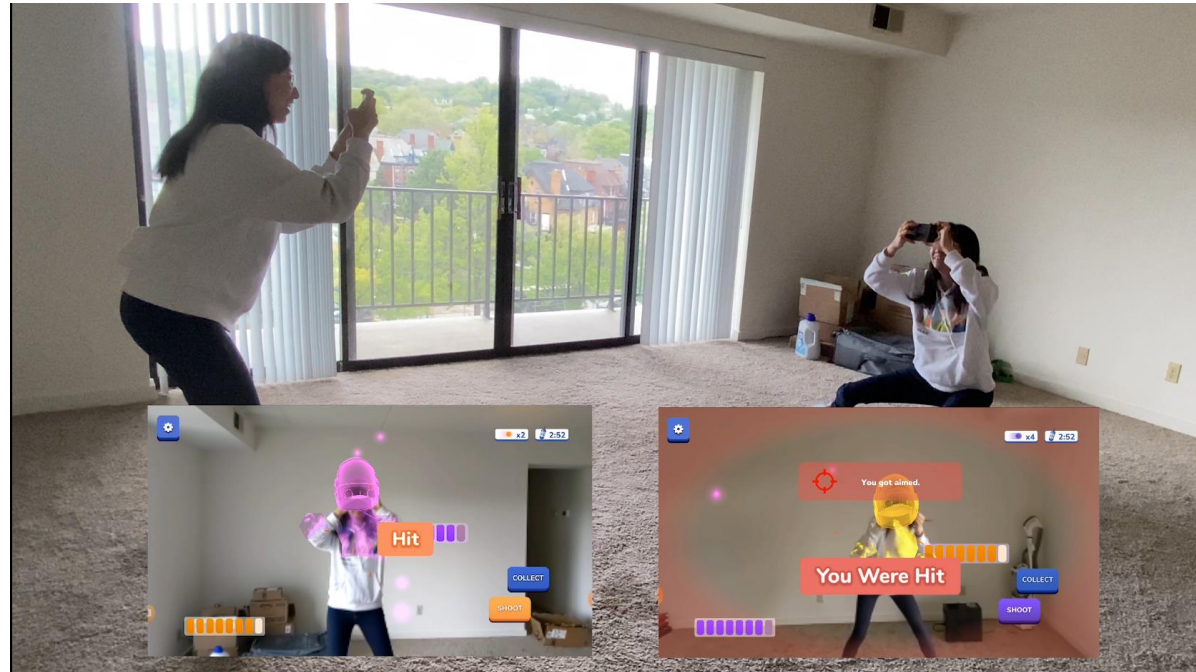


V-Light: Leveraging Edge Computing for Mobile Augmented Reality

