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Title: Bandwidth and Latency Requirements for Virtual Reality

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Abstract: Determining bandwidth and latency requirements for Virtual Reality using the LAB data.

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# Quality Requirements for VR

- **Announced by Technicolor, Oct. 2016 (m39532, MPEG 116<sup>th</sup> Meeting)**

Requirement	details
pixels/degree	<ul style="list-style-type: none"> <li>- 40 pix/deg</li> <li>- no HMD is capable of displaying 40pix/deg today</li> </ul>
video resolution	<ul style="list-style-type: none"> <li>- 3 times 4K(3840x1920) vertical resolution = 11520x6480</li> </ul>
framerate	<ul style="list-style-type: none"> <li>- 90 fps</li> <li>- a 90fps framerate offers a latency low enough to prevent nausea</li> </ul>
3D Audio	<ul style="list-style-type: none"> <li>- support of scene-based and/or environmental audio</li> <li>- 360 surround sound, object-based audio, Ambisonics</li> </ul>
motion-to-photon latency & motion-to-audio latency	<ul style="list-style-type: none"> <li>- how much time there is between the user interacts and an image / audio</li> <li>- maximum 20ms</li> </ul>
foreground & parallax	<ul style="list-style-type: none"> <li>- objects in the foreground shall be far enough to prevent nausea</li> <li>- if objects are too close it is likely they can become an important cause of nausea</li> <li>- interactive parallax with background shall be present for such objects</li> <li>- pic1 shows how it is possible to look behind the figure in the foreground</li> </ul>



Fig. 1. Importance of parallax.

# 12K(11520x6480) Bitrate

- Producing 12K video data by merging cropped 8K Test Sequence(5760x3240)
  - Gaslamp, Harbor, KiteFlite, Trolley (name of the sequence)
- Using the HM 16.6 Reference Software
- Encoded only 10 frames to measure the Bitrate at pilot
  - Under our test environment 3 hours of encoding time was required to encode 10 frames of 12K video data.
  - Due to this circumstance that 10 frames of bitrate was chosen arbitrarily.

Coding Structure	Quantization Parameter	12K Bitrate (@90fps)
RA	37	60 Mbps
	32	107 Mbps
	27	191 Mbps
	22	353 Mbps
LDB	37	58 Mbps
	32	106 Mbps
	27	192 Mbps
	22	357 Mbps

※ RA: Random Access

※ LDB: Low Delay Big-picture

※ HM: HEVC test Model (reference software of the H.265 Standard)

- Comparison of original and proposed method bitrate using 12K video
- Proposed Method : MVP(Merciless Video Processing) by MCSL

Coding Structure	Quantization Parameter	Original Bitrate (9 Tiles/@90fps)	Proposed Bitrate (4 Tiles/@90fps)	Proposed Bitrate (1 Tiles/@90fps)
RA	37	60 Mbps	28 Mbps(-53%)	7 Mbps(-88%)
	32	107 Mbps	50 Mbps(-53%)	12 Mbps(-88%)
	27	191 Mbps	88 Mbps(-53%)	22 Mbps(-88%)
	22	353 Mbps	162 Mbps(-54%)	40 Mbps(-88%)
LDB	37	58 Mbps	28 Mbps(-51%)	7 Mbps(-87%)
	32	106 Mbps	50 Mbps(-52%)	12 Mbps(-88%)
	27	192 Mbps	90 Mbps(-53%)	22 Mbps(-88%)
	22	357 Mbps	165 Mbps(-53%)	41 Mbps(-88%)

