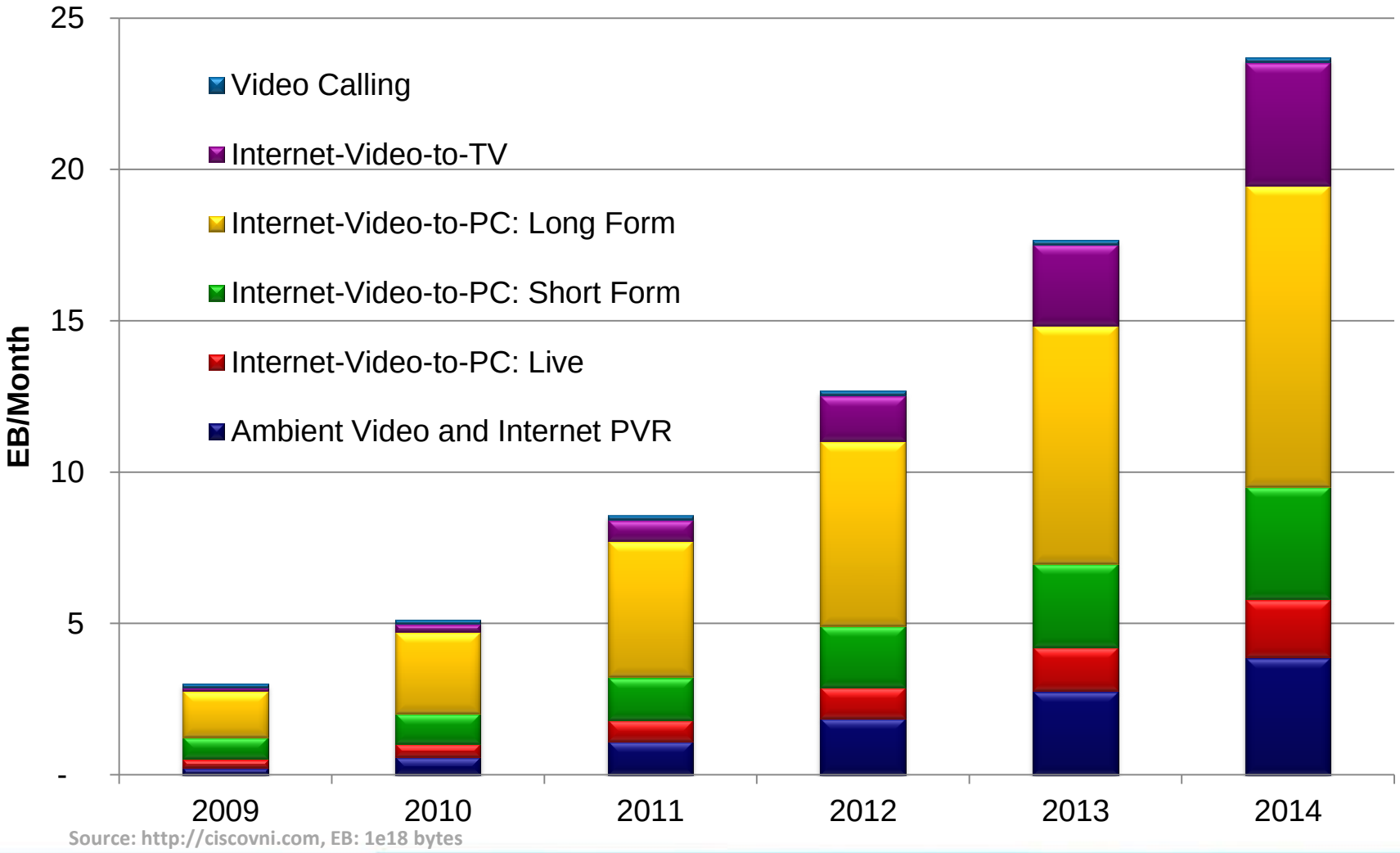
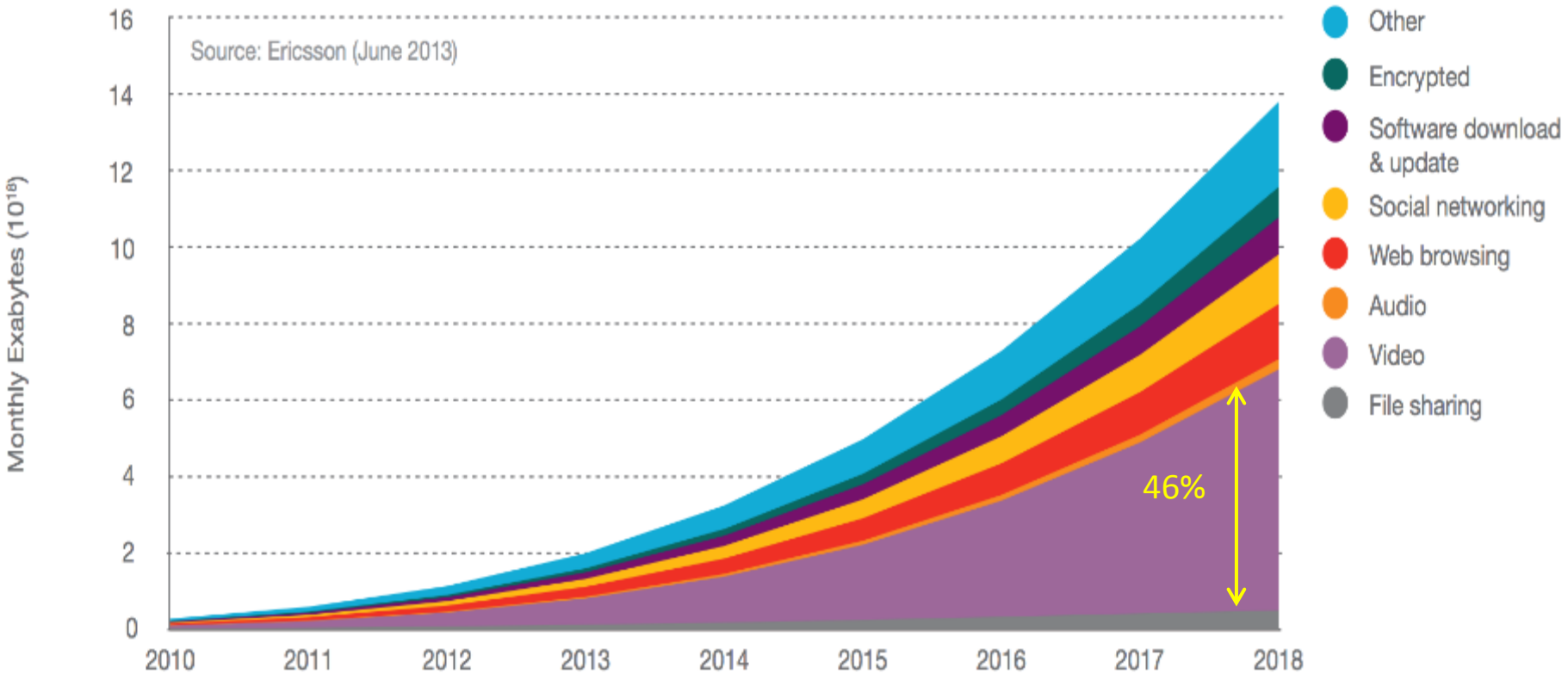
Motivation: Consumer Internet Video Composition



