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Video Infrastructure for the Web

TODAY'S AND FUTURE CHALLENGES WITH NEW FORMS OF CONTENT LIKE 360°, AR, AND VR

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MPEG WORKSHOP: GLOBAL MEDIA TECHNOLOGY STANDARDS FOR AN IMMERSIVE AGE

FULL-STACK VIDEO INFRASTRUCTURE

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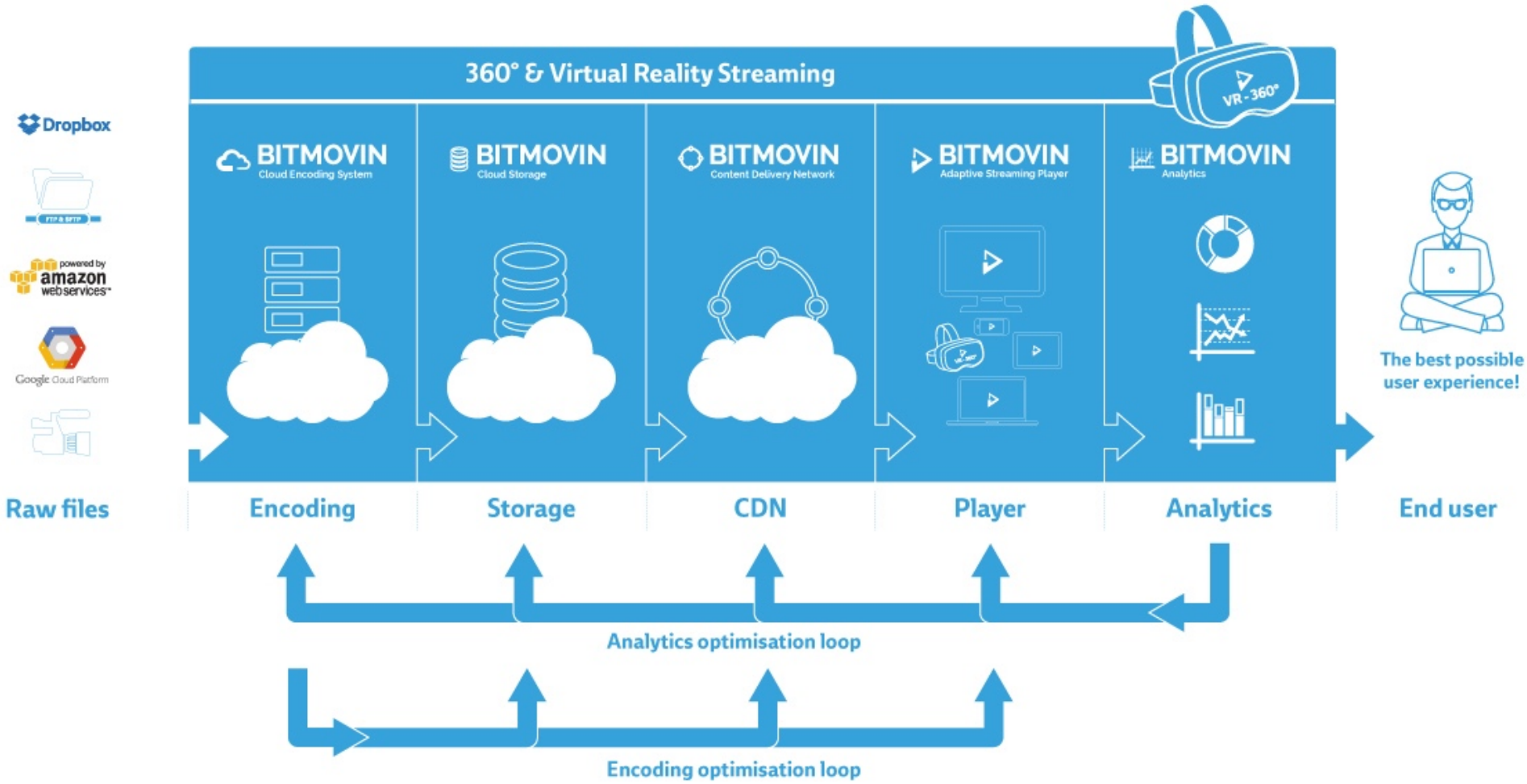

END-TO-END 360° INFRASTRUCTURE

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CUSTOMER USE CASES

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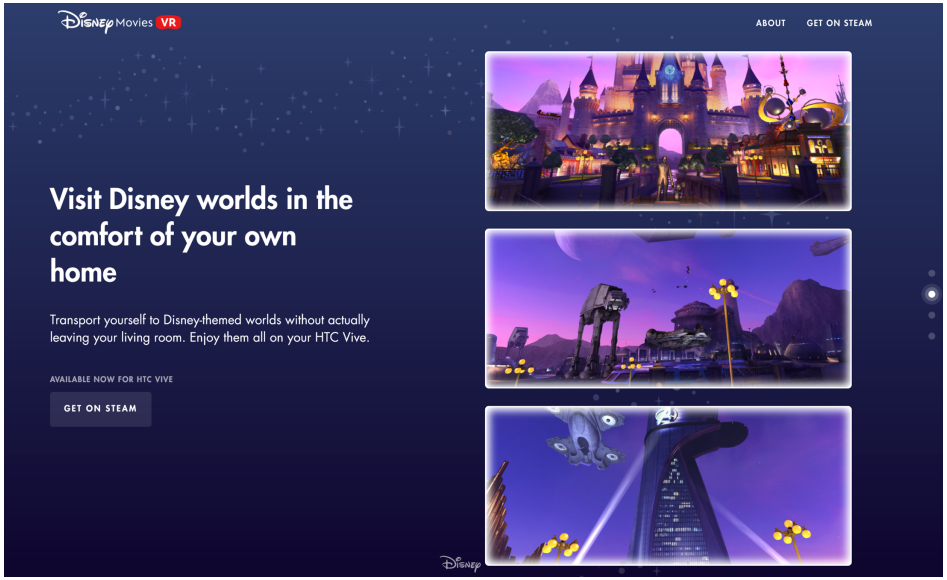

