SUBJECTIVE QUALITY EVALUATION OF TILE-BASED STREAMING FOR OMNIDIRECTIONAL VIDEOS

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Introduction: Tile based VR Streaming

Challenges

- Bandwidth
- Resolution of Video
- Latency

Solution

- User only sees a part of 360°video in HMD: Viewport
- Divide whole 360° video into tiles
  - Independent encoding and decoding of tiles possible
  - Stored on server/CDN
- Viewport ⟶ higher resolution / bitrate
- Background ⟶ lower resolution / bitrate

Brandenburg et al. CDN Optimization for VR Streaming, IBC 2017

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# Motivation and research goals

Overall goal

- Reproducible test set-up and method for subjective assessment of tile-based streaming

Dedicated tests as proof-of-concept

- Investigate under which test conditions results are more reliable?
  - Comparison of subjective quality of viewport-dependent streaming solution for different scenarios
    - Resolution- and Bandwidth-limited
    - Bandwidth limited
- Impact of network delay on quality ratings and simulator sickness
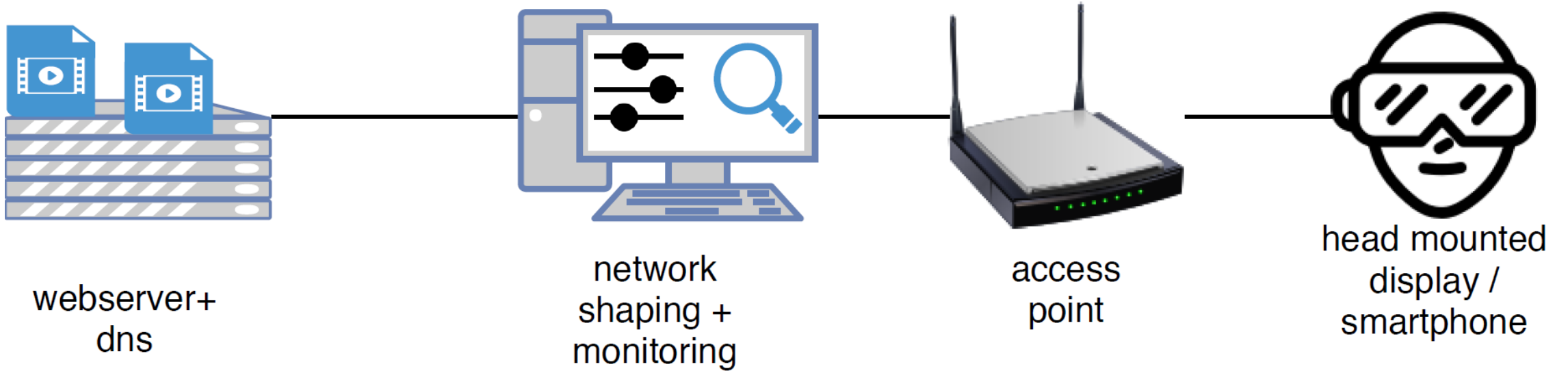- Effect of session duration and breaks on simulator sickness

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Tile-based adaptive streaming – behavior dependent

Tile-based encoding
(time and space)
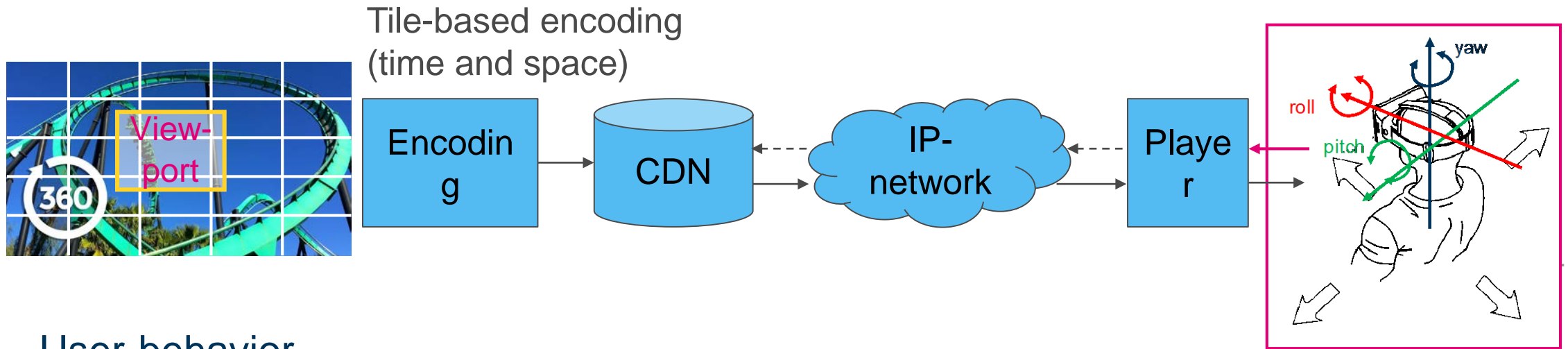
User-behavior