Source: http://ciscovni.com, EB: 1e18 bytes

Global Mobile Data Traffic



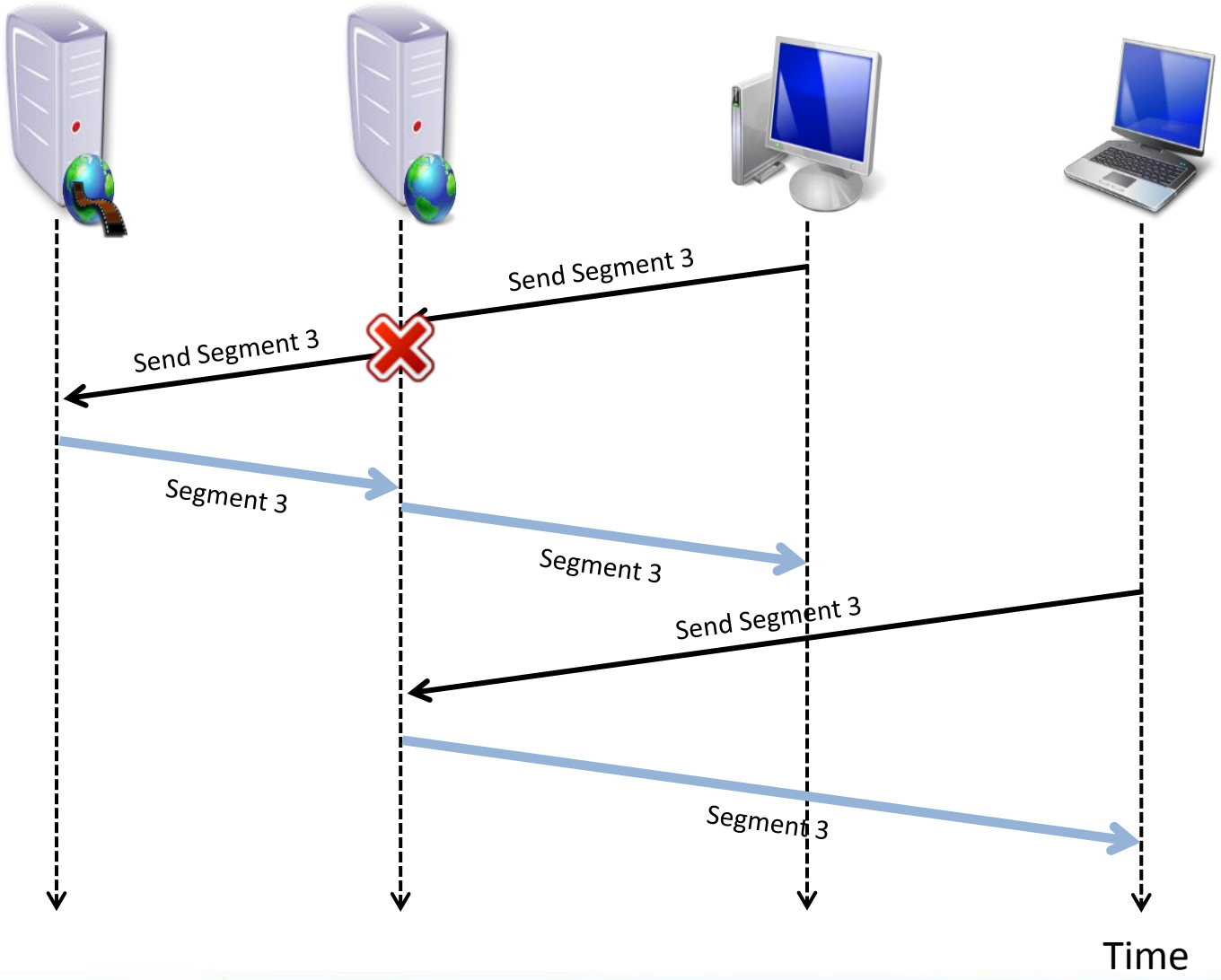
Source: http://www.ericsson.com/mobility-report