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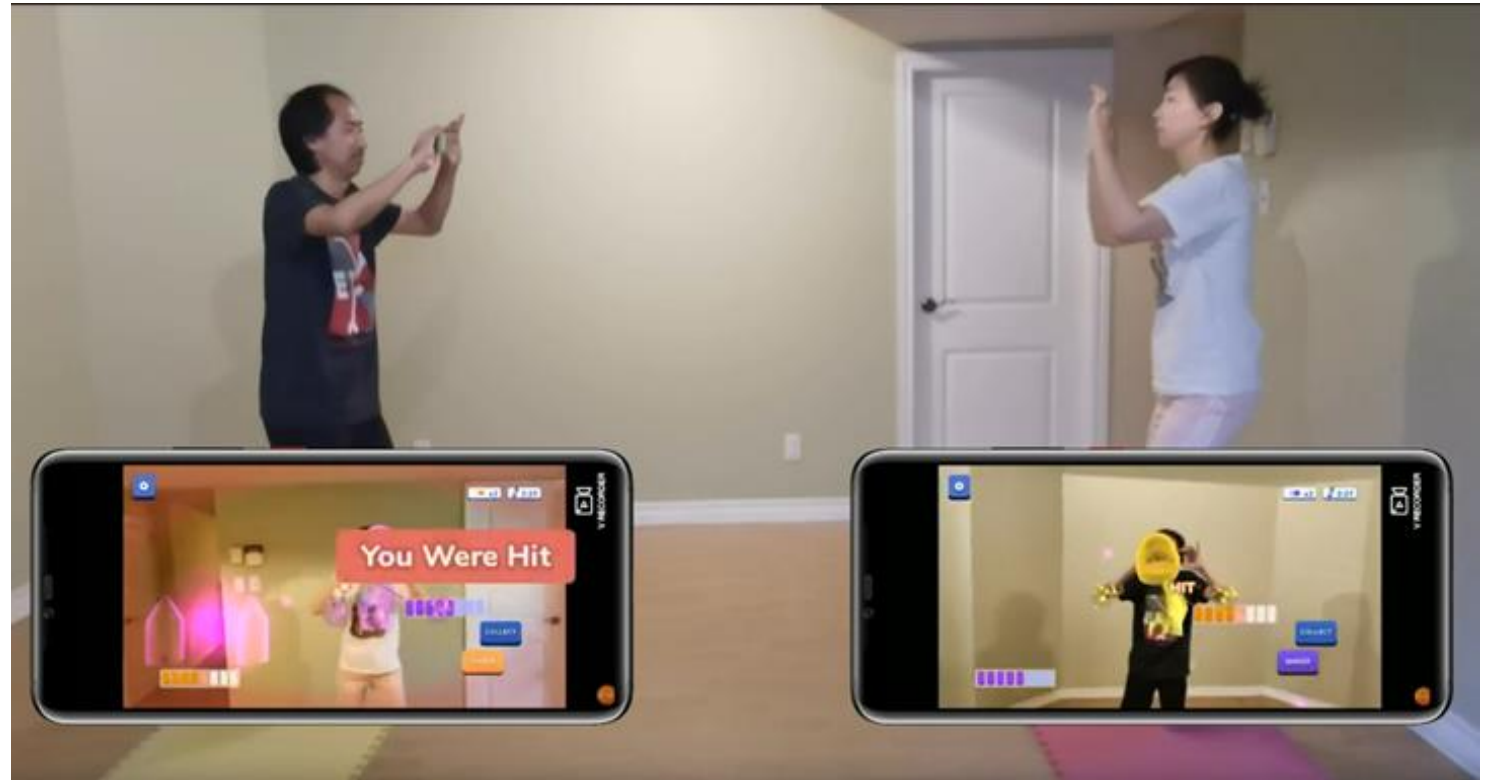