- 2D adaptive streaming
  - Play, start, stop, forward, rewind, ...
- Tile-based 360°adaptive streaming
  - ... Cf. 2D plus individual head rotations

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Technical Test Set-up

webserver+
dns

network
shaping +
monitoring

access
point

head mounted
display /
smartphone

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Contents (4K, 6K and 8K) – 30s videos

Content 1: CheerLeading

Content 2: Balboa

Content 3: F3

Pilot Tests
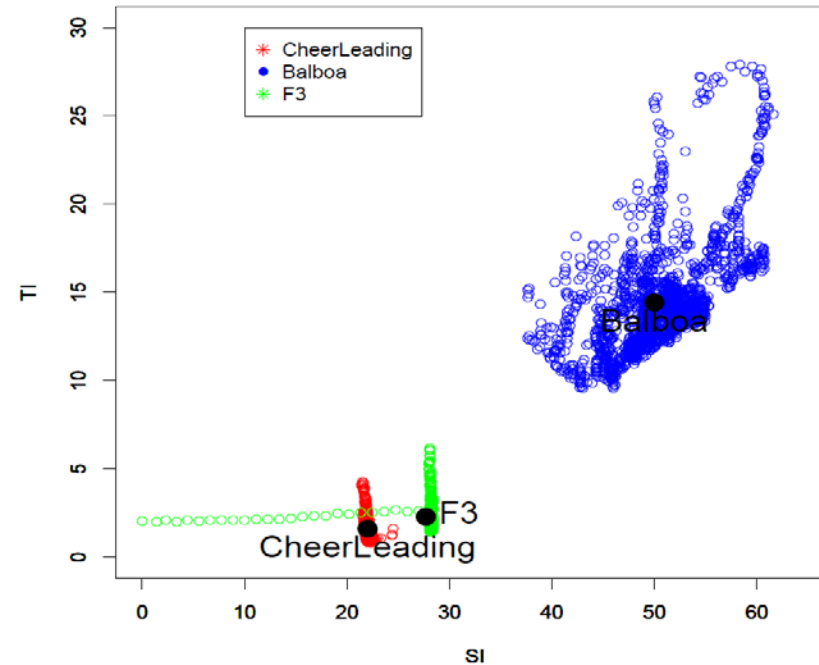
Samsung Gear VR
- 2960×1440
- 101° FOV
- ClearVR player
- Moon VR player (for anchors)

Test 1

Resolution and Bandwidth limited
- 2 Anchor conditions
- # of HRCs = 10 (per video)
- Duration: 10 mins (1 session)

28 Participants
- 14 Females
- 14 Males
- Avg. age = 25.07
- Median age = 25
- No Outliers
Absolute Category Rating

Test 2

Bandwidth limited
- 1 Anchor condition
- # of HRCs = 14 (per video)
- Duration: 14 mins (1 session)

25 Participants
- 12 Females
- 13 Males
- Avg. age = 25.36
- Median age = 25
- 1 Outlier
Absolute Category Rating

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HRCs (Hypothetical Reference Circuits) – Test 1

- 3 Test videos
  - Stored locally and on local server
  - 30 s
  - Tiledmedia

Total PVSs: 3*8 + 3*2 = 30

Resolution	Stored Where?? Phone / Server	Delay and Bandwidth settings				
		0 ms	12* ms	47* ms	112* ms	Maximum bit-rate
4K	Server		X	X	X	8 Mbps
6K	Server		X	X		20 Mbps
8K	Server		X	X	X	25 Mbps
4K (Anchor)	Phone	X				8 Mbps
6K (Anchor)	Phone	X				20 Mbps