Adaptive Streaming over HTTP

- **Basic Approach: Adapt Video to Web rather than Changing the Web**

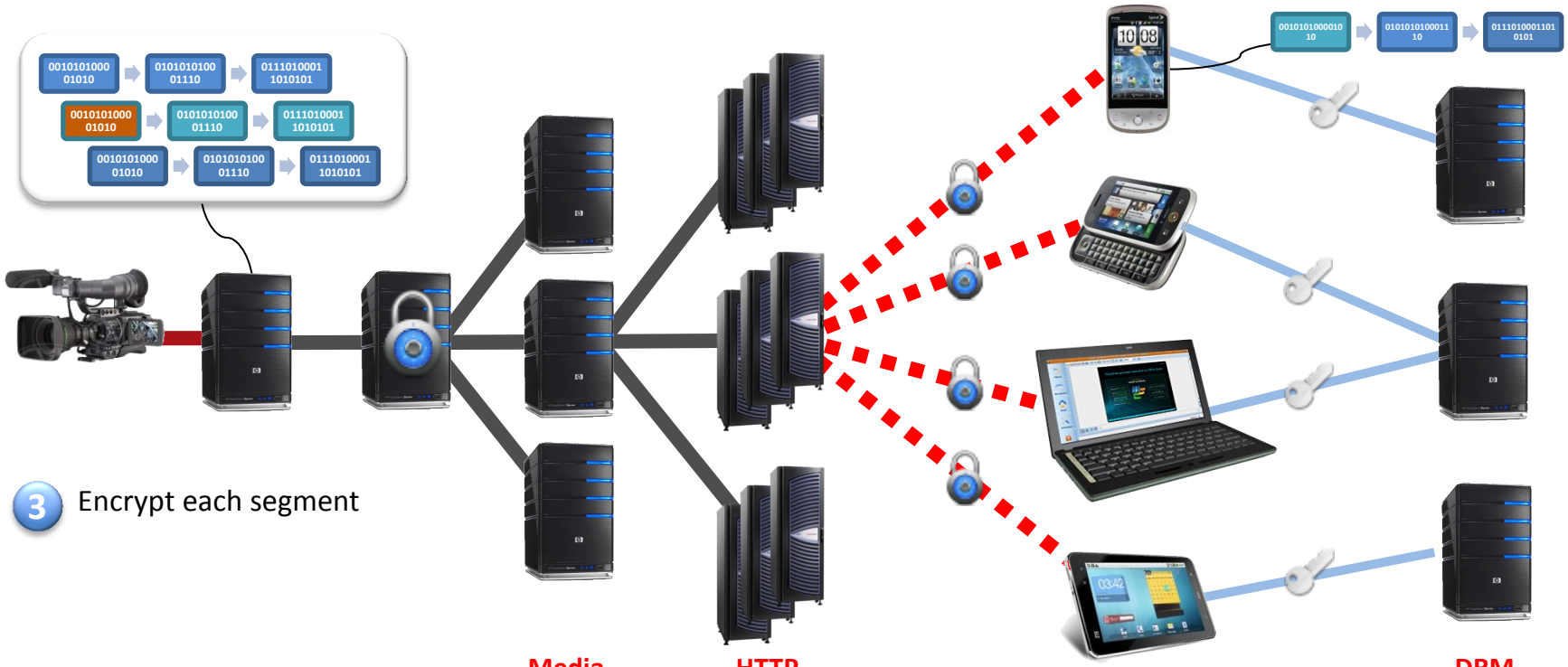
- **Streaming realized by continuous Short Downloads**
  - Downloads in small chunks to minimize bandwidth waste
  - Enables monitoring consumption and tracking clients
- **Adaptation to Dynamic Conditions and Device Capabilities**
  - Adapts to dynamic conditions anywhere on the path through the Internet or home network
  - Adapts to display resolution, CPU and memory resources of the client
  - Facilitates “any device, anywhere, anytime” paradigm
- **Improved Quality of Experience**
  - Enables faster start-up and seeking (compared to progressive download)
  - Reduces and may eliminate rebuffering, skips, freezes and stutters
- **Use of HTTP**
  - Well-understood naming/addressing approach
  - Provides easy traversal for all kinds of middleboxes (e.g., NATs, firewalls)
  - Enables cloud access, leverages existing HTTP caching infrastructure
  - Enables client-driven deployments
  - Enables reuse of existing web technologies: authentication, authorization, etc.

