

# Augmented Reality tOur guide architecture for 5G (AERO 5G)

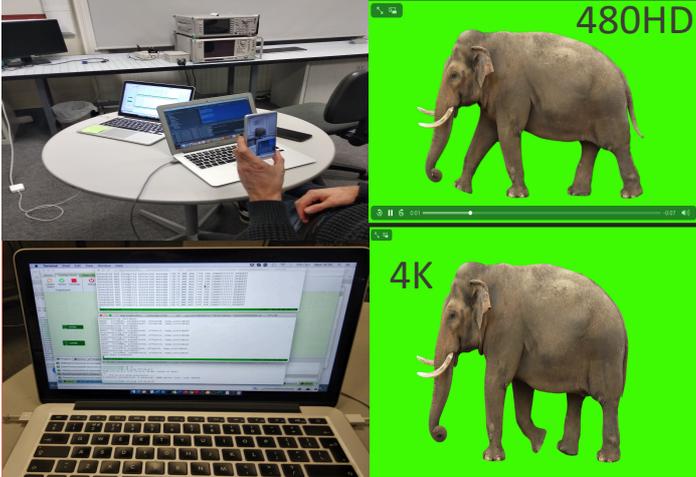
## GOALS

- Perform a feasibility study about extending Discover Places to support **Augmented Reality (AR)**.
- Analyse the performance of Discover Places AR running across 5G networks using srsLTE, Medium-access Edge Computing (MEC), Wi-Fi, etc..
- Provide a thorough description of proposed experiments for Stage 2.

## CHALLENGES

- Are 3G/4G networks capable of supporting AR video?
- Does AR benefit from Low-Latency – Edge computing?
- What radio technology could benefit our users the most – based on available wireless technologies?
- Scalability costs of current and future application are high – we need a sustainable tour development model

## DEMO SETUP



## RESULTS

Experimentation Scenario	Video Quality	Buffering Events %	Buffer Start Time (s) %	Buffer Start Time (s) sd	Buffer Start Time (s) se	Total Download Time (s) %	Total Download Time (s) sd	Total Download Time (s) se
4G SDR srsLTE-to-AWS	480SD	0	0.84s	5.86s	1.85s	16.03s	5.85s	1.86s
4G SDR srsLTE-to-AWS	720HD	1	19.77s	7.68s	2.43s	29s	7.68s	2.43s
4G SDR srsLTE-to-IMEC	480SD	0	3.62s	1.42s	0.45s	12.88s	1.40s	0.44s
4G SDR srsLTE-to-IMEC	720HD	1	20.23s	3.52s	1.33s	29.46s	3.36s	1.27s
4G SDR srsLTE-to-Hs-IMEC	480SD	0.1	4.07s	2.56s	0.81s	13.27s	2.57s	0.81s
4G SDR srsLTE-to-Hs-IMEC	720HD	1	13.77s	4.27s	1.35s	23.06s	4.25s	1.34s
Commercial 3 in 4G-to-AWS	480SD	0.1	9.85s	7.97s	2.52s	19.04s	7.96s	2.52s
Commercial 3 in 4G-to-AWS	720HD	0.8	24.56s	16.24s	5.16s	33.93s	16.33s	5.16s
2.4GHz Wi-Fi-to-IMEC	4K	1	16.03s	5.72s	1.81s	25.39s	5.79s	1.83s
5GHz Wi-Fi-to-IMEC	480SD	0	0.31s	0.03s	0.01s	9.46s	0.17s	0.04s
5GHz Wi-Fi-to-AWS	720HD	0	0.47s	0.08s	0.03s	9.62s	0.08s	0.02s
5GHz Wi-Fi-to-IMEC	1080HD	0	0.93s	0.16s	0.05s	10.09s	0.19s	0.06s
5GHz Wi-Fi-to-AWS	4K	0	2.22s	0.34s	0.04s	11.48s	0.25s	0.08s
5GHz Wi-Fi-to-IMEC	480SD	0	0.54s	0.97s	0.03s	9.71s	0.18s	0.06s
5GHz Wi-Fi-to-IMEC	720HD	0	0.71s	0.21s	0.07s	9.89s	0.22s	0.07s
5GHz Wi-Fi-to-IMEC	1080HD	0	1.07s	0.29s	0.09s	10.29s	0.28s	0.09s
5GHz Wi-Fi-to-IMEC	4K	0	2.49s	0.26s	0.08s	11.71s	0.25s	0.08s
5GHz Wi-Fi-to-Hs-IMEC	480SD	0	0.28s	0.04s	0.01s	9.41s	0.03s	0.01s
5GHz Wi-Fi-to-Hs-IMEC	720HD	0	0.53s	0.13s	0.04s	9.76s	0.15s	0.05s
5GHz Wi-Fi-to-Hs-IMEC	1080HD	0	0.77s	0.09s	0.03s	9.98s	0.09s	0.03s
5GHz Wi-Fi-to-Hs-IMEC	4K	0	2.4s	0.31s	0.10s	11.61s	0.28s	0.09s

Table 2: Evaluation results of the buffer start time and total download time KPIs concluded over the 2.4GHz and 5GHz Wi-Fi (802.11 a/n) technologies, MEC, and the commercial 4G LTE wireless mobile telecommunication technology.

## MORE RESULTS

### 4G Cannot Support 1080HD or 4K video

- 1080HD requires 47Mbps
- 4K Video needs 171Mbps

### Network delay with 480HD and 720HD Video

- 3s to 4.8s higher on Commercial 4G network compared to SDR in 5G MEC environment

### 5GHz Wi-Fi

- No buffering interruptions for any content bitrate in 5GHz Wi-Fi

### 4K video

- Network delay introduced by 2.4GHz Wi-Fi almost 7 times higher than 5GHz Wi-Fi

### Higher Variance experienced using AWS

- Difference due to dedicated resources compared to shared AWS environment

### Buffer start time KPI

- Slower startup time in 4G networks.
- 5GHz Wi-Fi startup very fast

### 5G Medium-access Edge Computing (MEC)

- Almost all scenarios experienced improvement from MEC environment. (However, some outliers, which we will investigate further in Stage 2)

## CONCLUSIONS

- AR integration is **Feasible** for Discover Places
- MEC environment is **beneficial**
- **High Bandwidth** is a fundamental requirement for AR

## Future Work

**Objective 1: Customisable scalable AR Audio and Video guide supported by Machine Learning technologies.**

**Objective 2: Development and deployment ETSI Virtual Network Function Descriptor (VNFD)**

**Objective 3: Explore benefits of auto-scaling in 5G networks using Open Source MANO (OSM) based on increasing / decreasing users**

**Objective 4: Analyse the performance of Discover Places AR running across 5G networks with more users, Wi-Fi ax, OAI 5G new Radio, MEC, etc..**

**Objective 5: Provisional objective – to technology deploy at real tourist site**