More Juice Less Bits: Content Aware Streaming

ACM MMSys 2016 – Klagenfurt, Austria

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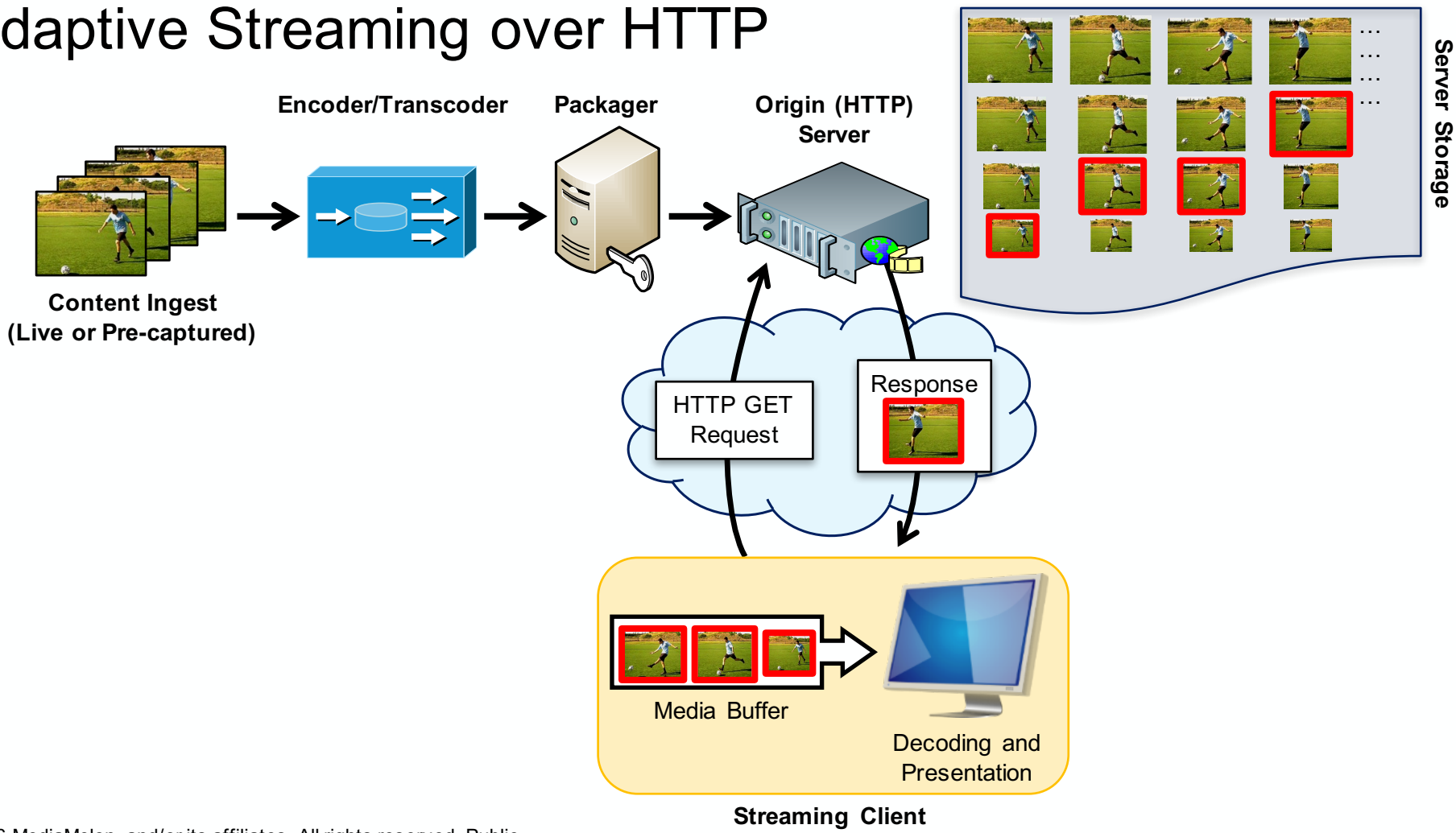
Adaptive Streaming over HTTP