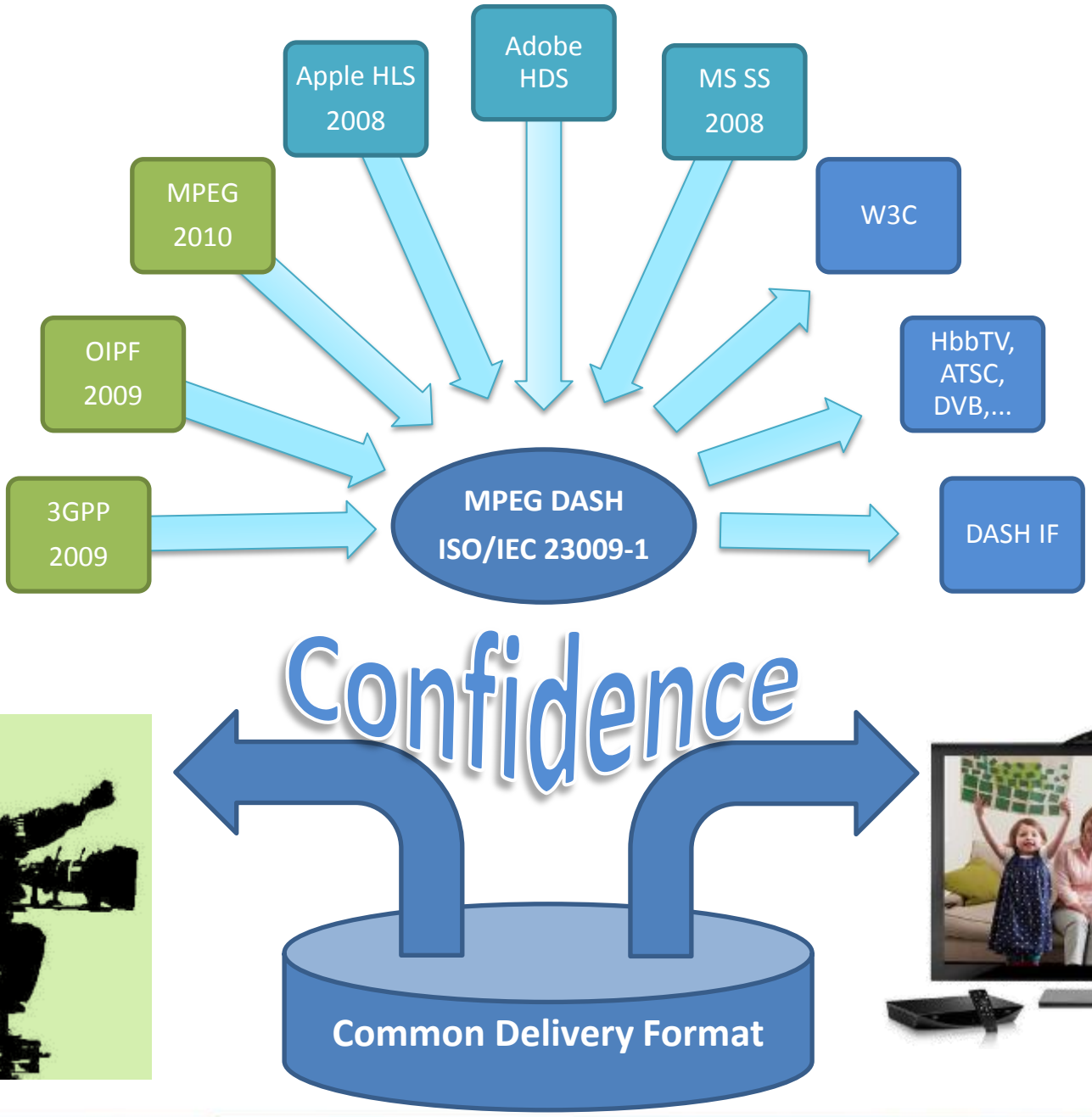
Scalability and Cost: Leveraging HTTP Caches



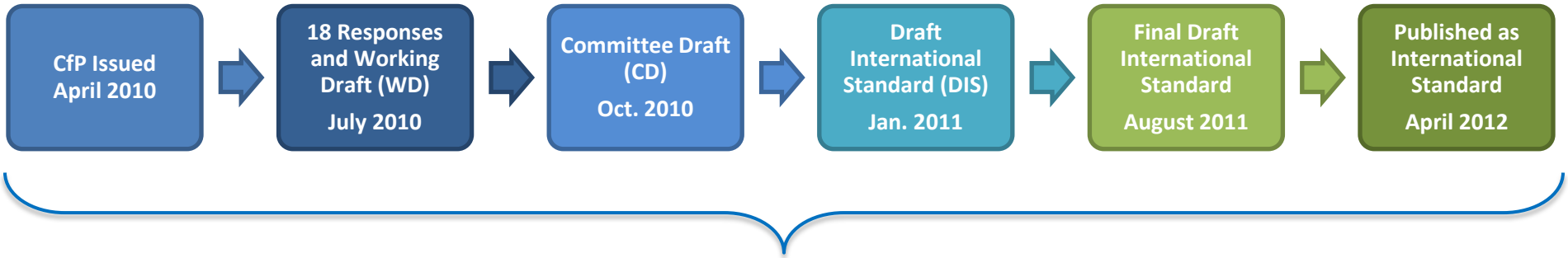
Adaptive Streaming over HTTP – Common Understanding