*Additional delay could be because of Server, Monitoring System and Access Point ~ 12 ms

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HRCs (Hypothetical Reference Circuits) – Test 2

- 3 Test videos
  - Stored locally and on local server
  - 30 s
  - Tiledmedia

Total PVSs: 13*3+1*3=42

Resolution	Stored Where?? Phone / Server	Delay and Bandwidth settings				
		0 ms	12* ms	47* ms	112* ms	Maximum bit-rate
TBD** by TM	Server		X	X		10 Mbps
4K, 8K and TBD** by TM	Server		X	X	X	15 Mbps
TBD** by TM	Server		X	X		25 Mbps
6K (Anchor)	Phone	X				40Mbps

*Additional delay could be because of Server, Monitoring System and Access Point ~ 12 ms
**TBD = To be decided

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ACR Test Method

| Test Video (30 Seconds) | Voting Time (10 Seconds) | Setting up Next Condition (20 Seconds) |

Presentation of One Stimulus

10
9 Excellent
8
7 Good
6
5 Fair
4
3 Poor
2
1 Bad
0

ACR Scale

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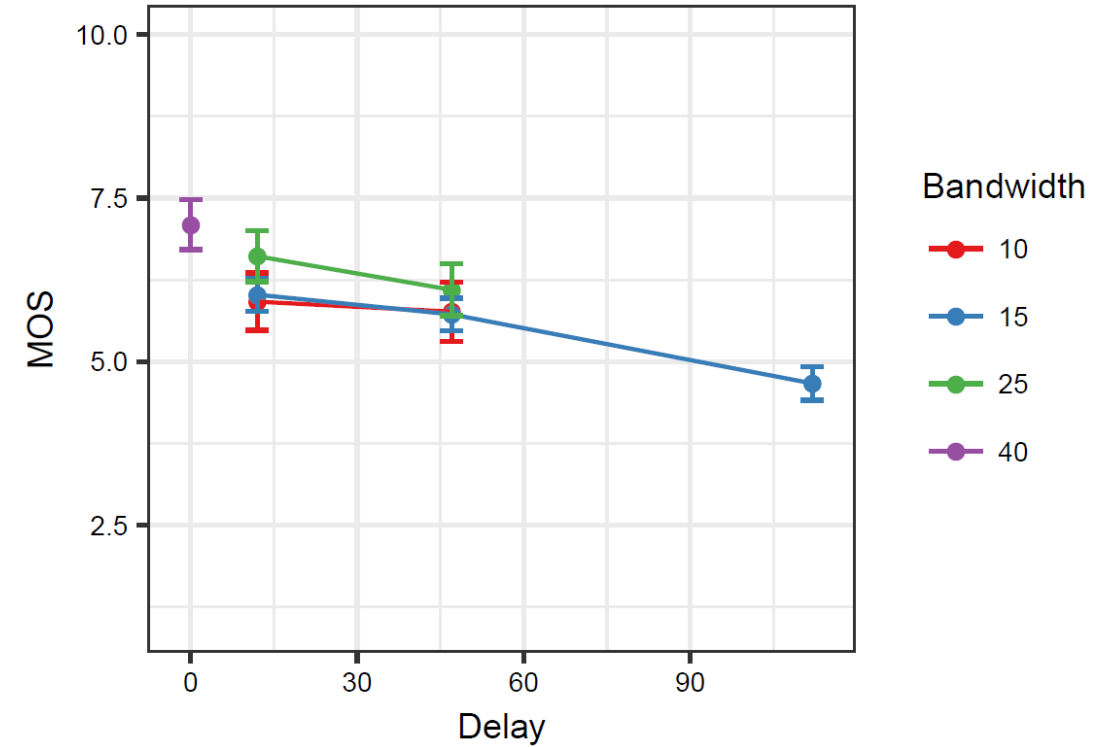
Results of Video Quality
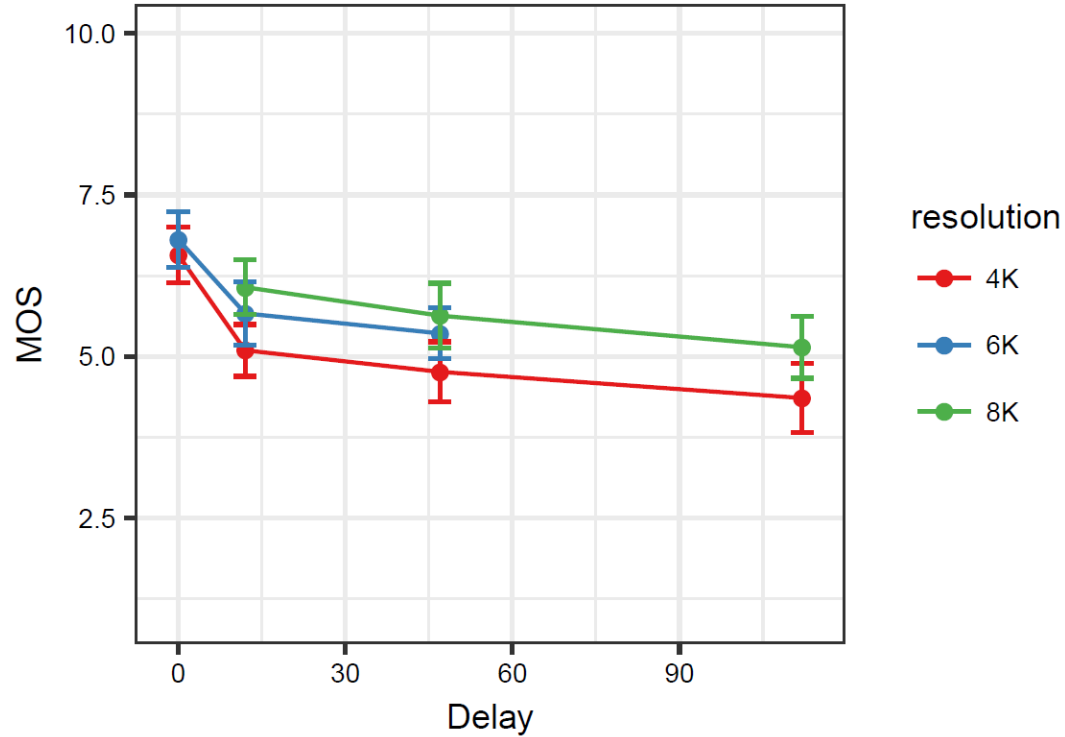
Experimental results: Statistical Realibility*