What Determines the Success of an Internet Video Service

- Broadcast TV-like experience
  - No buffering
  - Quick start
  - HD and 4K, HDR capable
- Multiscreen with seamless transitions
  - Watch TV content on smartphones and tablets “on the go”

- Ability to measure QoE and adapt the OTT service to deliver highest quality
  - Measure and move quickly
  - Make the right corrections to maximize gains in quality

Deliver high QoE

Deliver service to any screen

Measure QoE and engagement

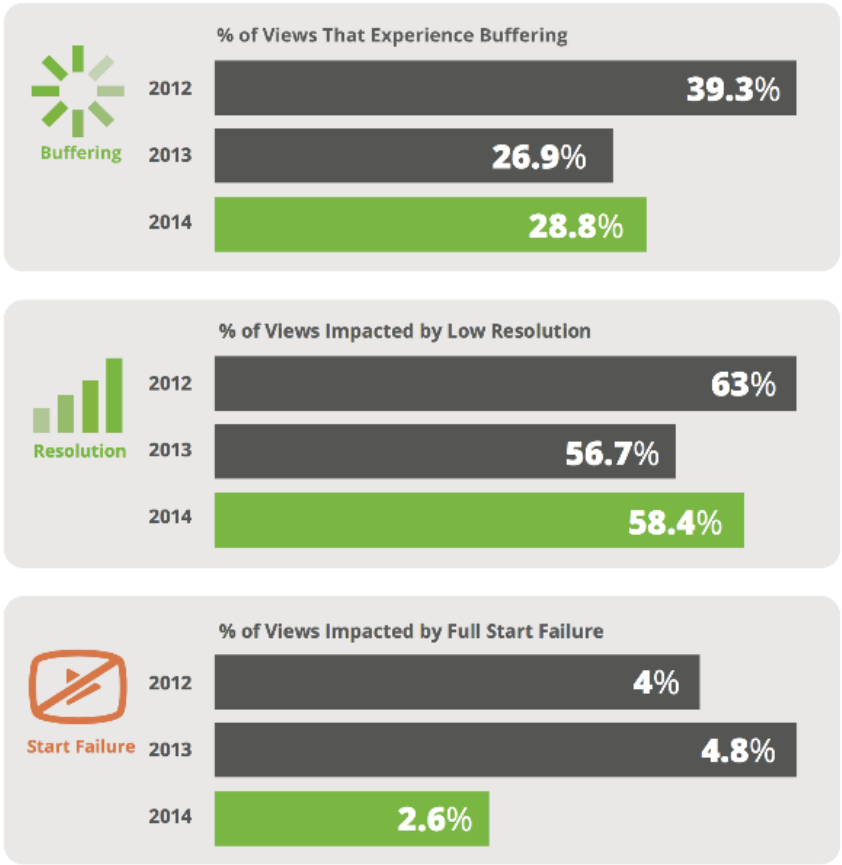
Is the Status Quo Adaptive Streaming Good Enough?