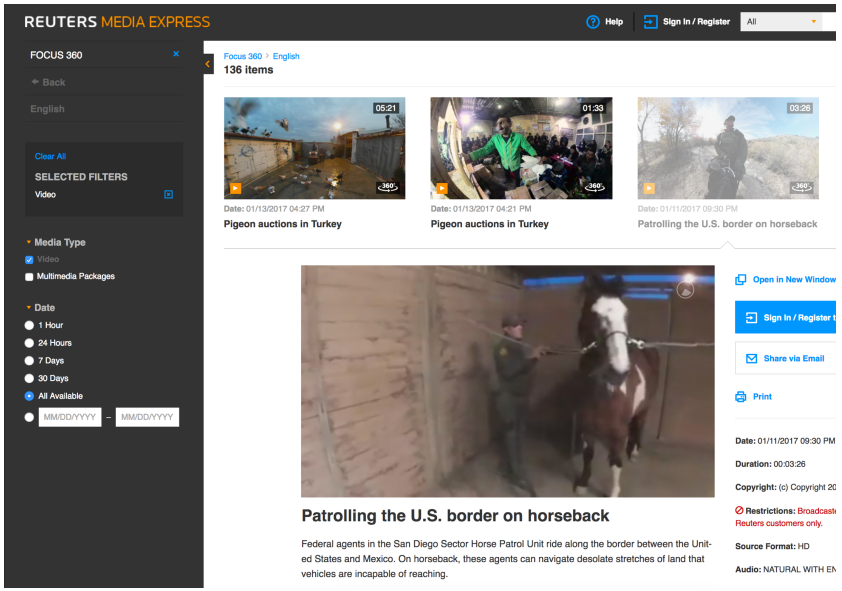

VIDEO CODING FOR 360° VIDEO?

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No special techniques for coding in spherical domain are widely available yet

- Encoding in rectangular domain
- Therefore we need the described projections to rectangular layouts
  - Equirectangular projection
  - Cube projection
  - Pyramid, Equal-Area projection and more . . .
- Traditional video codecs are used:
  AVC / HEVC (/ VP8 / VP9)

360° VIDEO – WHAT'S OUT THERE?

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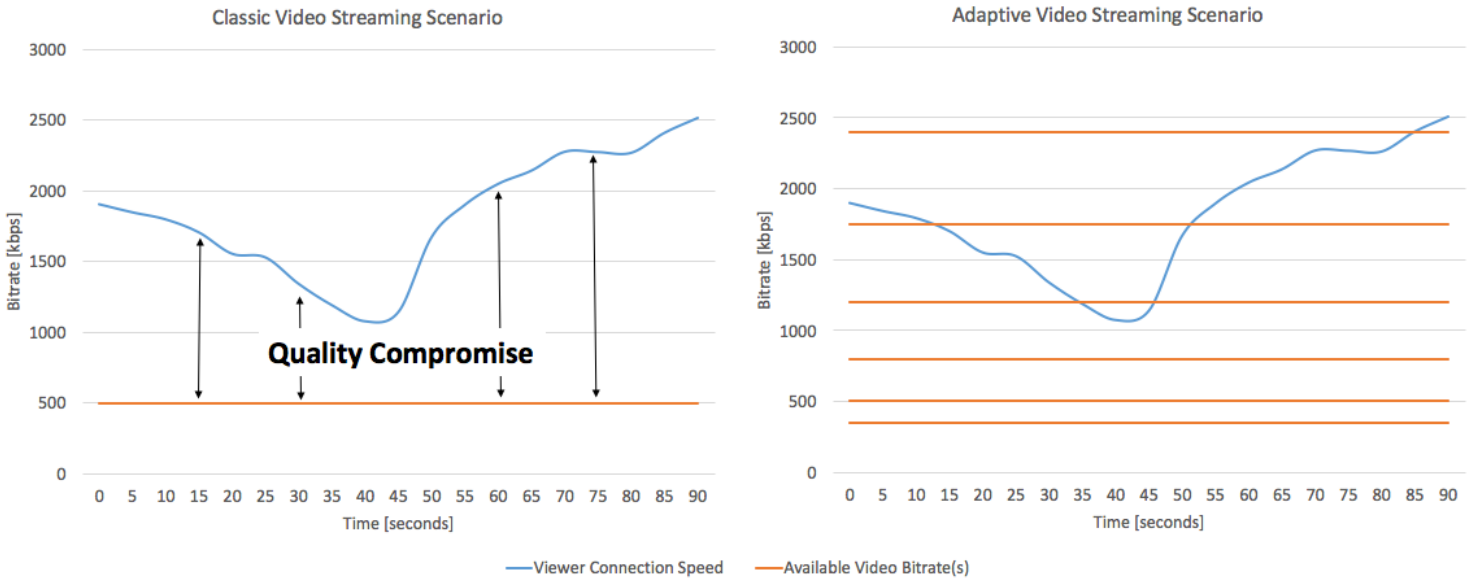
Primarily: Progressive MP4 for 360°

- 1080p to 4K Videos, using H.264 (some VP9)
- Why?
  - Browser/OS restrictions, e.g., on iPhone
  - Application has no access to frames
- Without adaptive streaming, the result is buffering and poor QoE



360° VIDEO – WHAT'S OUT THERE?