Introduction

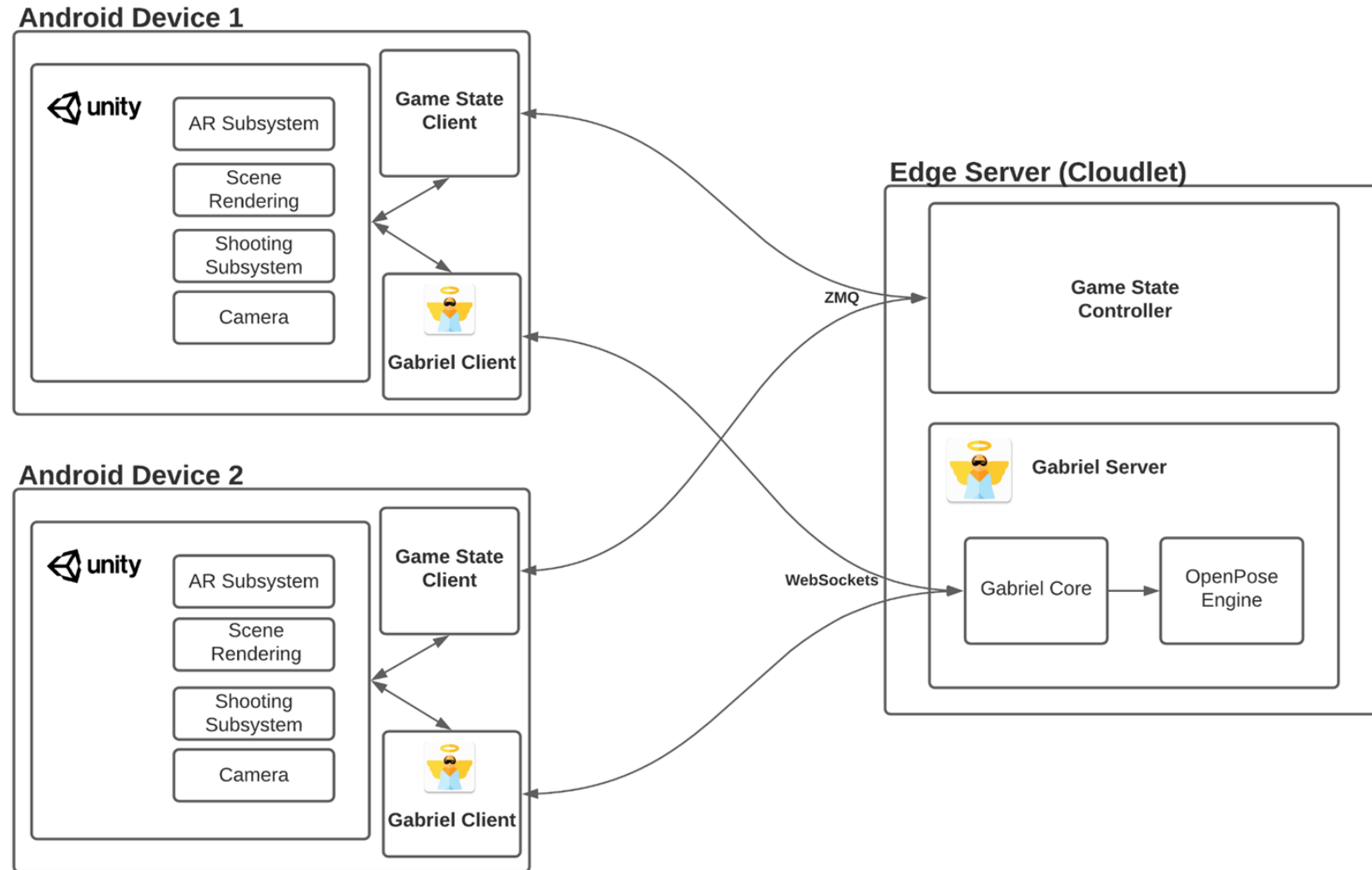
- Project within the CMU Entertainment Technology Center (ETC)
 - Sponsored by InterDigital
 - Collaboration with Satya's Edge Computing Lab
- Project Objectives:
 - Create a novel edge-native AR game to exploit the power of edge computing:
 - 1) Compute intensive
 - 2) Bandwidth hungry
 - 3) Latency sensitive
 - Data analysis to benchmark the performance of game and edge computing
 - Generate a conference paper to share insights

Game Description

- Real-time room-scale mobile AR shooting game
- OpenPose for body, hand, face and foot key point estimation
- Augmented reality armor can be shot by opposing player
- Ammunition can be found in the physical space – requiring a player to explore the room



V-Light Architecture



System Evaluation

Objective:

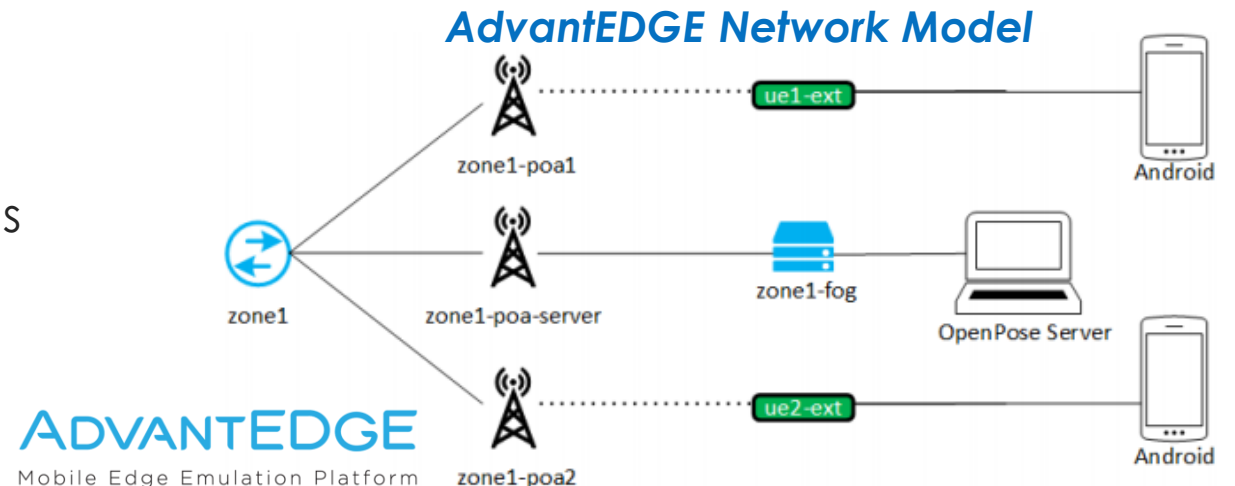
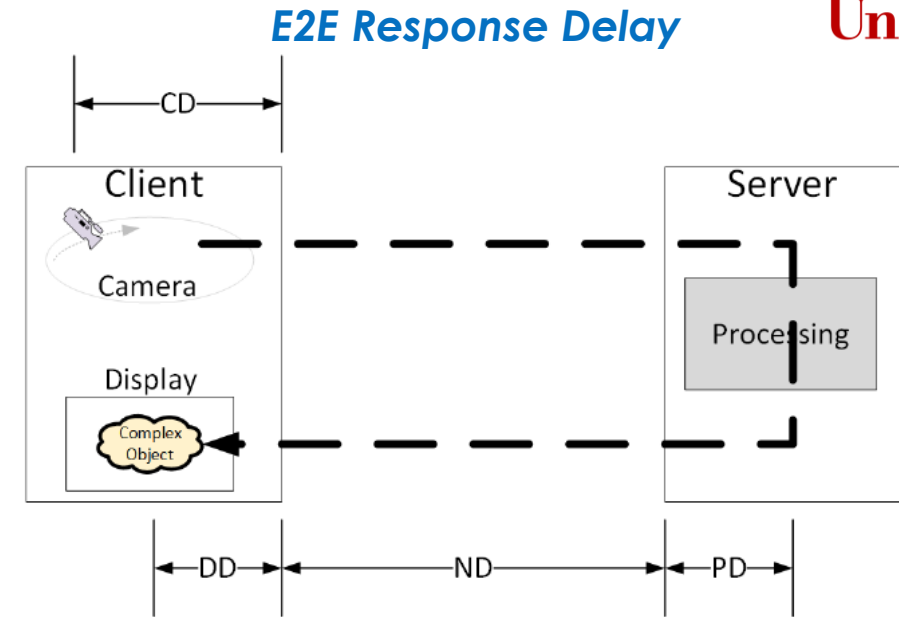
- Verify that V-Light provides an Edge-Native mAR experience
- Answer: Can we prove is this an Edge-Native application?

System Performance Measures:

- Video Frame Rate
- Response Delay

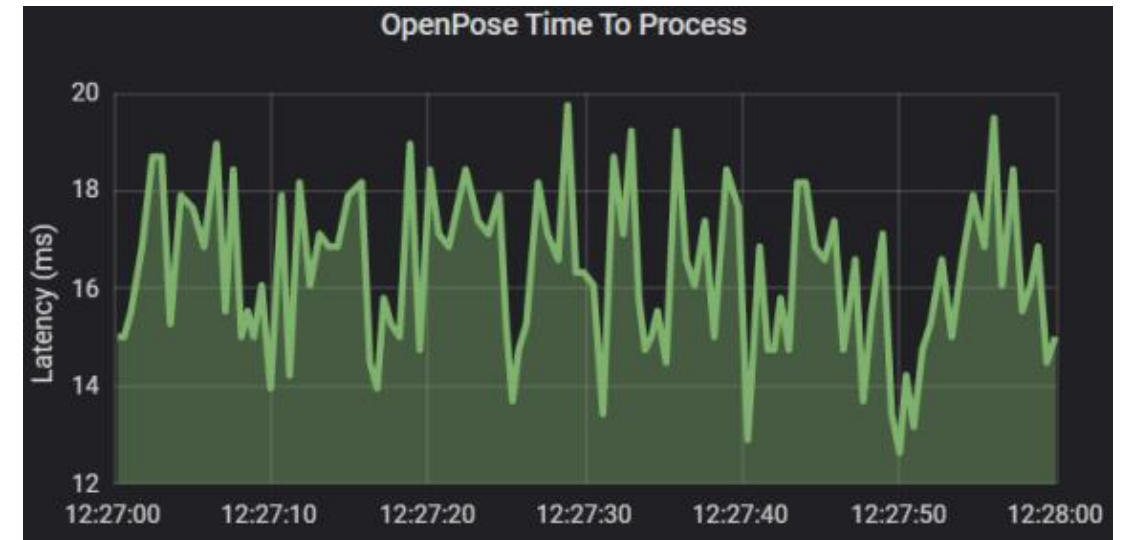
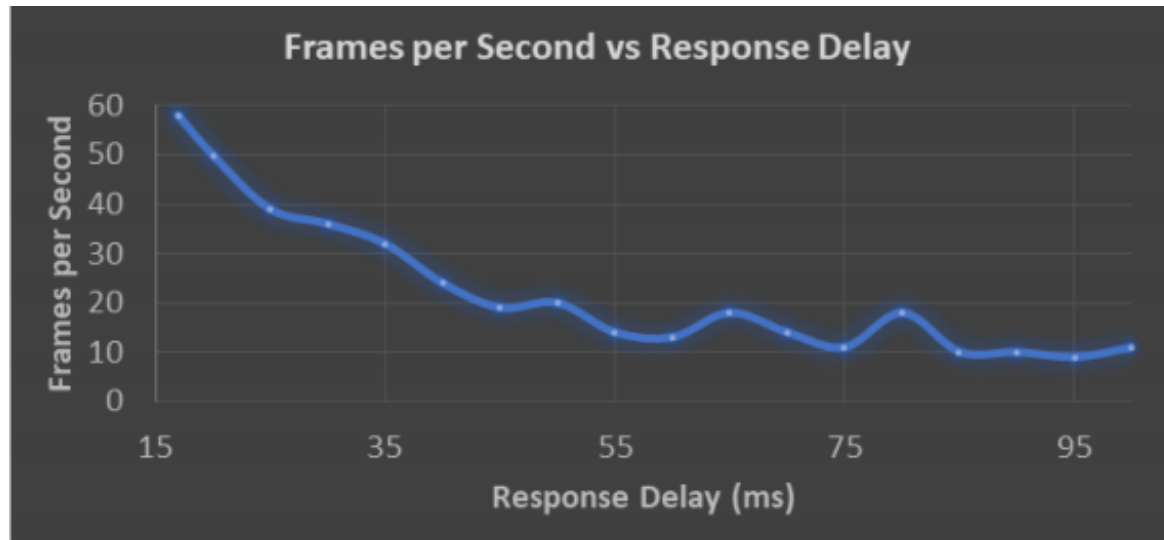
Evaluation Methods:

- AdvantEDGE emulation – varying network delay while capturing the KPIs
- Play testing by ETC team comparing edge vs. cloud deployments