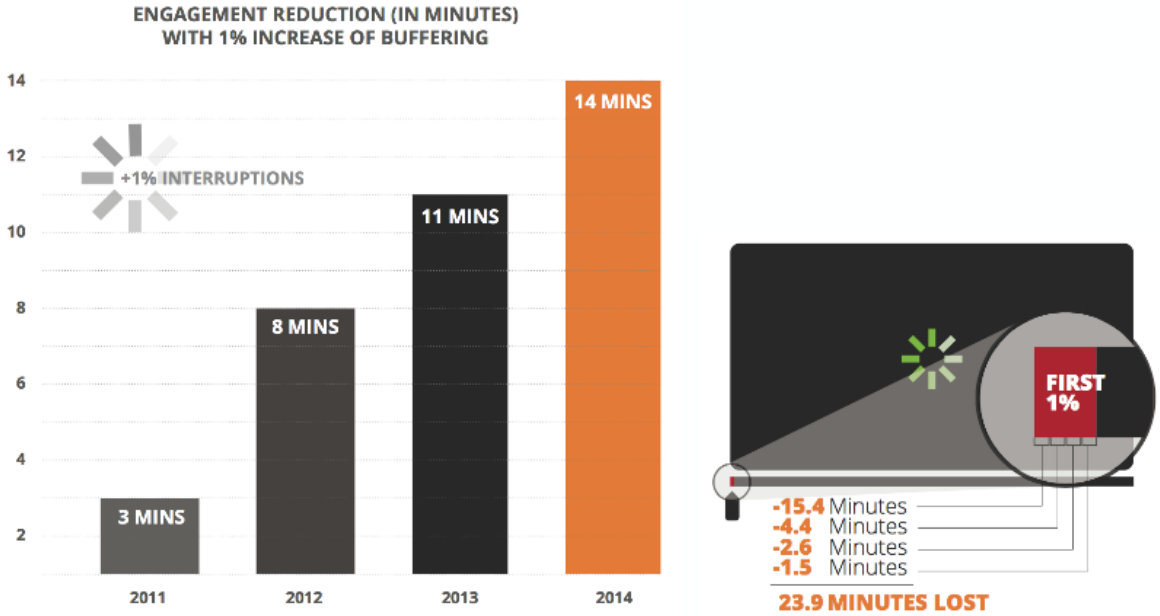
- Advantages
  - Adaptive streaming improves over progressive download; helps deliver same video content to clients with varying capabilities and bandwidth conditions
  - Reduces the chances of buffering in congested networks
- Limitations
  - High storage space requirements – store multiple bitrate layers of the same content
  - Demands constant-bitrate encodes with low bitrate variation resulting in poorer video quality
    - Apple's TN2224 limits bitrate variability to 10%

Traditional adaptive streaming suffers because it demands constant-bitrate encodes, resulting in variations in quality

Viewer Experience Statistics

Bad Quality Hurts





Source: Conviva Viewer Experience Report, 2015

Modeling and Measuring Quality of Experience

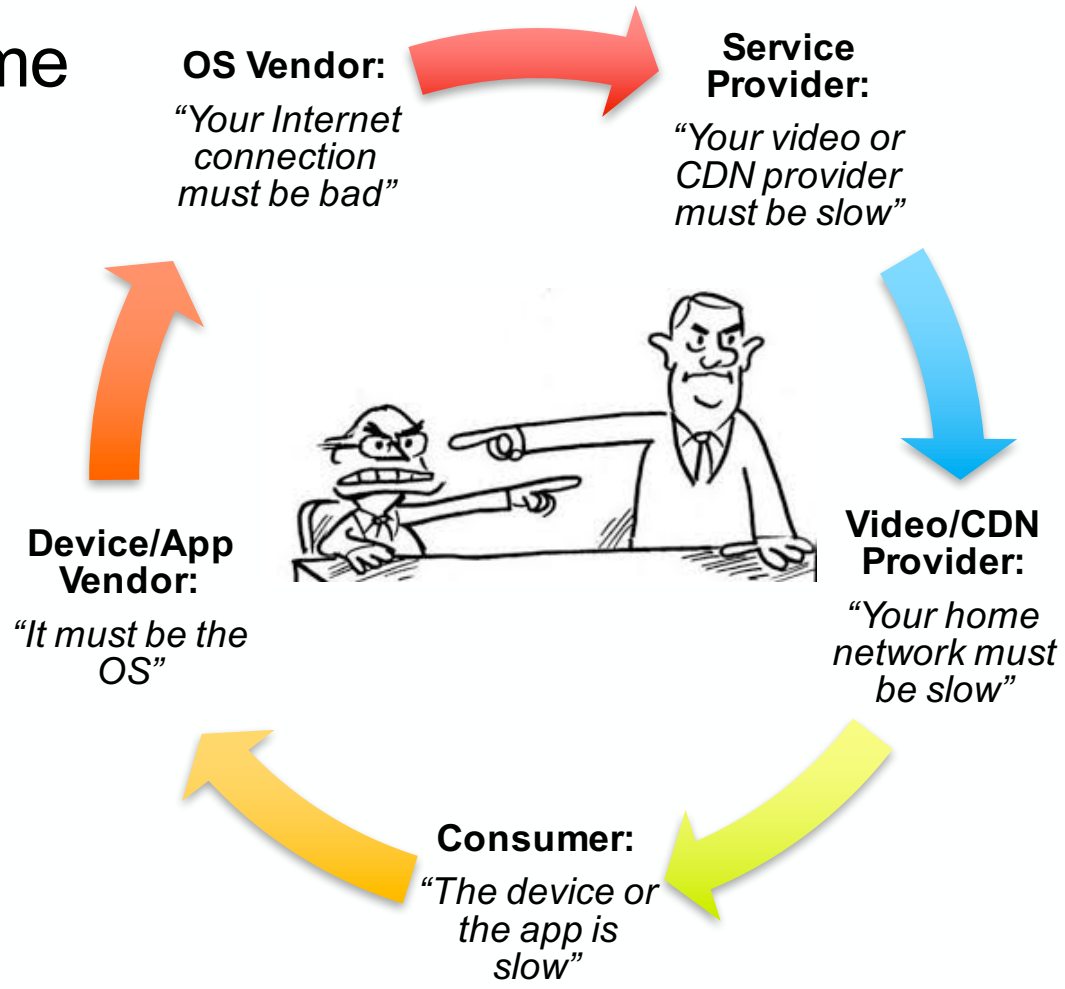
Understanding the Impact of QoE on Viewer Engagement