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Current trends? MPEG-DASH / HLS

- Logical next step to use adaptive streaming
- Especially for high bitrate/resolution content

Challenges:

- Device coverage & issues
  - Desktop browsers, mobile Web, smartphone apps, VR headsets, TVs, casting devices, etc.
  - 360° rendering and access to frames is different on all platforms
  - Lack of frame access, DASH/HLS support, etc.
- Overlays and ads
  - How to position/communicate/integrate different types of ads
- DRM protection
  - No access to decoded frame
  - See also next slides

PROBLEMS: DRM

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Content owners have to protect their content

E.g. in Browsers: HTML5 Encrypted Media Extensions

› DRM protection for adaptive streaming in HTML5
› Support for DASH / CENC content in HTML5

Where is the problem?

› 360°/VR content needs to be rendered in JavaScript
› Equirectangular to viewpoint rendering
› However: touching the frame for rendering breaks the DRM security principles (one could store the unprotected frames)

PROBLEMS: HTML5 EME + 360°

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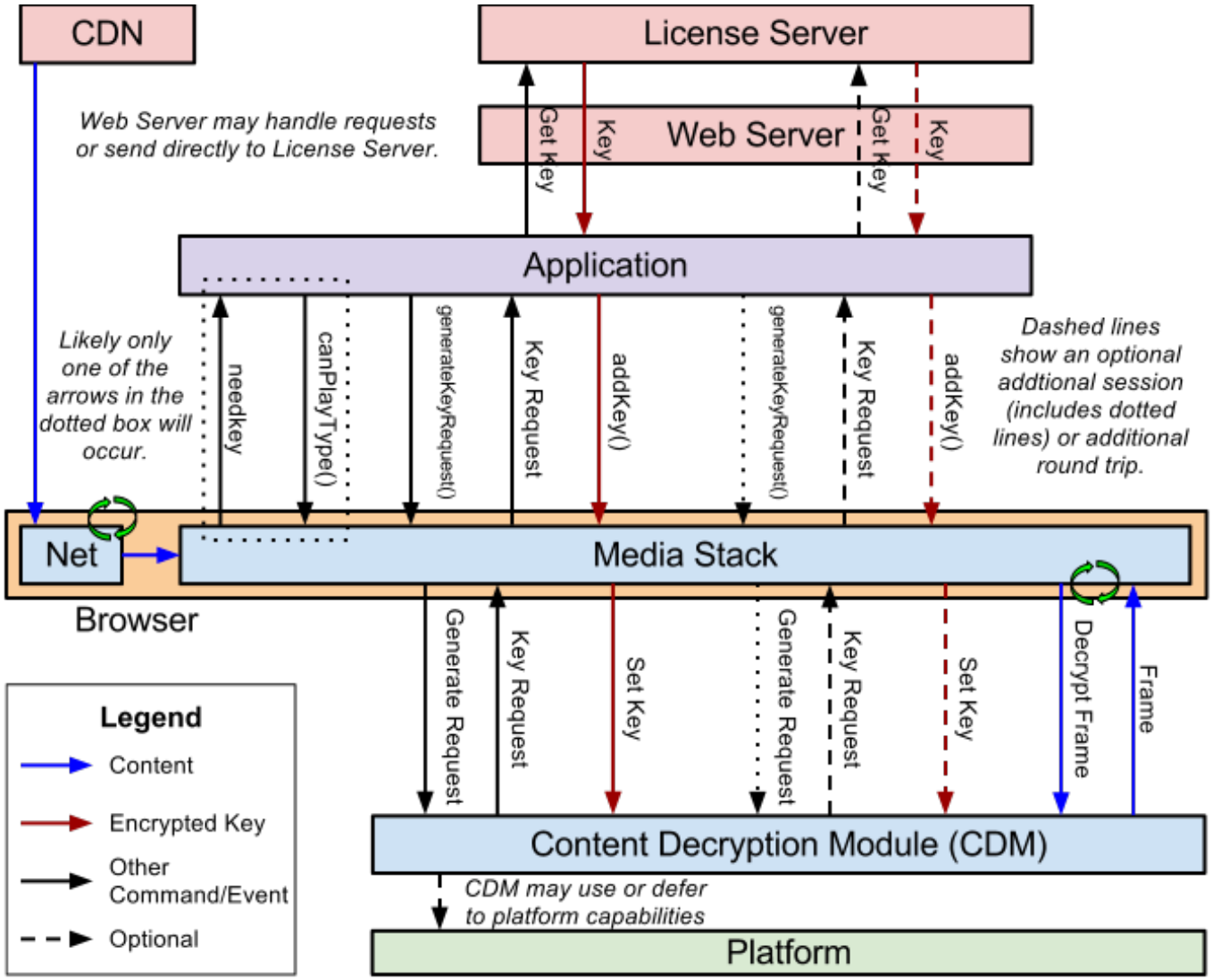

PROBLEMS: DRM

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This problem needs to be solved to enable business cases

By whom?

» Standardization bodies (W3C, MPEG, etc.)
» Platform providers (Browsers, mobile OS vendors)
» DRM systems (Fairplay, Playready, Widevine, etc.)

