# Tile Extractor Optimization for Low-latency Viewport-dependent 360 Video Tiled Streaming

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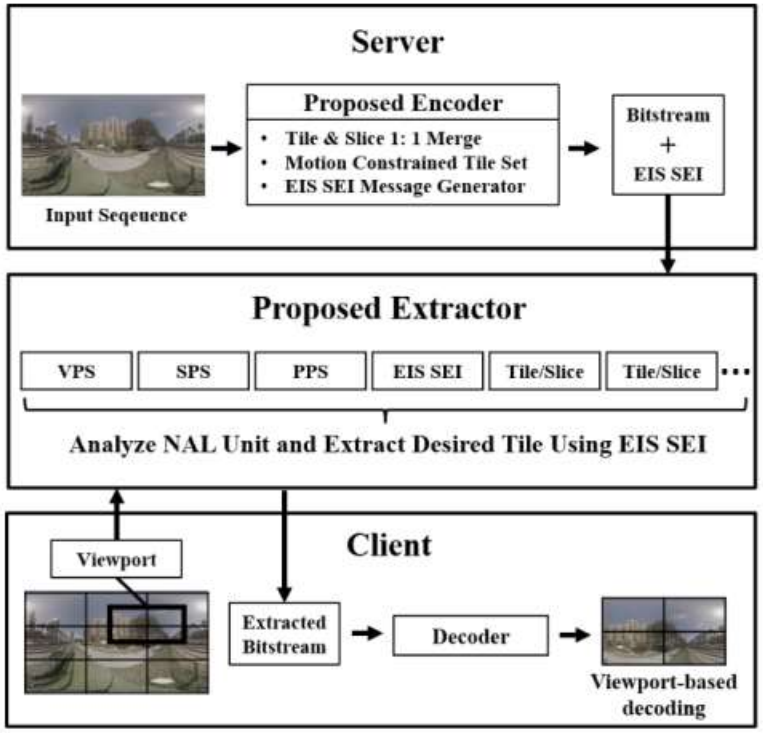
# 360-degree Video Tiled Streaming

- High resolution and framerate for high-quality 360-degree video streaming
  - high bandwidth
- Tiled streaming based on MCTS for viewport-dependent streaming
  - well-known selective streaming method




360-degree video tiled streaming system

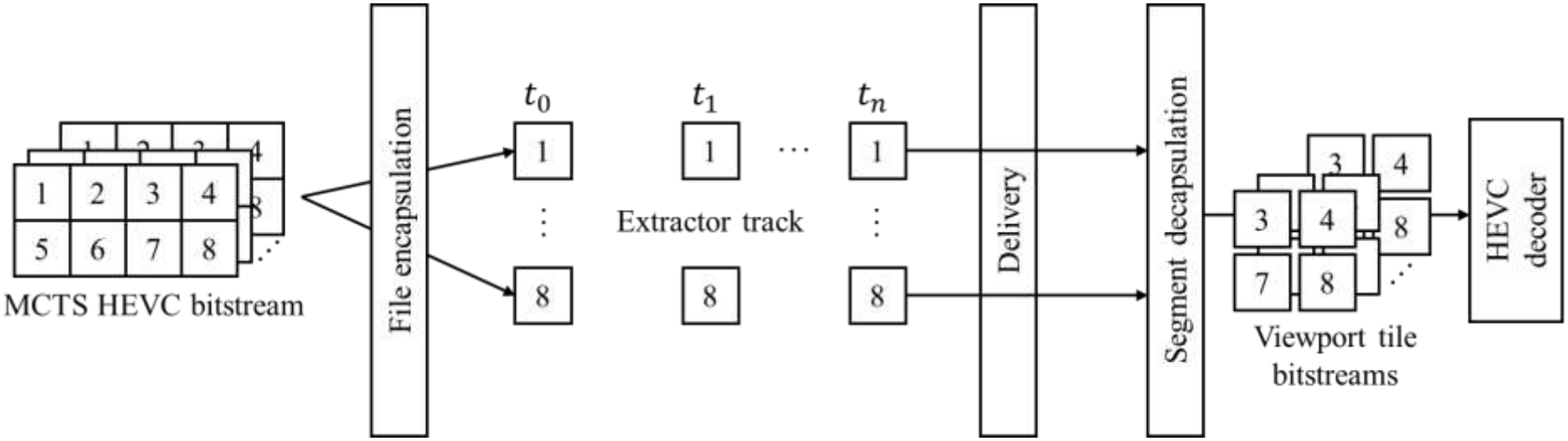
| Requirement | details |
|---|---|
| **pixels/degree** | 40 pix/deg |
| **video resolution** | 11520x6480 |
| **framerate** | 90 fps |

Requirements for high quality VR
Source:Technicolor, Oct. 2016 (m39532, MPEG 116th Meeting)

Source: Jangwoo Son, Dongmin Jang, and Eun-Seok Ryu. 2018. Implementing 360 video tiled streaming system. In Proceedings of the 9th ACM Multimedia Systems Conference. ACM, 521–524.