- MCI: Mean Confidence Interval
- MOS Range: Difference between highest and lowest MOS
- $MCI_{Norm} = \dfrac{MCI}{MOS\ Range}$

	Test 1	Test 2
MCI	0.7635	0.686
MOS Range	4.107	4.541
MCI_{norm}	0.1859	0.1510

- Test 2 → statistically more reliable

AVT

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Results of Short Simulator Sickness Questionnaire

- Short Simulator Sickness Scores have been computed for the different contents averaged over all the subjects, delay and resolution
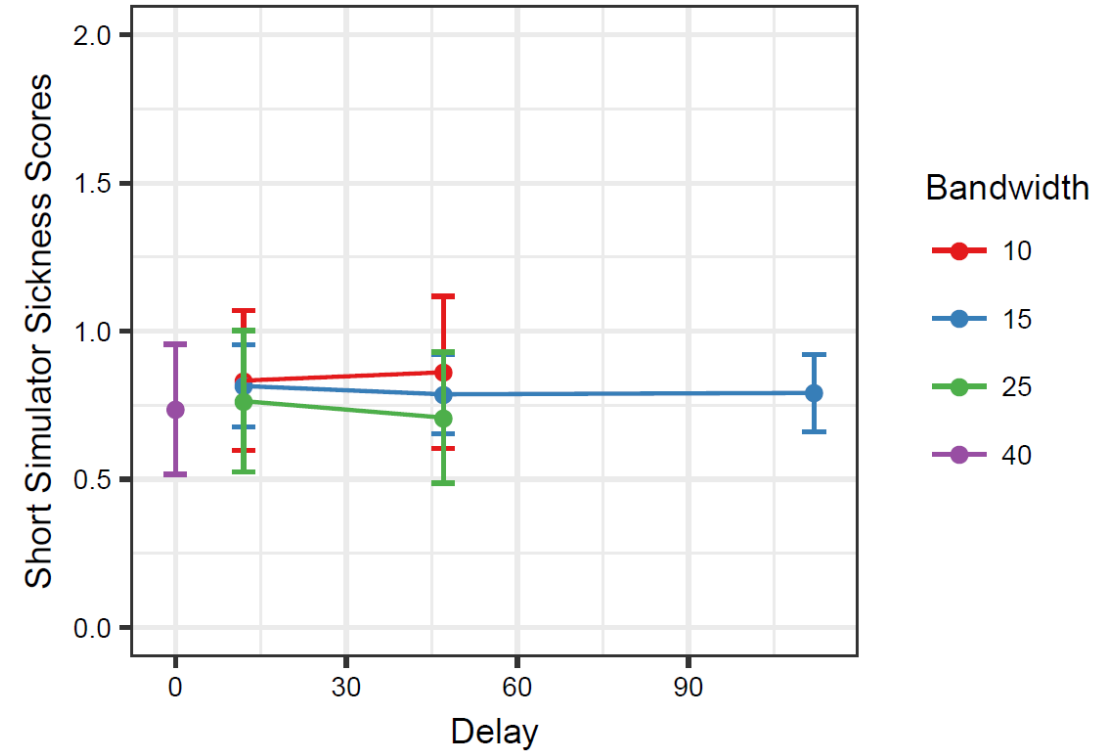
