



JCTVC-Z0034:

# Spherical viewport SEI for HEVC and AVC 360 video

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# Overview

- SEI message is proposed for HEVC and AVC to indicate two different but related spherical viewport modes for 360 degree video
  - “ROI mode”: Allows the encoder to indicate a “director’s view,” which is a recommended rectangular viewport in a rectilinear projection from the coded spherical video
  - “Viewport mode”: Indicates that the bitstream contains a rectangular region in a rectilinear projection format that has already been extracted from a spherical video and (re-)encoded.
- Two modes have similar syntax
- MPEG OMAF AHG on ROI is studying defining systems signaling for a similar functionality as the “ROI mode”

# Modes

SEI mode	Coded video contents (yaw x pitch angles)	Projection format	Metadata indicates
ROI mode	360° x 180°	Many options – ERP, CMP, ISP, OSP, SSP, etc.	Content creator's recommended viewing region ("Director's view")
Viewport	FOV, i.e. 75° x 75° or 90° x 90°, which was previously extracted from a sphere	Rectilinear	Region that was extracted from a sphere, based on communicated client HMD position

# ROI Mode

- When viewing omnidirectional video, the viewer typically views only a small portion of the full  $360^\circ \times 180^\circ$  video at a given time.
  - A viewer may miss the “most interesting” area of the video
  - Content creator can recommend a region to view
  - Viewer can follow the recommendation or override it
- Syntax needed to indicate position and size of recommended region
  - To indicate rectangular rectilinear region:
    - Spherical center position (yaw, pitch, roll)
    - Range of yaw and pitch angles of a rectangular region in a rectilinear projection of a sphere

# Related OMAF AHG on ROI activity

- Was suggested for “director’s view” type of ROI indication, most appropriate shaped region to indicate is a rectangular region on a rectilinear viewport, as that is what will ultimately be displayed for viewing
- Other uses cases considered rectangular region in ERP format
- The region is bounded by two horizontal “great circles” and two vertical “great circles,” where a great circle is a diameter of the sphere.