# 360-degree Video Tiled Streaming: Challenges

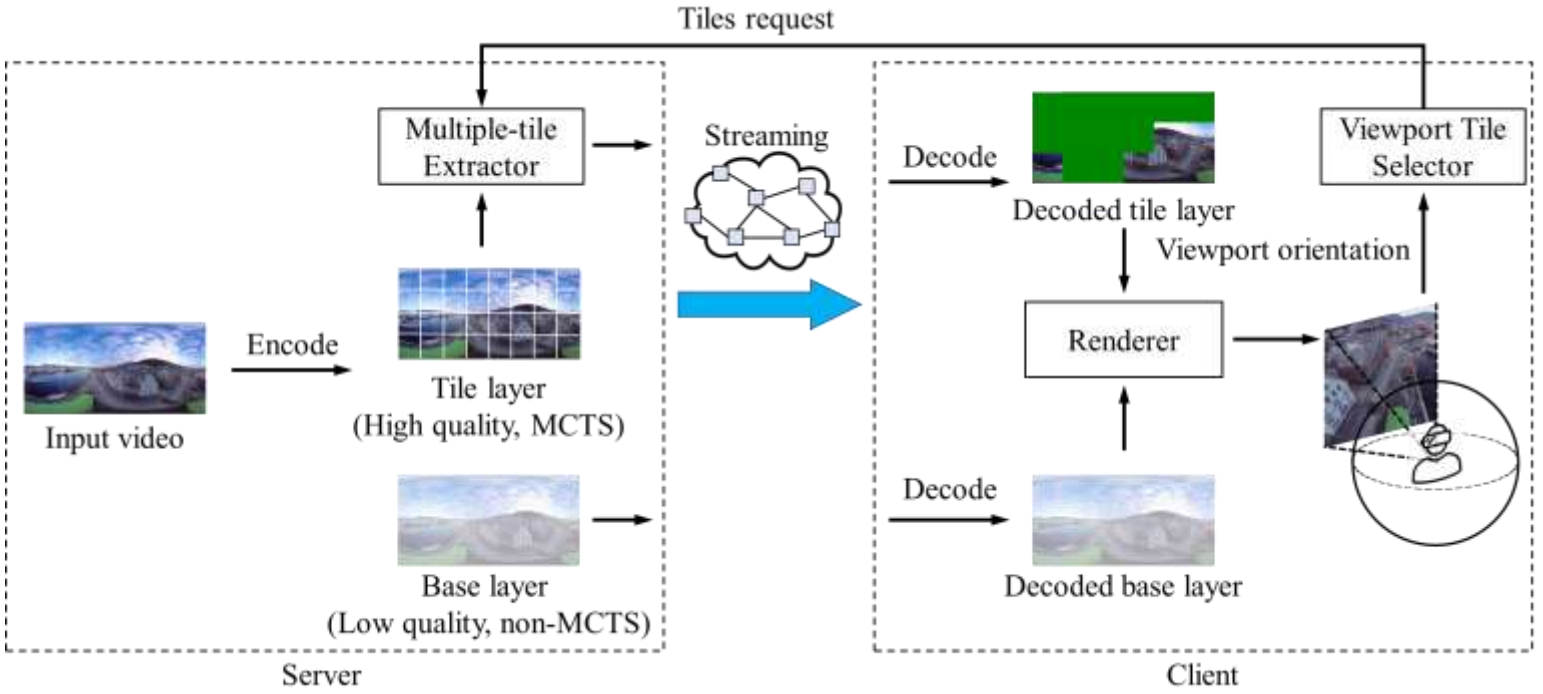
- In HEVC test model (HM) 16.20, a tile extraction SW is included
  - single tile extraction is available
- Based on HM 16.20, number of tile bitstreams are generated
- Generally, a VR player has one or few number of decoders
  - single tile extraction causes decoding resource issues




Example of viewport-dependent 360-degree video streaming

# Multiple-tile Extraction for Low-latency Streaming

- Server-driven approach to reduce the latency:
  multiple-tile extraction, base layer simulcasting
- Extracts multiple tiles and generates single bitstream
  - ➢ two decoders for high-quality low-latency tiled streaming



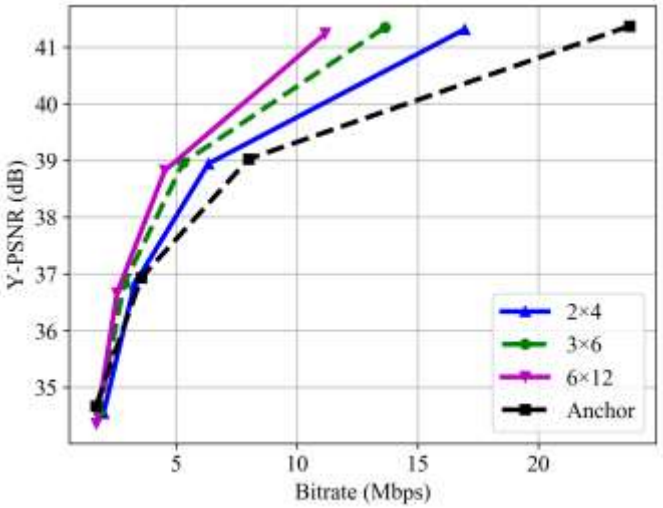

Low-latency 360-degree video streaming using multiple-tile extraction

# Experimental Results: BD-rate Saving

- Used four 4K 360-degree test sequences
- Three tiling scenarios (2 × 4, 3 × 6, 6 × 12) were used
- In tiled streaming, low-quality base layer (e.g. QP=42) was transmitted
- 16.98% of BD-rate saving for Y-PSNR was shown
- 6 × 12 tiling showed the best BD-rate
  - in traditional tiled streaming, generates many bitstreams