1. Encode each video at multiple bitrates
2. Split the videos into small temporal segments
3. Encrypt each segment
4. Make each segment addressable via an HTTP-URL
5. Client makes decision on which segment to download
6. Client acquires a license for encrypted content
7. Client splices segments together and plays back





Timeline and Standards in MPEG



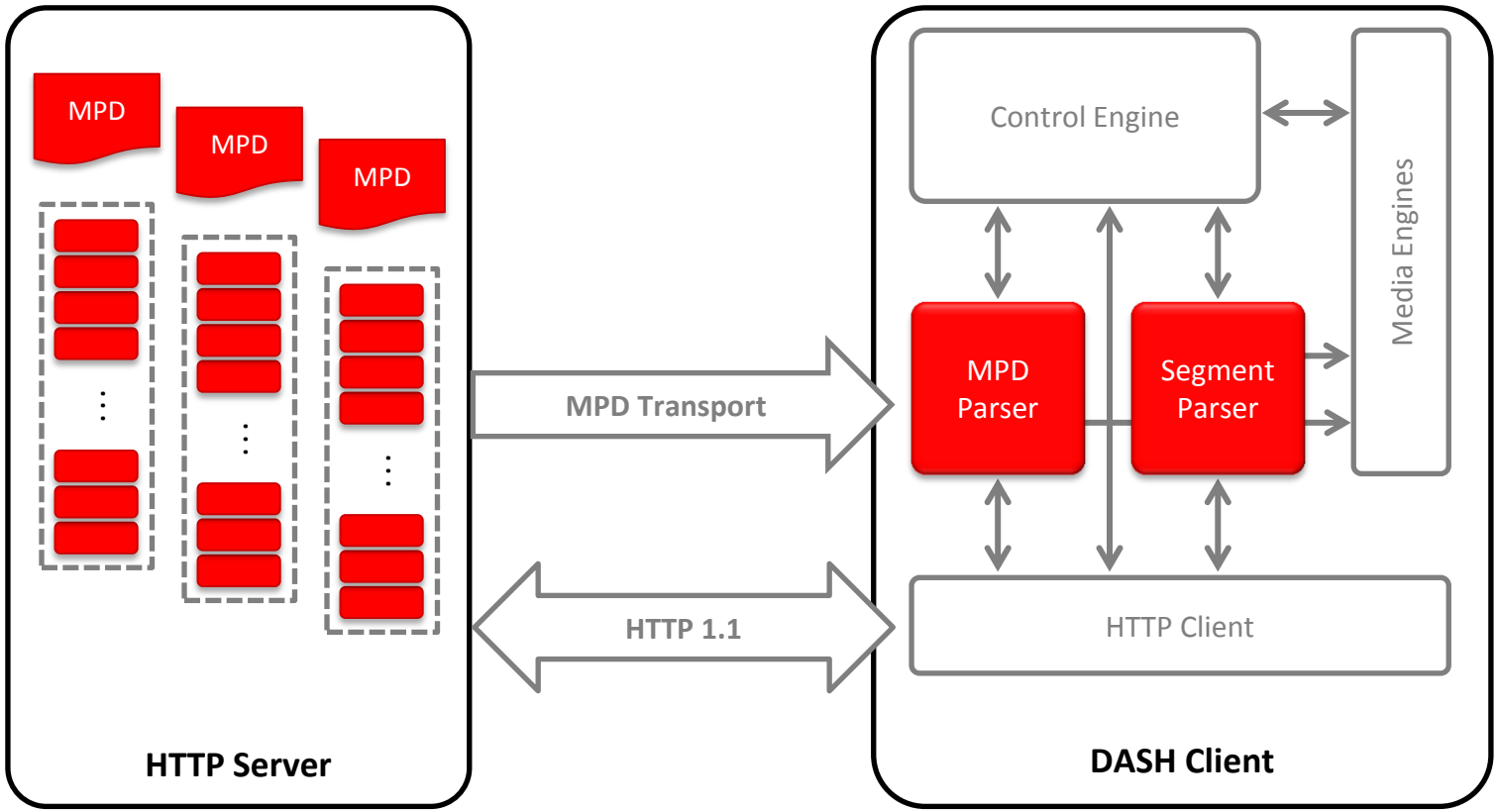
Fastest time ever that a standard was developed in MPEG to address the demand of the market

- **ISO/IEC 23009 Parts**
  - Part 1: Media Presentation Description and Segment Formats
  - Part 2: Conformance and Reference Software
  - Part 3: Implementation Guidelines
- **Other Relevant MPEG Standards**
  - 14496-12: ISO Base Media File Format (ISOBMFF)
  - 14496-15: Carriage of NAL unit structured video in ISOBMFF
  - 23001-7: Common Encryption in ISOBMFF
  - ISO/IEC 14496-30: Timed Text and other visual overlays in ISOBMFF
  - Codec specs for AVC, HEVC, audio, etc.