NEW APPROACHES: ADAPTIVE PYRAMID MAPS

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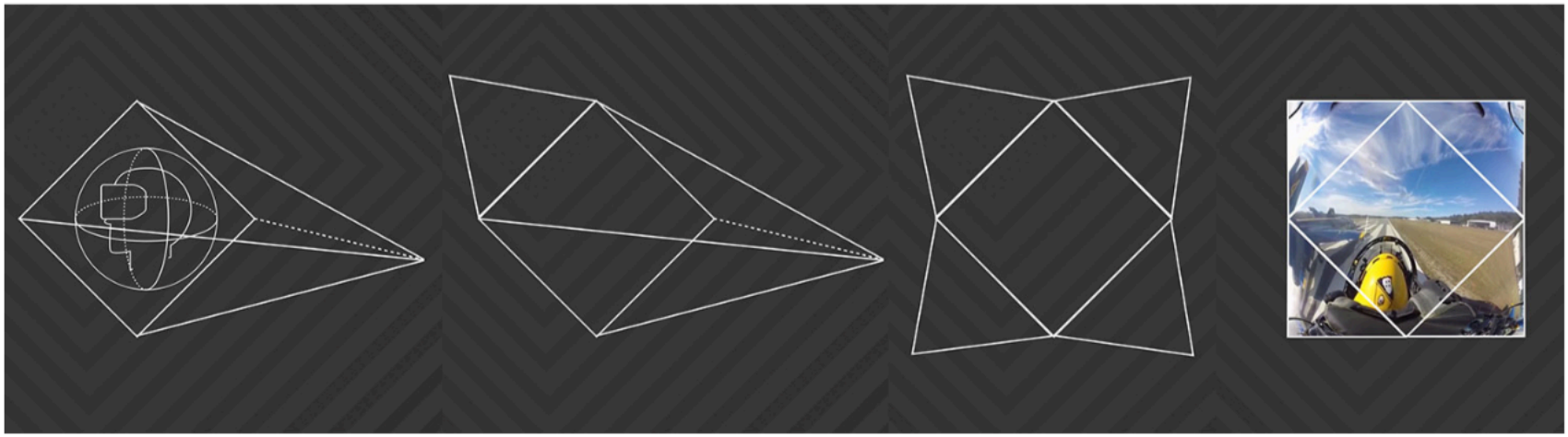
- Base of pyramid represents
- Field of View: **high quality**
  Sides of pyramid contain rest of whole panorama: **low quality**
- File size **reduced by 80 percent** against the original



NEW APPROACHES: ADAPTIVE PYRAMID MAPS

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- Approach was developed by Facebook
- No public available scientific demos, evaluations or sources so far
- When the viewer shifts perspective, a new pyramid is streamed and rendered
- In total **30 viewports** covering the sphere, separated by about 30 degrees
- **5 different resolutions** for each stream
- Results in **150 different versions** of same video, thus **significantly increase storage and encoding** requirements

WHAT ARE THE REAL NEEDS FOR 360°?

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- 360° content allows the user to change the viewing orientation while watching a video
  - Large areas of the video are not seen
- Full 360° area has to be stored
  - Large file sizes
  - Challenge of streaming of such content
- → Increase streaming efficiency
  - Choose the “right” content representation
  - Utilize new delivery approaches

WE NEED MORE BANDWIDTH EFFICIENT APPROACHES

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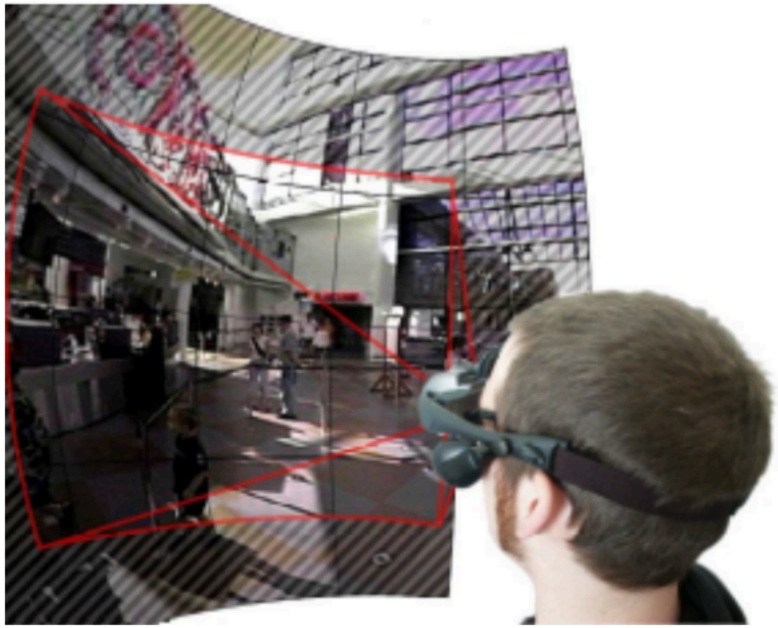
The state of the art streaming technology is to encode the video with each frame containing the full panorama as a whole in one uniform quality

- This is inefficient because
- only a part of each video frame is presented to the user based on the current viewing angle
- But all parts are streamed in same high quality