- How can we
  - Model adaptive streaming dynamics such as rate/resolution shifting for different genres?
  - Take into account shorter buffering and faster trick modes in this model?
- Does QoE impact viewer engagement?
  - If yes, how?

We need to be able to answer these questions for:

- Designing a client that takes QoE into account
- Keeping viewers happy and engaged, subsequently increasing ad revenues

Cycle of Blame



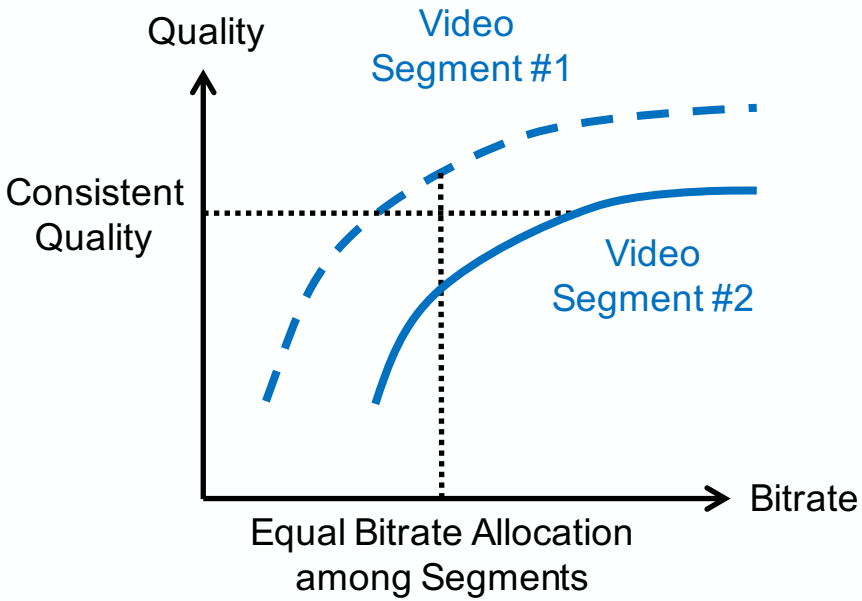
So, How Can We Improve QoE?

Some Current Approaches

- Network capacity upgrades, use of P2P networking
- Video codec improvements, pre and post-processing of video
- Better transport mechanisms for linear and on-demand content
- Better client and application designs