MPEG – Dynamic Adaptive Streaming over HTTP

- **Goal**
  - Develop an international, standardized, efficient solution for HTTP-based streaming of MPEG media
- **Major Objectives and Design Principles**
  - Do the necessary, avoid the unnecessary
  - Be lazy: reuse what exists in terms of codecs, formats, content protection, protocols and signaling
  - Be backward-compatible (as much as possible) to enable deployments aligned with existing proprietary technologies
  - Be forward-looking to provide ability to include new codecs, media types, content protection, deployment models (ad insertion, trick modes, etc.) and other relevant (or essential) metadata
  - Enable efficient deployments for different use cases (live, VoD, time-shifted, etc.)
  - Focus on formats describing functional properties for adaptive streaming, not on protocols or end-to-end systems or implementations
  - Enable application standards and proprietary systems to create end-to-end systems based on DASH formats
  - Support deployments by conformance and reference software, implementation guidelines, etc.

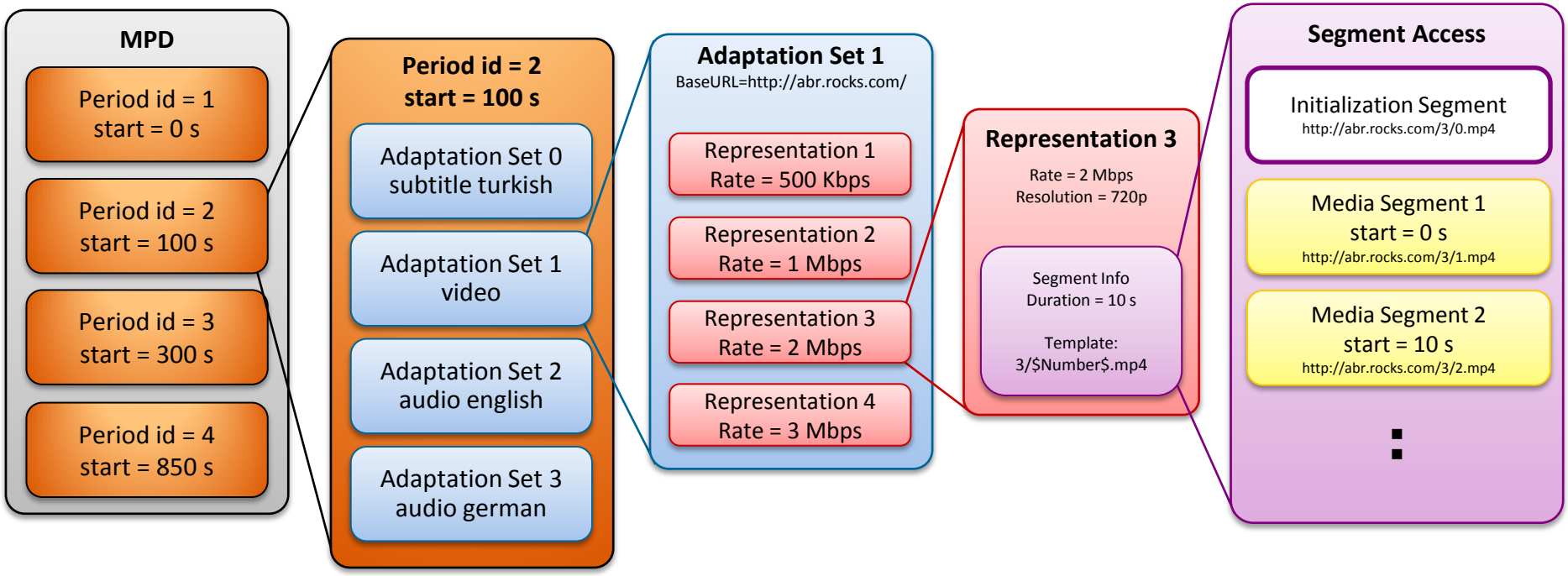
Scope of MPEG DASH (Shown in Red)



Major Functional Components (1) – Data Model

- Provide information to a client, where and when to find the data that composes A/V experience → **MPD**
- Provide the ability to offer a service on the cloud and HTTP-CDNs → **HTTP-URLs and MIME Types**
- Provide service provider the ability to combine/splice content with different properties into a single media presentation → **Periods**
- Provide service provider to enable the client/user selection of media content components based on user preferences, user interaction device profiles and capabilities, using conditions or other metadata → **Adaptation Sets**
- Provide ability to provide the same content with different encodings (bitrate, resolution, codecs) → **Representations**
- Provide extensible syntax and semantics for describing Representation and Adaptation Set properties → **Descriptors**
- Provide ability to access content in small pieces and do proper scheduling of access → **Segments and Subsegments**
- Provide ability for efficient signaling and deployment optimized addressing → **Playlist, Templates, Segment Index**
- Provide ability to enable reuse of existing encapsulation and parsing tools → **MPEG2-TS and ISO-BMFF**