| Tiling | Y-PSNR | VMAF | MS-SSIM | IV-PSNR |
|---|---|---|---|---|
| 2 × 4 | -6.05% | 2.95% | -1.73% | -5.14% |
| 3 × 6 | -19.93% | -8.36% | -12.90% | -17.86% |
| 6 × 12 | -24.97% | -13.96% | 18.77% | 24.32% |
| **Average** | **-16.98%** | **-6.45%** | **-11.13%** | **-15.77%** |

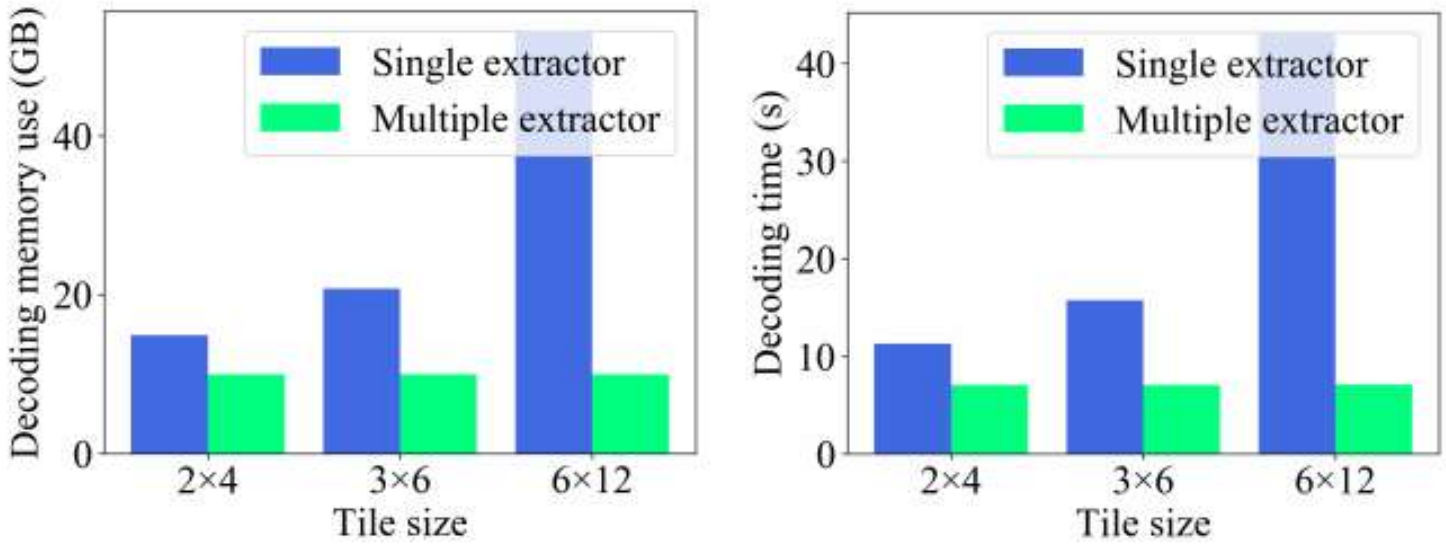
BD-rate savings of the tiled streaming compared to non-tiled streaming




RD-curve of the tiled streaming, non-tiled streaming

# Experimental Results: Decoding Resource Saving

- Compared single-tile extractor (STE) and multiple-tile extractor (MTE) in terms of: decoding memory use and delay
- The client has a Intel i7-7700k CPU (4 cores, 8 threads), 16 GB memory, GTX 1080 Ti
- 6 × 12 tiling consumed 52.99 GB of memory and 43.04 seconds using STE
  - MTE required 10.00 GB and 7.08 seconds




(a) (b)

Performance comparison between a single tile extractor and multiple tile extractor in terms of (a) decoding memory use, (b) decoding delay

# Conclusion

- Motivation
  - 360-degree video streaming requires high bandwidth: tiled streaming can be used
  - Single tile extraction requires number of decoders
    - ➢ increases latency which influences quality of experience (QoE)
- Proposed Methods and Insights
  - Multiple-tile extraction for generating single bitstream
  - Showed decoding resource savings compared to the single tile extraction
    - ➢ 66.16%, 69.79% decoding memory and decoding delay savings
- Future Work
  - Experiments on high-resolution video (e.g. 8K / 16K) will be conducted