GPAC: delivery of VR/360 videos using Tiles

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What is GPAC?

- **Multimedia Packagers, Streamers and Player**
  - Multi-platform: all desktops, mobile (iOS, Android), embedded linux
  - Features
    - Any codec, any protocol
    - Graphics & Interactivity

- **Advocating Multimedia Standards**
  - MPEG, W3C, IETF
  - Reference and Utility Software for various MPEG Standards

- **Open Source Software**
  - Dual LGPL v2.1 / Commercial Licensing
  - 600000+ lines of C code
  - Hosted on GitHub
  - Per month: 17000+ visits, 4000+ dl
  - gpac.io
  - gpac-licensing.com

- **Academic Dissemination**
  - 100+ academic references
  - 300+ publications using GPAC

- **Collaborations**
  - 8 EU funded projects
  - 18 French funded projects
  - Several industrial-funded projects

- **Teaching**
  - Labs session
  - Students projects
  - Corporate Training
Key GPAC Tools

**Multimedia Packagers (MP4Box)**
- MPEG-2 TS (Live Multicast, or DASH/HLS)
- ISOBMF Packager & Analyzer
- DASH Segmenter/Live simulator/Encoder
- Support HEVC (+layered HEVC), AVC, HE-AAC…

**Multimedia Player (MP4Client)**
- MPEG-2 TS, RTP, ISOBMF, DASH, HLS
- Multi-path delivery of layered coded data
- SVG/BIFS/VRML + JavaScript
- VR / 3D / Auto-stereoscopic output
• New public test infrastructure.
• Range extension support for AVC and HEVC.
• Improved TTML support.
• Support of VR/360 videos, including using Tiles => This Talk.
• Hardware decoding
  • for OSX and iOS (VideoToolBox).
  • for Android (MediaCodec).
• Coming soon:
  • Support for more PIFF and Smooth Streaming file format (branch).
  • Hardware accelerated encryption (branch).
• Other projects: check [https://github.com/gpac](https://github.com/gpac)
Streaming of VR/360 content

- **Bandwidth is expensive**
  - 360 videos require at least 4K x 2K.
  - Some claim: 12K x 6K for achieving 4k field of view resolution.

![360° panorama of a basketball game](image)
Streaming of VR/360 content

- Necessity to reduce bandwidth
  - Video Compression
    - of a 2D video after some projection
    - possibly after some shuffling & packing
  - Adaptive delivery
    - Deliver parts of the video based on viewpoint/viewport
    - Lower quality outside the viewpoint/viewport
    - Necessary to react quickly to motion (motion-to-photon latency)
360 Projection & Packing Examples

- Equirectangular Projection (ERP)
- ERP with specific packing
- Cube-map with packing

- Projected videos will probably be packed and compressed based on rectangular regions (Tiling)
  - MPEG Omnidirectional Media Application Format (OMAF)

Text of ISO/IEC CD 23000-20
Omnidirectional Media Application Format, MPEG N16636, Jan. 2017
Tiling and Adaptive Streaming Principles

- Stream tiles with different qualities

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</tbody>
</table>

*Technologies under Consideration for DASH*
MPEG N16659
Jan. 2017
Tiling and Adaptive Streaming Principles

- Or stream some tiles or even only one tile
Tiling and Adaptive Streaming
MPEG-DASH SRD

- **Description of 2D relationships between videos**
  - In the source content (not a composition description)
  - X,Y,W,H (possibly in arbitrary units)

- **Codec agnostic**
  - No assumption of tiling coding tools
  - Can be used with multiple independent videos

- **Can already be used for projected videos**
  - MPEG discussions about extending it to 3D relationships

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MPEG-DASH SRD and HEVC tiling for VR/360 videos

Tile-based adaptation using independent videos
MPEG-DASH SRD and HEVC tiling for VR/360 videos

- HEVC Motion-constrained Tile-based adaptation
Tiling and Adaptive Streaming Using HEVC

- **HEVC Tiles**
  - Motion-Constrained
  - Single Decoder

- **Extensions to ISOBMFF**
  - Independent access to tile data
    - HEVC tile tracks “hvt1”
  - Reconstruction of the entire video
    - Track references “sabt”/”tbas”
    - Reconstruction Rules

- **MPEG-DASH**
  - SRD
  - Use of @dependencyId

[Diagram of HEVC tile-based adaptation process]

https://gpac.wp.imt.fr/2017/02/01/hevc-tile-based-adaptation-guide/
Tiling and Adaptive Streaming Streaming Strategies

- Which tiles to favor (region of interest)?
- What is the acceptable quality degradation btw. tiles?

J. Le Feuvre and C. Concolato,
*Tiled-based Adaptive Streaming using MPEG-DASH*,
ACM MMSys, Klagenfurt, Austria, May 2016
Tiling and Adaptive Streaming
360° video

Demo using GPAC

https://gpac.io/2016/05/25/srd/
MediaCodec statistics

Demo using GPAC

Audio (44100 Hz 2 channels)

Video (3840x2160)

Statistics (4 cores - 4 GB RAM)

Video 2 statistics:
Size: 3840x2160
Status: Playing - clock time: 21.16 (drift 211)
Composition Memory: 3/4
Buffer: -1 ms (min -1 - max 0) 0 AUs in DB
529 frames (0 dropped) - 19.87 ms/frame (max 113.64)
Average GOP size: 31 - 21.06 ms/irap (max 113.64)
Average bitrate: 32 Mbps - Maximum 37 Mbps
Download bandwidth: 0 Kbps
Codec: MediaCodec hardware AVCH264
Service: NBA_score_table_2_uhd.mp4

Audio (44100 Hz 2 channels)

Video (3840x2160)

Statistics (4 cores - 4 GB RAM)

Video 2 statistics:
Size: 3840x2160
Status: Playing - clock time: 11.84 (drift 84)
Composition Memory: 1/4
Buffer: -1 ms (min -1 - max 0) 0 AUs in DB
164 frames (145 dropped) - 106.49 ms/frame (max 441.95)
Average GOP size: 33 - 311.24 ms/irap (max 441.95)
Average bitrate: 24 Mbps - Maximum 37 Mbps
Download bandwidth: 0 Kbps
Codec: FFmpeg h264 - version Lavc56.1.100
Service: NBA_score_table_2_uhd.mp4
Questions ?