WHY WE NEED MORE BANDWIDTH EFFICIENT APPROACHES

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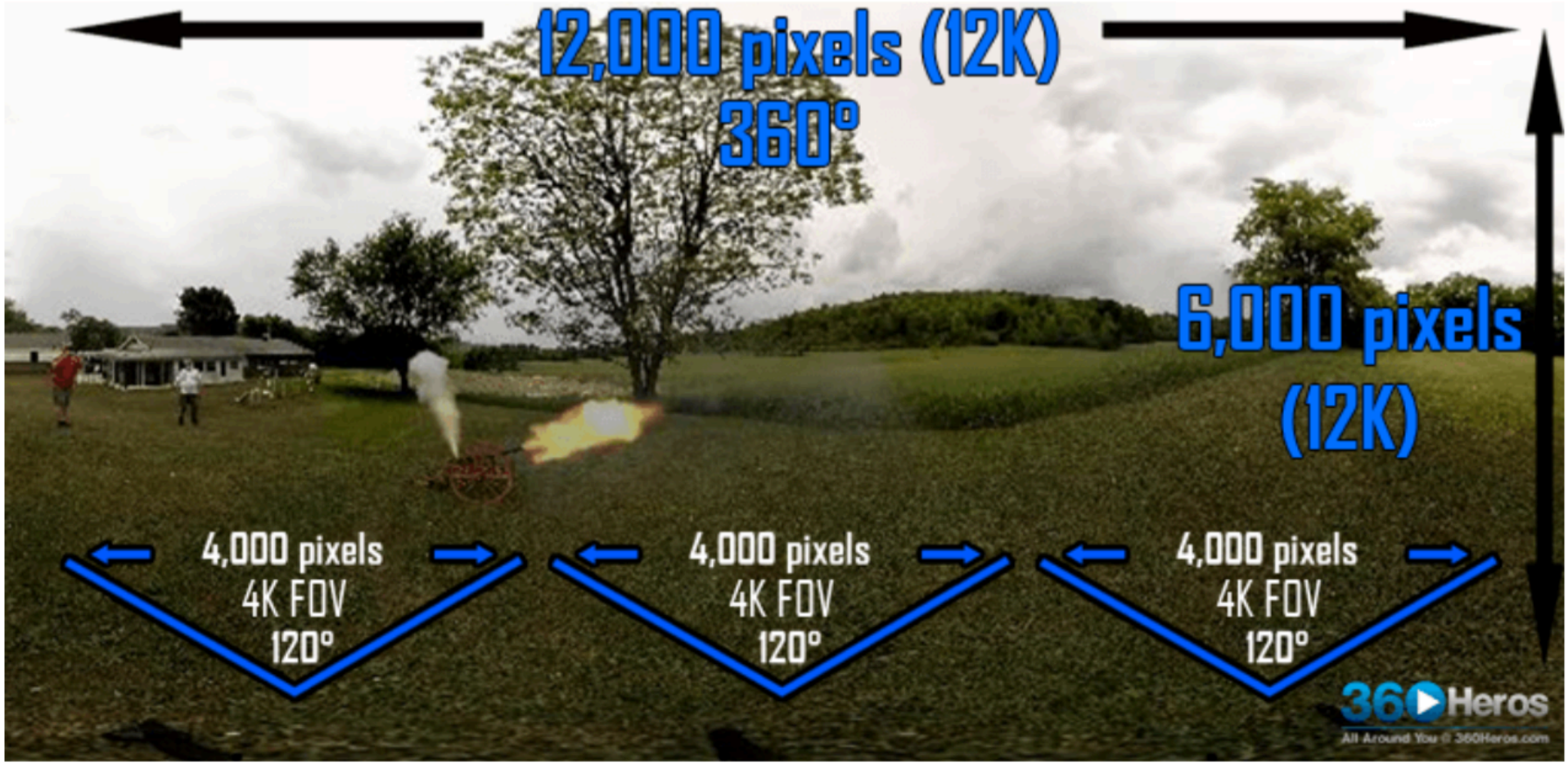
Needed resolution of panoramic video for achieving 4k field of view resolution:



MOTIVATION

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- Field of view << full panorama
  - E.g., 90° → only a fourth of the full panorama displayed
- Render FoV in 2K → full panorama should be 8K
  - Won't work well with traditional streaming approaches
- Traditional codecs (AVC/HEVC) need a rectangular two-dimensional video representation to work well
  - Equirectangular, cubic, pyramid, etc. projections
  - Traditional packaging and storing technologies can be used
  - Streaming technologies like DASH and HLS can be used
- Special video player is needed
  - Must know which projection is used
  - Must provide interaction possibilities

NEW APPROACHES: TILED BASED STREAMING

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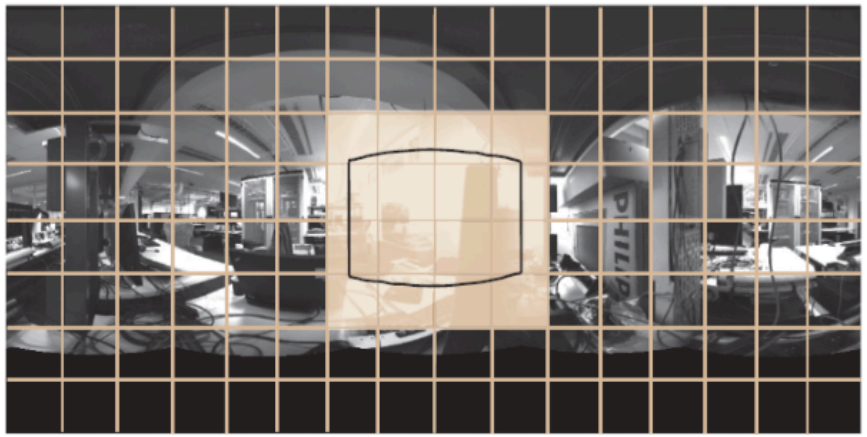
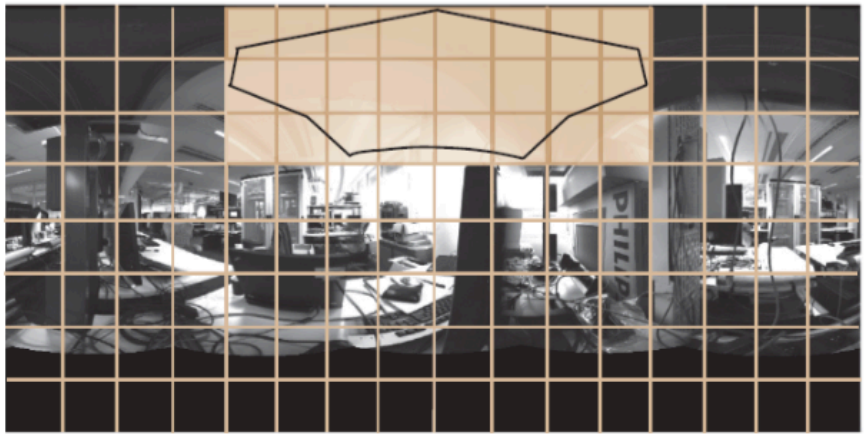
- Video is sliced into tiles
- Tiles are encoded in several qualities
- Only needed tiles are streamed in high quality
- Tiles outside FoV are streamed in descending quality, lower quality or not at all