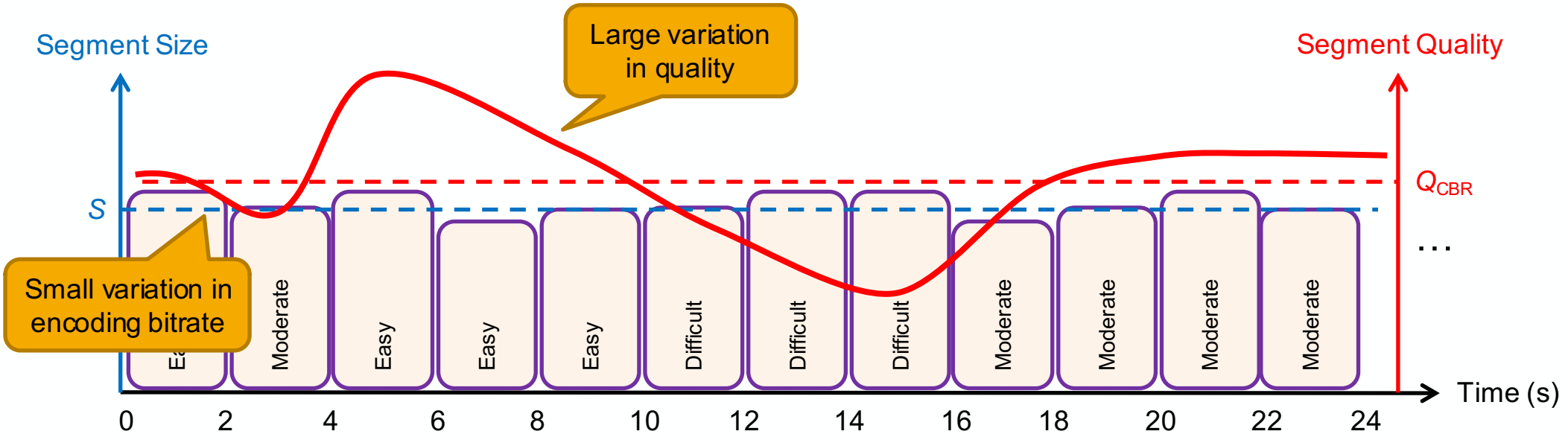
All of these could be useful but they cost $$$ and
are not all viable for every vendor, provider or consumer

Segments Have Different Complexities



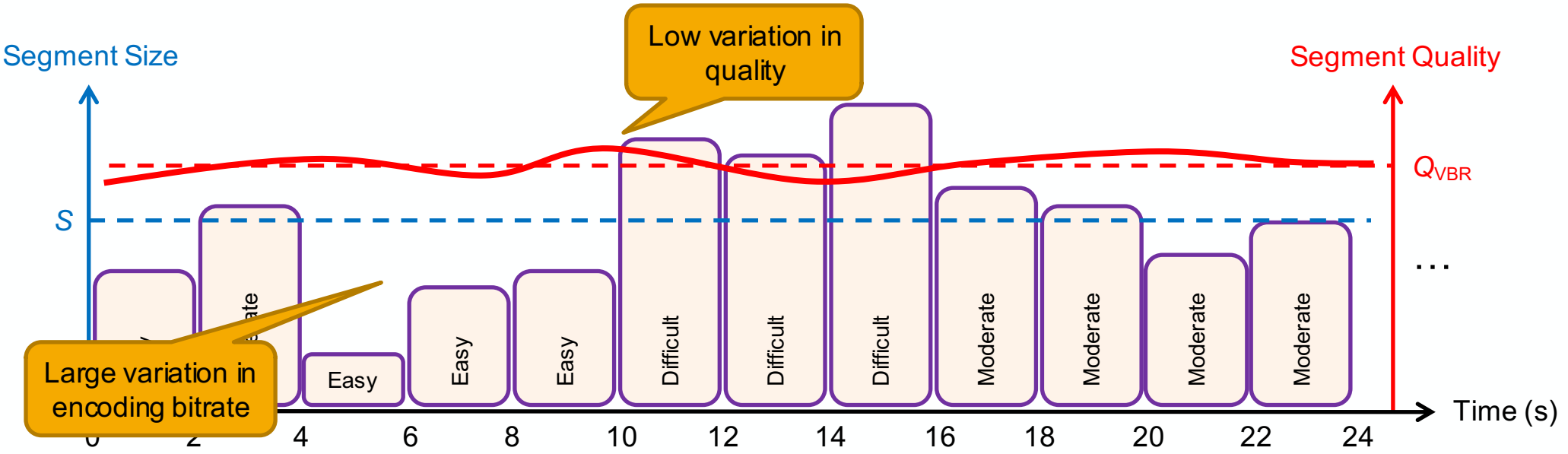
Adaptation Feature Does Not Deliver Consistent Quality