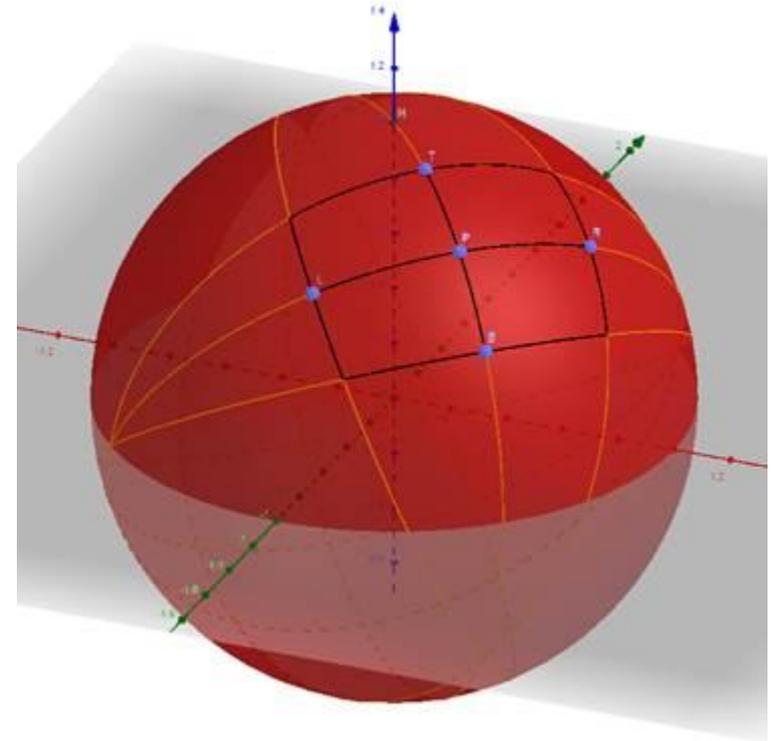
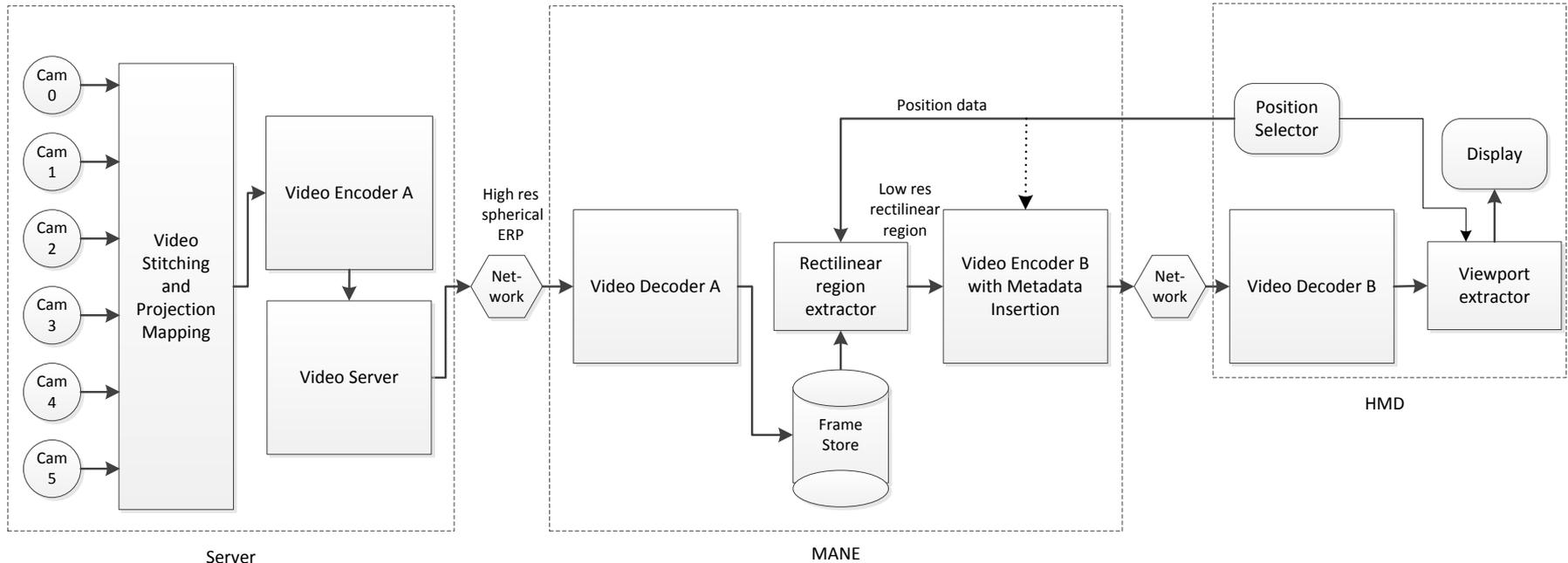


Figure from Emmanuel Thomas on OMAF ROI AHG reflector

# Viewport Mode

- MANE-assisted distribution system can offload decoding compute resources from client and reduce network bandwidth by extracting a viewport based on the Head Mounted Display (HMD) position



# Viewport mode

- Useful to indicate that the coded video represents a rectilinear region extracted from spherical video
  - Extracted region contains an expected viewport, possibly with buffer
- At the HMD, it is necessary to have information about the position and size of the extracted region in order to properly display the appropriate viewport, because the HMD position may change continuously
- Same metadata is needed for this mode as for the ROI mode
  - Spherical center position (yaw, pitch, roll)
  - Range of yaw and pitch angles of a rectangular region in a rectilinear projection of a sphere

# Proposed SEI message syntax

	<b>Descriptor</b>
spherical_viewport( payloadSize ) {	
<b>spherical_viewport_cancel_flag</b>	u(1)
if( !spherical_viewport_cancel_flag ) {	
<b>spherical_viewport_mode</b>	u(1)
<b>spherical_viewport_precision</b>	ue(v)
<b>spherical_viewport_yaw</b>	se(v)
<b>spherical_viewport_pitch</b>	se(v)
<b>spherical_viewport_roll</b>	se(v)
<b>spherical_viewport_range_yaw</b>	se(v)
<b>spherical_viewport_range_pitch</b>	se(v)
<b>spherical_viewport_persistence_flag</b>	u(1)
}	
}	

# Proposed semantics

When the associated picture has PicOutputFlag equal to 1, the spherical viewport SEI message informs the decoder of a mode which indicates either that a region of interest of a spherical projection is recommended to be displayed, or that the decoded picture corresponds to a region previously extracted from a spherical projection, bounded by two great circles and two small circles on the sphere.

**spherical\_viewport\_cancel\_flag** equal to 1 indicates that the SEI message cancels the persistence of any previous spherical viewport SEI message in output order.