TILED STREAMING

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- Each tile can be encoded separately and independently streamed, decoded, and rendered
  - Each tile can have different bitrates and resolutions
  - Adapt quality of each tile independently
- H.265/HEVC provides tile support
  - Unfortunately not H.264
  - Need for a single decoder (enabled by HEVC), as usage of multiple decoders is not (yet) possible on consumer devices
- Can be used to realize a compressed domain mixing of tiles
  - Implementation as network services
  - Client side implementation

NEW APPROACHES: TILED BASED STREAMING

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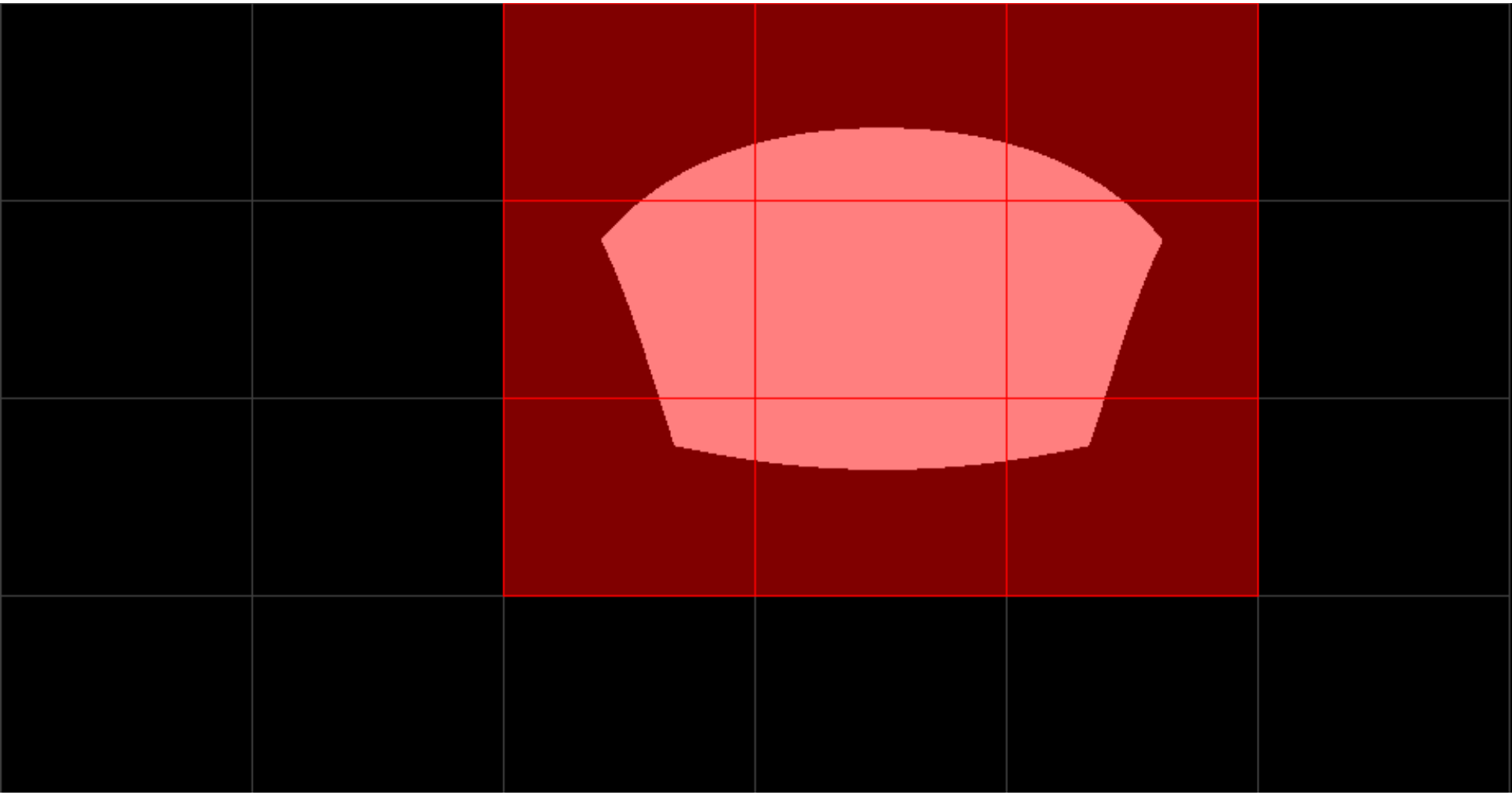
Front view, 6x4 tiles:



NEW APPROACHES: TILED BASED STREAMING

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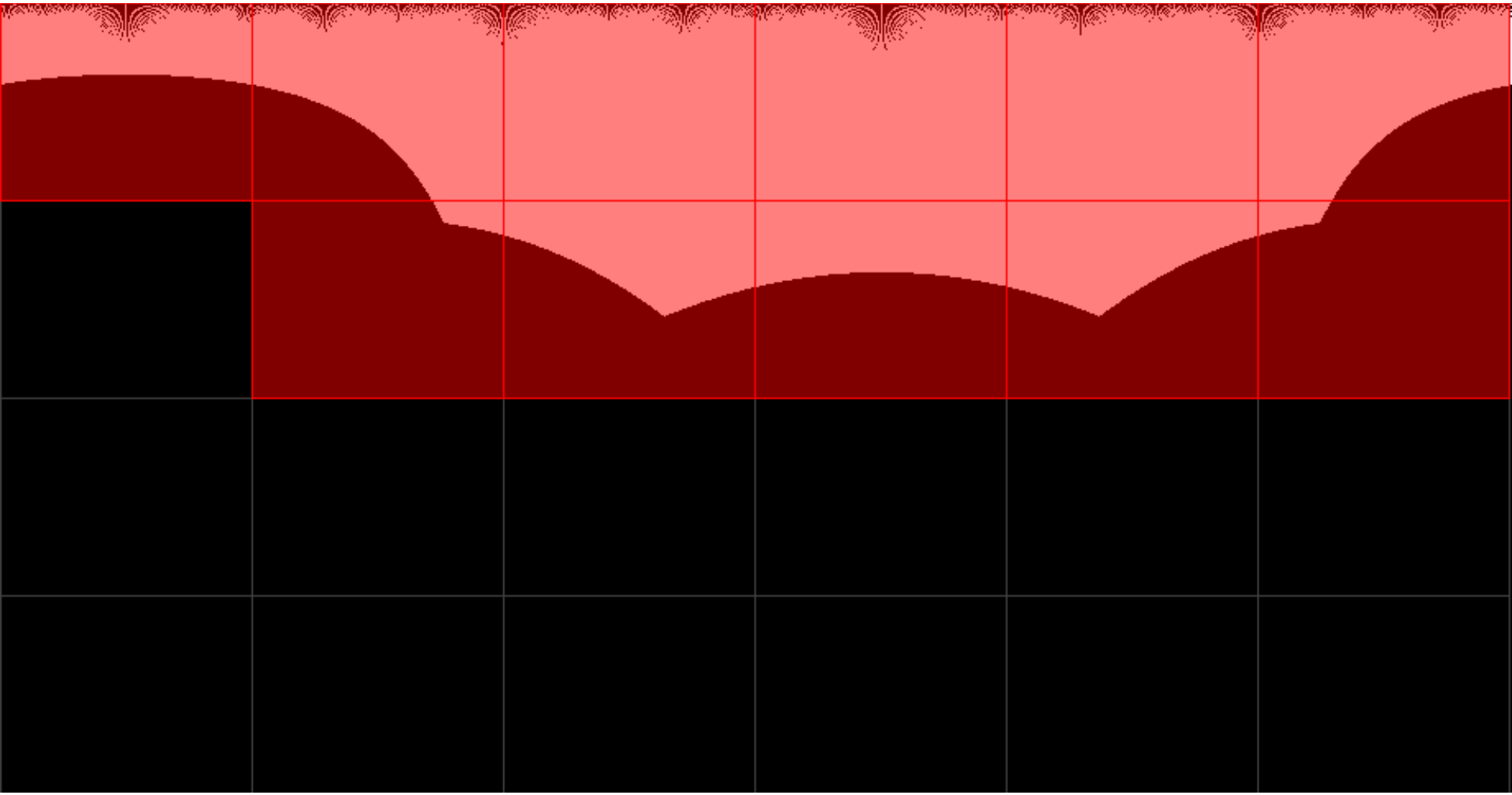
Top view, 6x4 tiles:



NEW APPROACHES: TILED BASED STREAMING

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Front view, 3x2 tiles:

COMBINING STANDARDS: DASH + HTML5

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- Client-based approach, using a single decoder
  - Written in JavaScript
  - Using Media Source Extensions (MSE)
- Different need to be mixed into a single video stream
  - Only one decoder is required
  - No need for synchronization
- Three different quality levels for each tile
- 6 x 4 tiling scheme[1]

1- Where a higher number of tiles in general might lead to an increased user experience, but decreases the efficiency of the codec

DASH + HTML5 EXAMPLE

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play pause

Tiling scheme selector

0	0	0	0	0	0
0	1	2	2	1	0
0	1	2	2	1	0
0	0	0	0	0	0

DASH + HTML5 EXAMPLE

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OVERHEAD USING TILES IN HEVC

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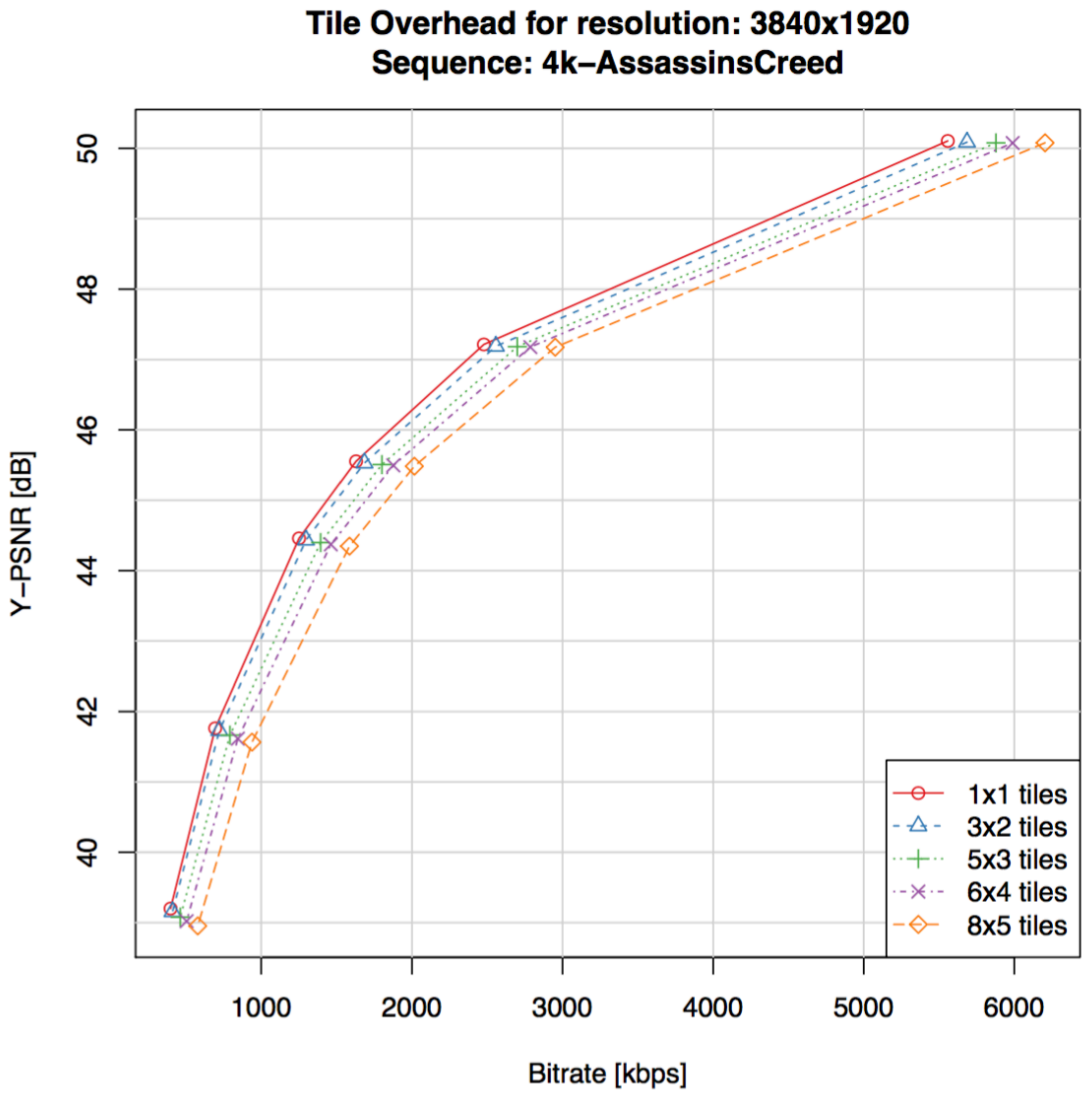