Guidelines Limited Bitrate Variability to (Mostly) 10% So Far



If there is something worse than having to watch a video at a lousy quality, it is to watch that video with varying quality

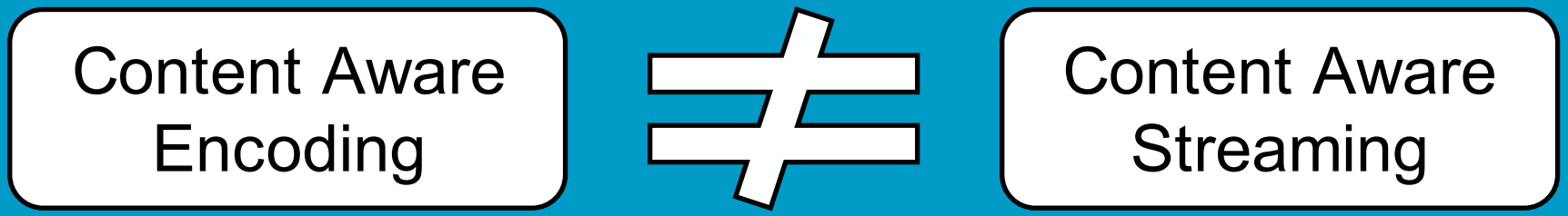
What if We Encode in a More Subtle Fashion?



While we spend the same total amount of bits, we not only increase average quality but also reduce quality variation

HLS authoring spec for ATV allows 2x capping rate for VoD. For linear content, variability is limited to 10-25% range.

Generating VBR-encoded segments is easy, but streaming them is not!