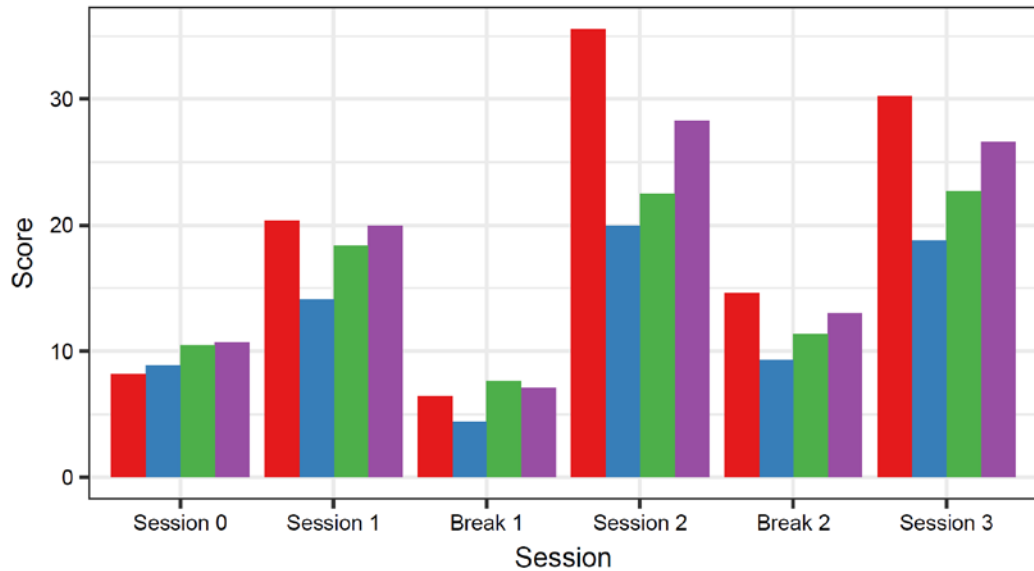TECHNISCHE UNIVERSITÄT ILMENAU
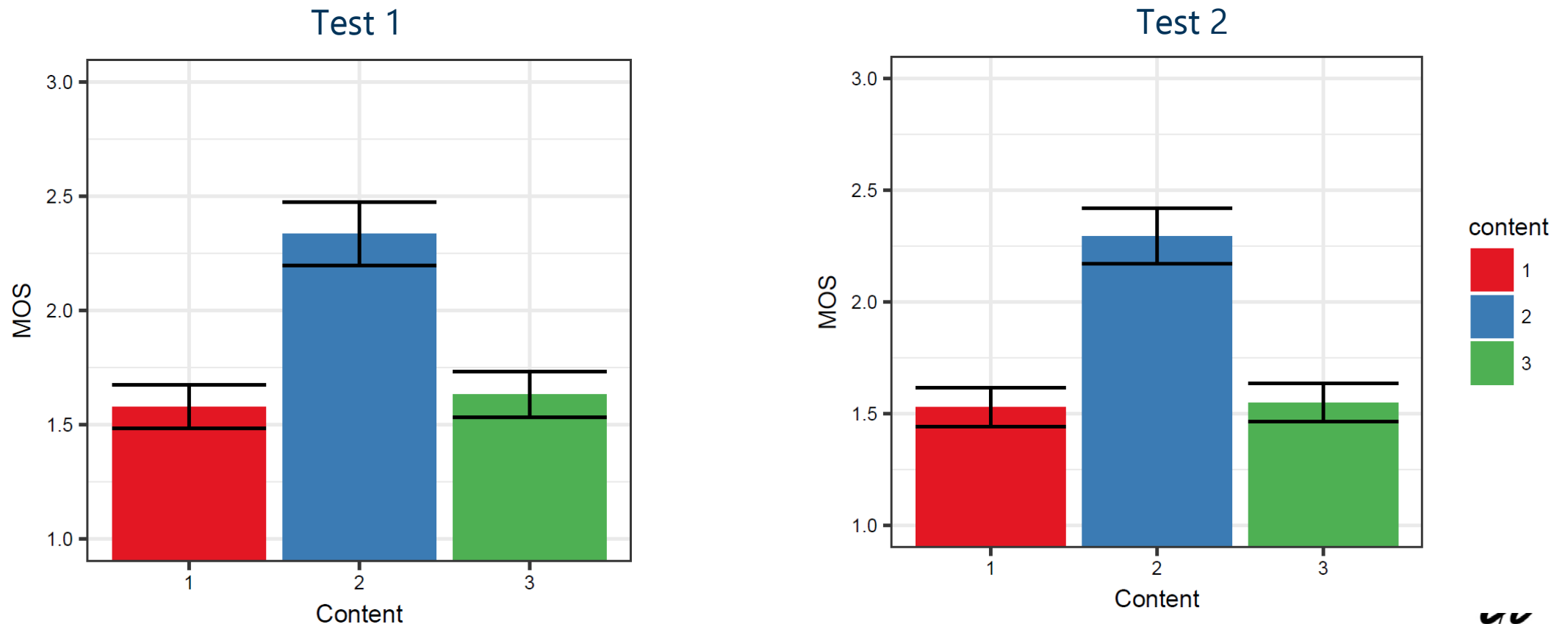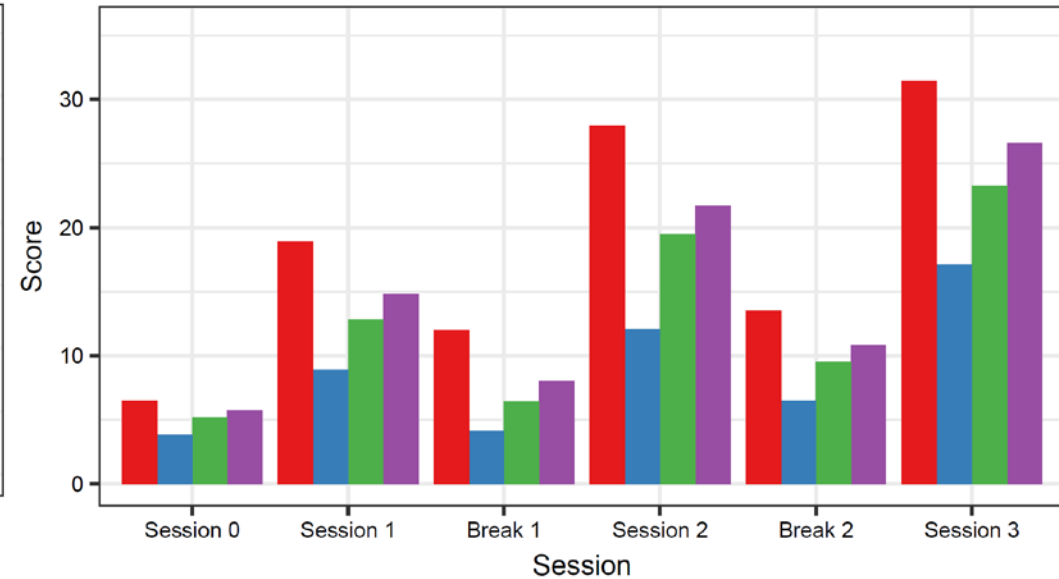
Results of Short Simulator Sickness Questionnaire
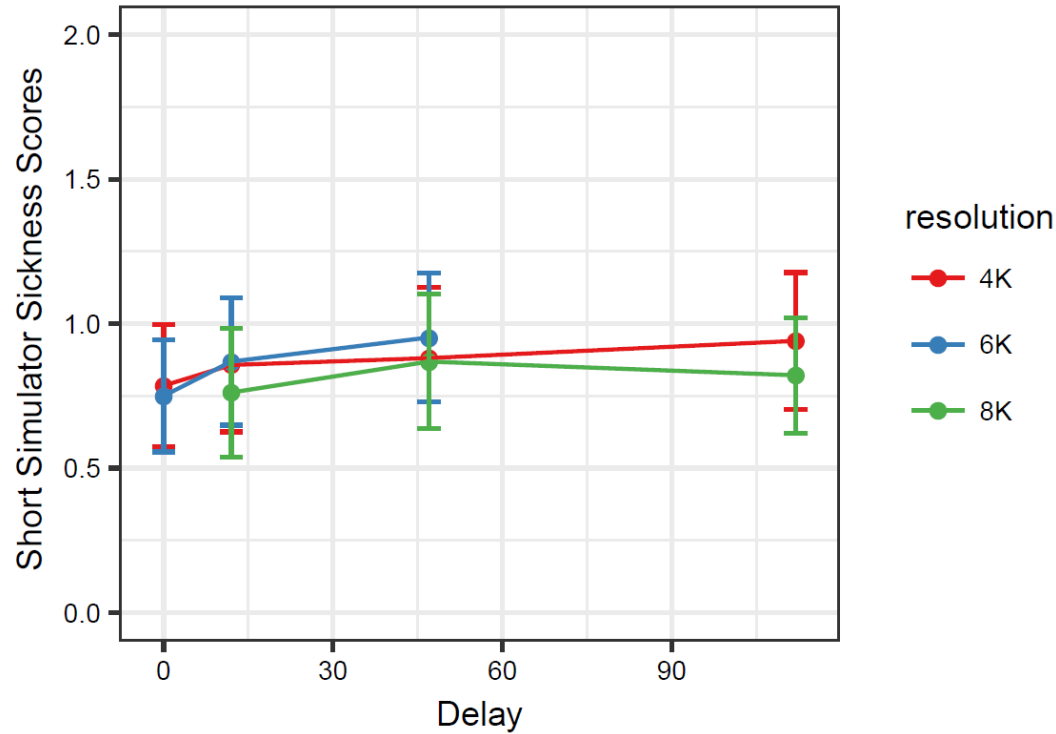
Results of Long Simulator Sickness Questionnaire

Test 2

Session duration : 14 mins

Test 1

Session duration : 10 mins

*Simulator sickness scores (for Test 2) for Session 0 are higher because of sweating (very hot in Ilmenau).

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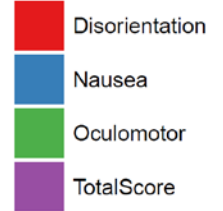
Conclusion

- Video Quality
  - Tile-based streaming solution evaluated under bandwidth limited scenario are more statistically reliable as compared to resolution- and bandwidth-limited
  - **Lower delay (Motion-to-High-Resolution Latency) values up to 47 ms have minimal effect on quality ratings**

- Simulator Sickness
  - **No effect of delay**
  - Simulator scores are increasing with session time
  - Breaks help in reducing simulator sickness

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Questions