60%+ BANDWIDTH REDUCTION

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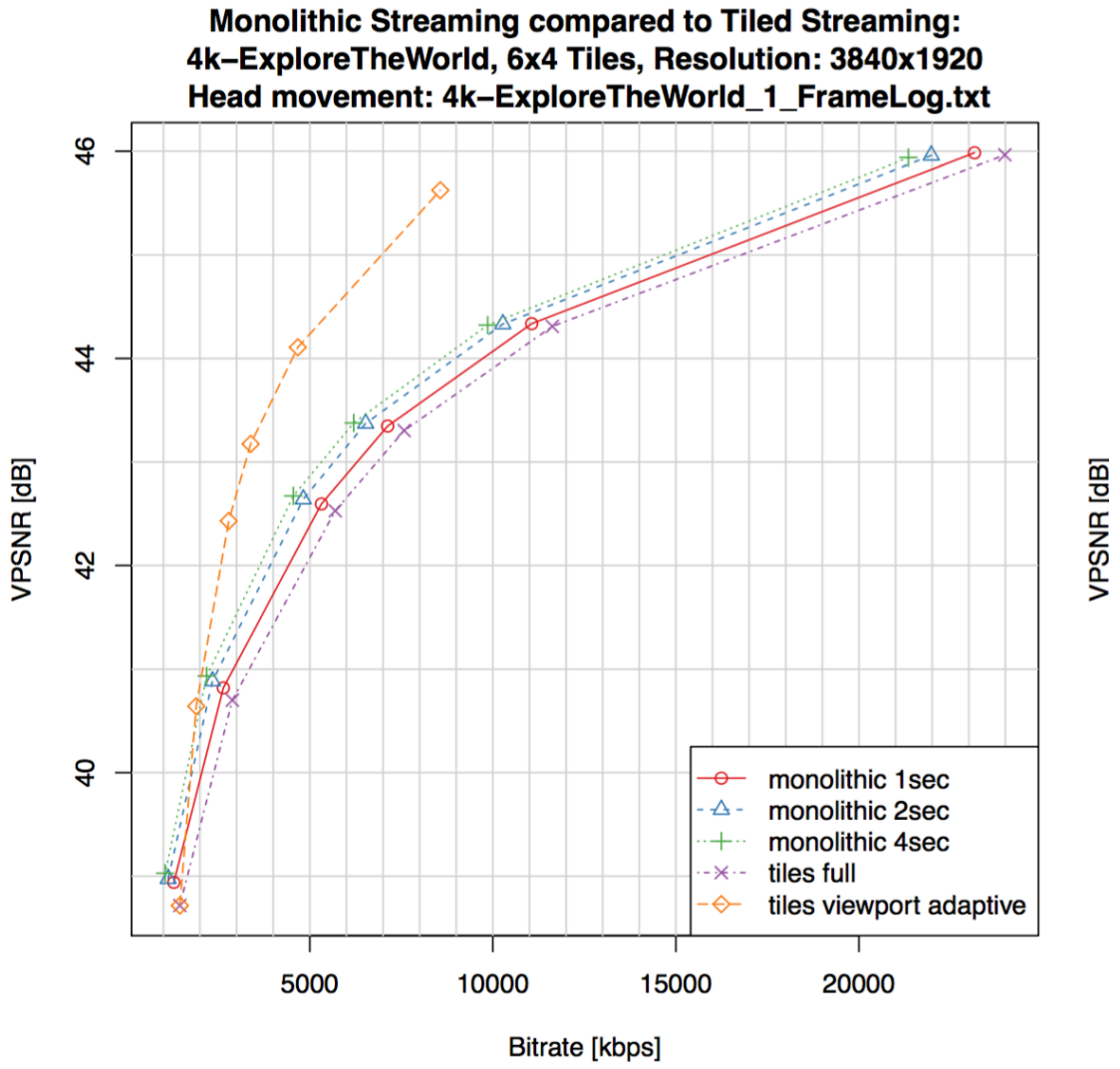

WHAT WE NEED IN THE FUTURE?

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- 6 degrees of freedom
  - Light field, point cloud, multi-view, etc. approaches
  - Codecs, streaming standards, platform support, tools, etc.

- Good demos so far:

http://8i.com/experience

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