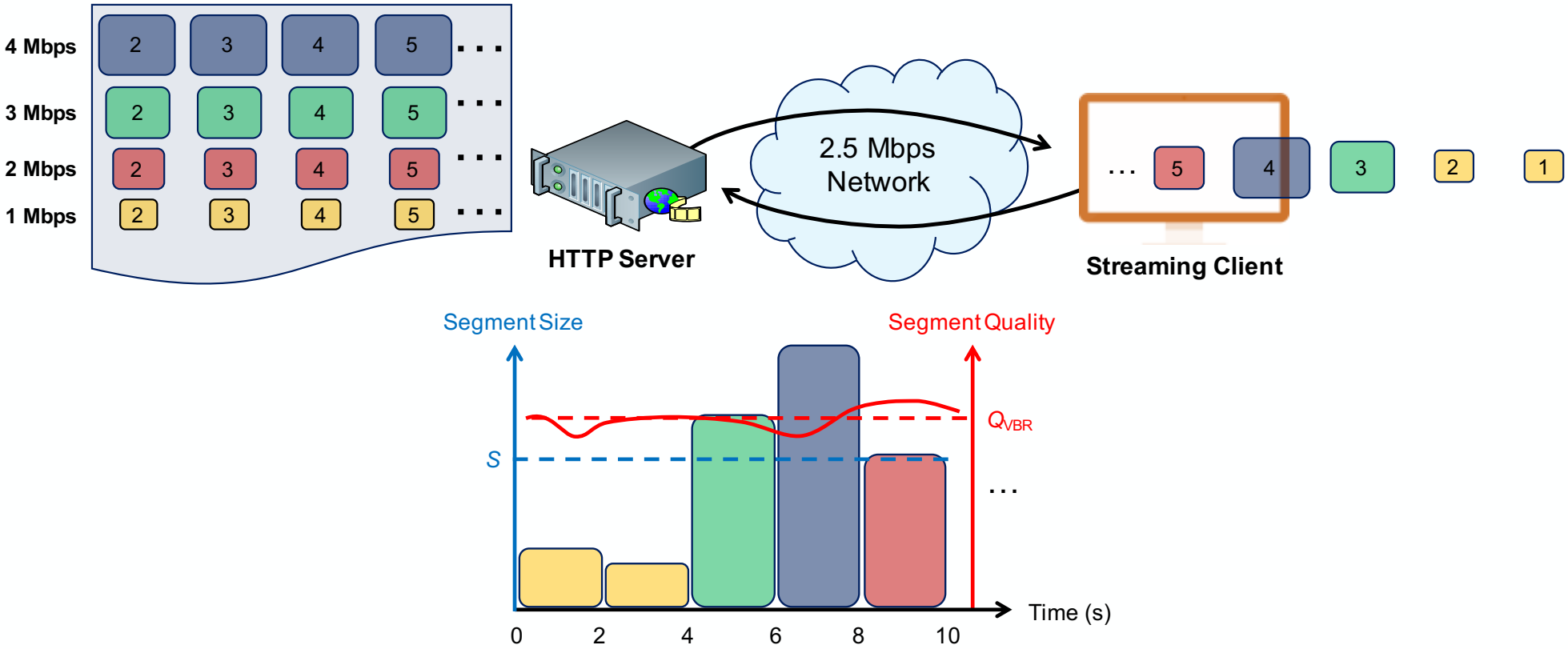
QBR: Content Aware Streaming

- Analyze content to generate a video buffer and video quality complexity map
- Use the complexity map in the player to improve adaptation decisions
- Consequently, the player can now
  - Stream simple scenes at low bitrates without degrading quality
  - Thus “make space” to download complex scenes at bitrates above network constraints
- End result is consistently excellent video quality even when viewer’s connection does not automatically allow for such crisp video

Use video complexity information to improve streaming
Result: Deliver higher quality using fewer bits

Multiple Representations Naturally Enable “Cherry-Picking”

QBR Can Be Applied to Content Already Encoded in CBR



Why Use QBR?

Improve Video Quality and Reduce Cost of Streaming

- Content encoded in CBR
  - Eliminates artifacts of CBR encoding when the bitrate is not sufficient to encode a complex scene
  - Improves quality by choosing higher bitrate segments for complex scenes while managing the playback buffer efficiently
  - Saves bandwidth by choosing lower bitrate segments for scenes which do not show improvement with bitrate increase
- Content which can be freshly encoded in VBR
  - Allows streaming of VBR content encoded with larger bitrate variability
  - Results in higher quality encodes and eliminates artifacts
  - Delivers consistent quality using least bits