**spherical\_viewport\_cancel\_flag** equal to 0 indicates that spherical viewport information follows.

**spherical\_viewport\_mode** equal to 0 indicates that a region of interest is recommended for display. **spherical\_viewport\_mode** equal to 1 indicates that the decoded picture represents a specific region that had been extracted from a spherical projection, bounded by two horizontal great circles and two vertical great circles.

**spherical\_viewport\_precision** specifies the precision of **spherical\_viewport\_yaw**, **spherical\_viewport\_pitch**, **spherical\_viewport\_roll**, **spherical\_viewport\_range\_yaw**, and **spherical\_viewport\_range\_pitch**. **spherical\_viewport\_precision** shall be in the range of 0 to 15 inclusive.

**spherical\_viewport\_yaw**, when **spherical\_viewport\_mode** equal to 0, specifies the center of a recommended viewing region of the projection mapped decoded picture in  $180 * \text{spherical\_orientation\_yaw} \div 2^{\text{spherical\_viewport\_precision}}$  degrees along the Z-axis. **spherical\_viewport\_yaw**, when **spherical\_viewport\_mode** equal to 1, specifies the Z-axis position of the center of a region on a sphere from which the current picture was extracted.

**spherical\_viewport\_pitch**, when **spherical\_viewport\_mode** equal to 0, specifies the center of a recommended viewing region of the projection mapped decoded picture in  $180 * \text{spherical\_orientation\_pitch} \div 2^{\text{spherical\_viewport\_precision}}$  degrees along the Y-axis. **spherical\_viewport\_pitch**, when **spherical\_viewport\_mode** equal to 1, specifies the Y-axis position of the center of a region on a sphere from which the current picture was extracted.

**spherical\_viewport\_roll**, when `spherical_viewport_mode` equal to 0, specifies the center of a recommended viewing region of the projection mapped decoded picture in  $180 * \text{spherical\_orientation\_roll} \div 2^{\text{spherical\_viewport\_precision}}$  degrees along the X-axis. `spherical_viewport_roll`, when `spherical_viewport_mode` equal to 1, specifies the X-axis position of the center of a region on a sphere from which the current picture was extracted.

**spherical\_viewport\_range\_yaw**, when `spherical_viewport_mode` equal to 0, specifies the size of a recommended viewing region of the projection mapped decoded picture in  $180 * \text{spherical\_orientation\_range\_yaw} \div 2^{\text{spherical\_viewport\_precision}}$  degrees along the Z-axis. `spherical_viewport_range_yaw`, when `spherical_viewport_mode` equal to 1, specifies the Z-axis size of the region on a sphere from which the current picture was extracted.

**spherical\_viewport\_range\_pitch**, when `spherical_viewport_mode` equal to 0, specifies the size of a recommended viewing region of the projection mapped decoded picture in  $180 * \text{spherical\_orientation\_range\_pitch} \div 2^{\text{spherical\_viewport\_precision}}$  degrees along the Y-axis. `spherical_viewport_range_pitch`, when `spherical_viewport_mode` equal to 1, specifies the Y-axis size of the region on a sphere from which the current picture was extracted.

**spherical\_viewport\_persistence\_flag** specifies the persistence of the spherical viewport SEI message for the current layer.

`spherical_viewport_persistence_flag` equal to 0 specifies that the spherical viewport SEI message applies to the current decoded picture only.

Let `picA` be the current picture.

`spherical_viewport_persistence_flag` equal to 1 specifies that the spherical viewport SEI message persists for the current layer in output order until one or more of the following conditions are true:

- A new CLVS of the current layer begins.
- The bitstream ends.
- A picture `picB` in the current layer in an access unit containing a spherical viewport SEI message that is applicable to the current layer is output for which `PicOrderCnt( picB )` is greater than `PicOrderCnt( picA )`, where `PicOrderCnt( picB )` and `PicOrderCnt( picA )` are the `PicOrderCntVal` values of `picB` and `picA`, respectively, immediately after the invocation of the decoding process for picture order count for `picB`.

# Conclusion

- Recommend to add an SEI message to indicate two spherical viewport modes
  - “ROI mode” similar to OMAF systems layer study, but recommend SEI message regardless of OMAF decision, in order to have self-contained bitstream
  - “Viewport mode” provides information needed to enable system with MANE viewport extraction
- Two modes have similar syntax