DASH Data Model



Splicing of arbitrary content, e.g. ad insertion

Selection of Components/Tracks based on properties

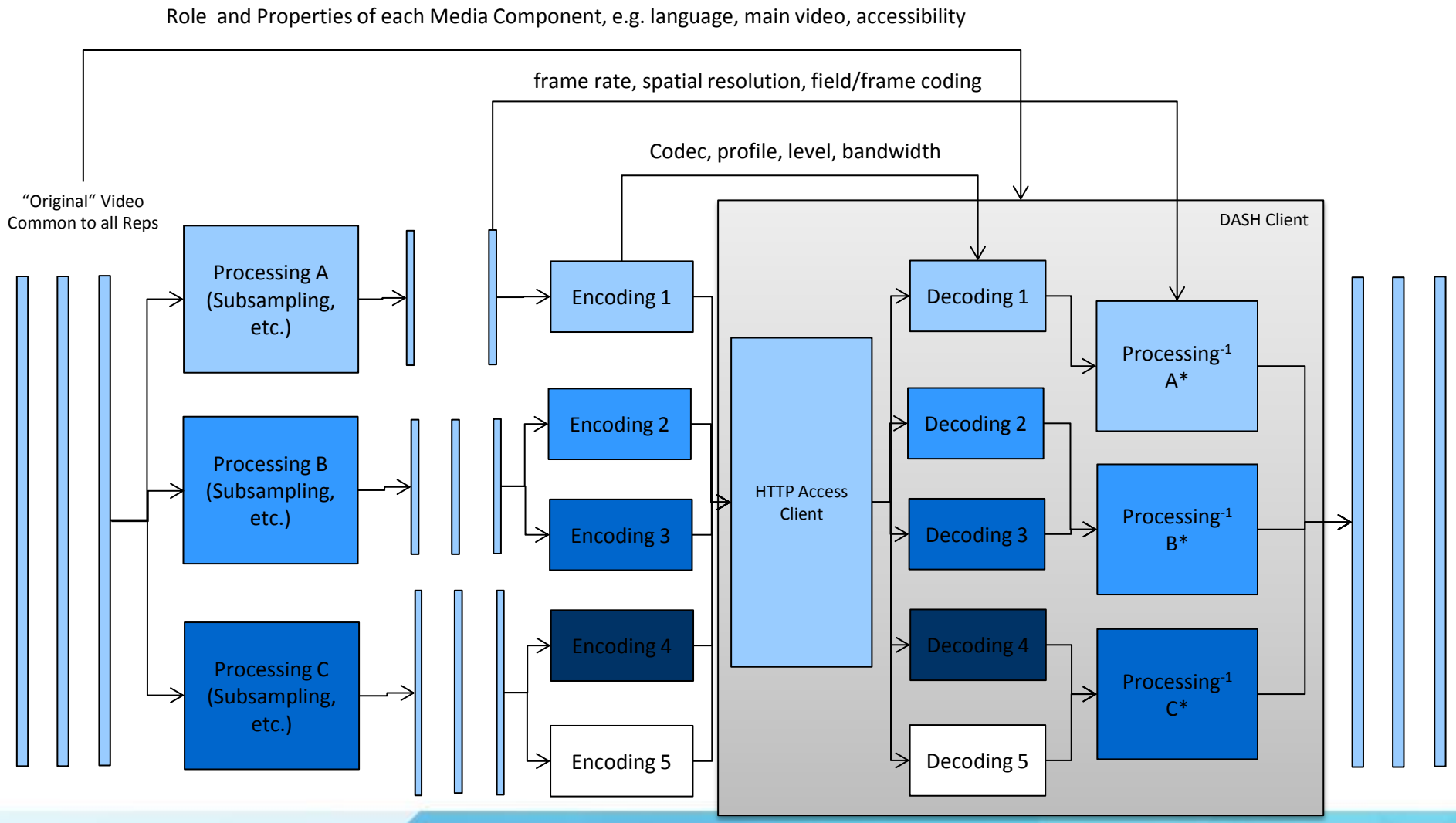
Selecting/Switching of Representation based on bandwidth, etc.

Well-defined media format, i.e. ISO BMFF or MPEG-2 TS

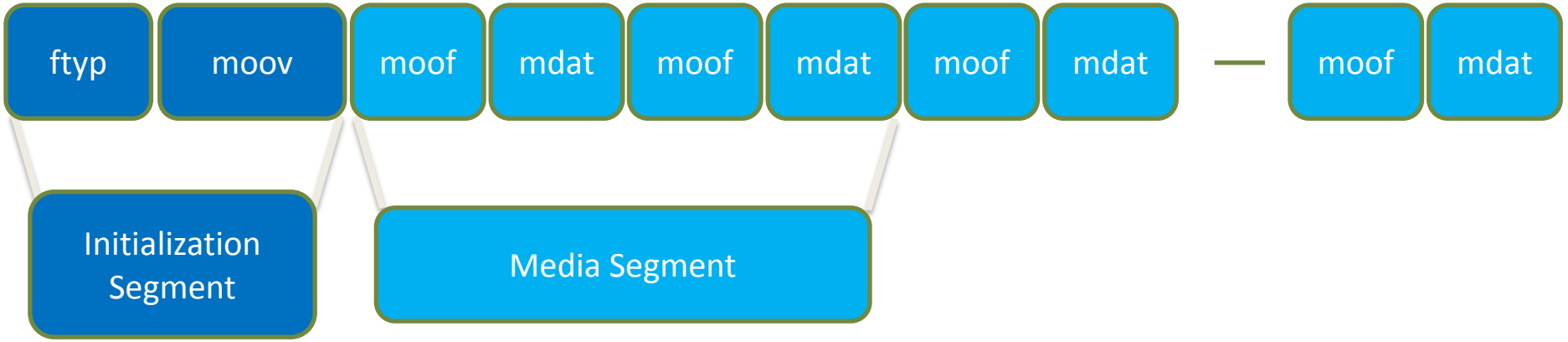
Media Delivery Format, chunks with unique addresses + associated timing