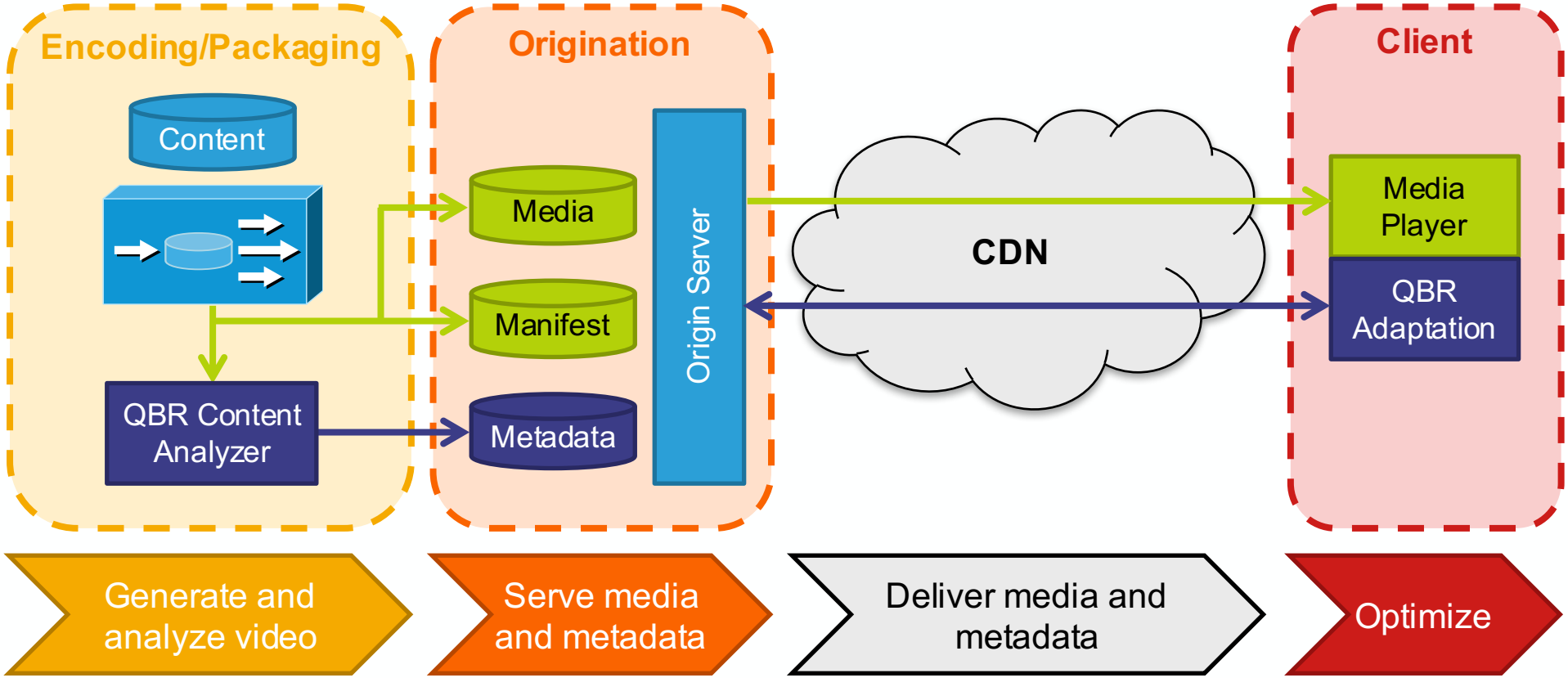
35%
Bandwidth savings

30%
Storage savings

95%
Reduction in artifacts

80%
Reduction in quality inconsistency

QBR Workflow



Deployment Challenges

- Challenge 1: Development of quality metrics and temporal pooling models
  - A common metric that is suitable for a variety of content types
  - A temporal pooling model that will reliably work for different viewer profiles, devices and networks
    - Different viewers have different sensitivity levels to glitches for different content types, and they are also forgiving in different time scales
      - A young viewer (likely to have longer-term memory) watching sports on a big screen vs. an elder viewer (likely to have short-term memory) watching news on a smaller screen
- Challenge 2: Integration into popular streaming client implementations
  - Many ecosystems are closed or proprietary, and one may not have access to the client algorithm to make the necessary changes (e.g., Apple HLS in iOS)
  - Standards bodies and industry consortiums may lead the way to develop certain guidelines

Deployment Challenges

- Challenge 3: Development of metadata standards
  - Computing the quality metric for each segment in each representation for each content is a tedious task, which is the easiest to deal with at the encoder or packager
  - Packing the metric values and conveying this information to all the clients in a timely and scalable manner is an equally important task
  - The timed metadata spec in MPEG (ISO/IEC 23001-10) is a good candidate for this task, and the standard should be completed soon

Deployment Challenges

- Challenge 4: Expansion to multi-client scenarios
  - We need controlled unfairness (which is fairness in quality not bitrate) among clients adaptively streaming the same or a different content over a network sharing resources (e.g., access network)
    - Easy scenario: One adult watching sports on a big screen vs. one adult watching a food show on a tablet
    - More complex scenario: One adult watching sports on a phone vs. three adults watching news on a big screen
  - The optimization across a number of streaming clients has to be done based on the utilities of the streamed videos, which depend on factors such as:
    - Spatial pooling model
    - Content types
    - Content features
    - Rendering devices
    - Audience profiles and sizes
  - Server and Network-assisted DASH (SAND) can help deploy controlled unfairness that we need in quality-aware streaming in multi-client scenarios

Key Takeaways: When to Use QBR

Use QBR in Any OTT Application: Live or On-Demand

- Legacy encoded content and storage optimization
- Genre independent streaming → Automatically chooses the best bitrate per scene
- VBR streaming enabler
- Live streaming optimization

Thank you

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