Representations in One Adaptation Set

➔ Enabling Seamless Switching



Representation and Segments for ISO BMFF



- Representations are conceptual, Segments are accessible and well defined data units
- For ISO BMFF based media formats, segments are based on fragmented movie files
- Signaling per Representation in MPD
  - The type of the segment, mostly an Initialization or Media Segment
  - The URL of each media segment through explicit list or template, or byte range
    - Number template: http://abr.rocks.com/Rep1/$Number$.mp4 → http://abr.rocks.com/Rep1/1.mp4
    - Time template: http://abr.rocks.com/Rep1/$Time$.mp4 → http://abr.rocks.com/Rep1/3465.mp4
    - Segment Index & byte ranges: http://abr.rocks.com/Rep1.mp4 ➔ http://abr.rocks.com/Rep1.mp4 range 3190-8959
  - The (approximate) start time and duration of each media segment (for seeking)
  - Start with SAP indication: Indicates SAP type at the start of a segment
  - The mapping of the internal movie time to the global media presentation timeline
  - The segment availability times for dynamic services

Major Functional Components (2) - Timing

- **Common Media Presentation Time**
  - Provide ability to present content from different adaptation sets synchronously
  - Provide ability to support seamless switching across different representations
- **Switching Support features**
  - Signalling of Stream Access Points
  - Segment Alignment to avoid overlap downloading and decoding
- **Play-out and decode times per Segment and Track fragment**
  - Provide ability to randomly access and seek in the content
- **Segment Availability Time**
  - Mapped to wall-clock time
  - Expresses when a segment becomes available on the server and when ceases it to be available
  - Provide ability to support live and time-shift buffer services with content generated/removed on the fly

Major Functional Components (3) - Operations

- Provide ability for personalized access to media presentation, e.g. targeted advertisement → **MPD Assembly with xlink**
- Provide ability to provide redundant content offering → **Multiple Base URLs**
- Provide ability to announce unforeseen/unpredictable events in live services → **MPD Updates**
- Provide ability to send events associated with media times → **Inband and MPD-based Event Messages**
- Provide the ability to log and report client actions **➔ DASH metrics**
- Provide ability to efficiently support trick modes → **Dedicated IDR-frame Representations and Sub-representations**
- Provide ability to signal collection of a subset/extension of tools → **Profiles and Interoperability Points**

Status of MPEG DASH in Industry

- DASH Industry Forum (http://dashif.org)
  - Founded in 2012 to promote and catalyze market adoption of MPEG DASH (70 members)
  - Established a mediator role among different communities: standardization organizations, interoperability groups, larger and smaller business entities, researchers, open source community, public and press
  - Successful demonstrations and events at IBC'12, MWC'13, NAB'13, …
  - Published DASH-AVC/264 Interoperability Guidelines
  - Published draft versions of test vectors, test services, conformance software and open source reference client based HTML-5 extensions and Javascript
- Many SDOs adopt MPEG-DASH as THE technology for Internet TV
  - HbbTV, DTG, 3GPP, DLNA, ATSC, OIPF, CableLabs and many more …
- Internet Streaming Services based on DASH
  - YouTube: http://dash-mse-test.appspot.com/dash-player.html
  - Netflix continues to stream DASH compatible content (but does not use MPDs)
  - NAGRA and Abertis telecom launch hosted multi-screen service
  - DASH is the transport format for LTE broadcast systems
  - Samsung and Orange announced to deploy DASH and HEVC
  - …

DASH Related Standardization Activities in Different SDOs

- MPEG ➔ bug fixing & some core experiments
- 3GPP ➔ lots of work on DASH over eMBMS/LTE Broadcast
- DVB ➔ defining a toolset for broadcasters to deploy their services with DASH over the top (mostly HbbTV context)
- ATSC, SCTE ➔ deploying OTT/Hybrid based on DASH
- DASH-IF ➔ create and demonstrate functionalities and interoperability
- W3C ➔ browser integration
- IETF ➔ delivery optimizations: CDNI, HTTP2.0, Multicast

Ongoing Work on DASH in MPEG

- Recurring work: Corrigenda, Conformance, Guidelines, integration of new codecs
- Amendment of Second Edition on the way to support
  - Improved live services and robustness
  - Profile for Ad Insertion
- Specific topics currently under work
  - Descriptor for Spatial Relationship in DASH (SRD)
  - Server and Network assisted DASH Operation (SAND)
  - DASH Client Authentication, Content Access Authorization, Controlling the Client Behavior
  - Quality-based streaming
  - DASH over emerging protocols HTTP/2.0 and web sockets
  - SAP-Independent Segment SIgnalling (SISSI)
  - Content aggregation and playback control (CAPCO)
  - …