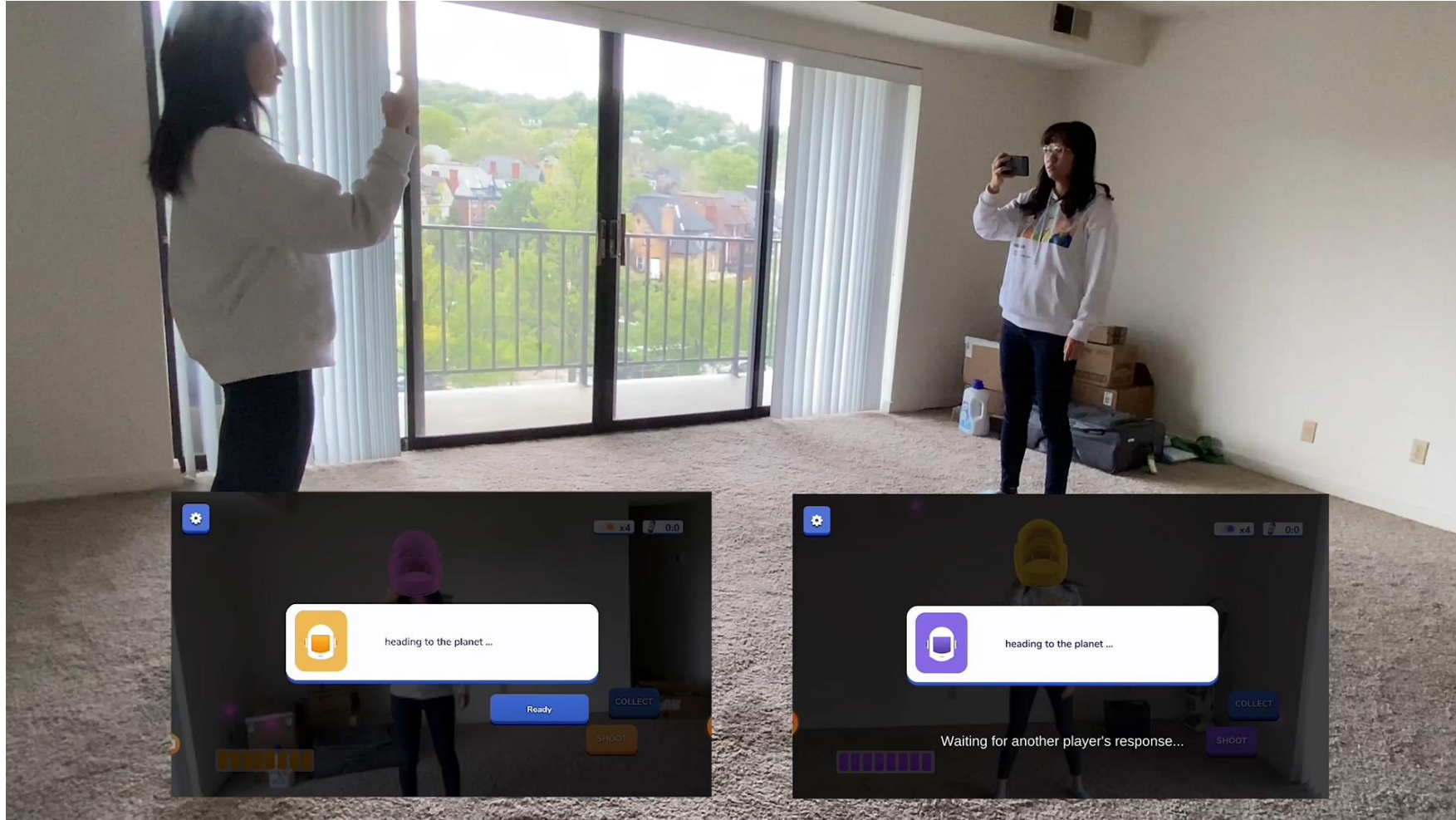
System Evaluation

Resulting video frame rate and response delay only meets AR/VR/XR requirements when the V-Light Game Controller and OpenPose Engine are deployed at the Edge (on-premise).



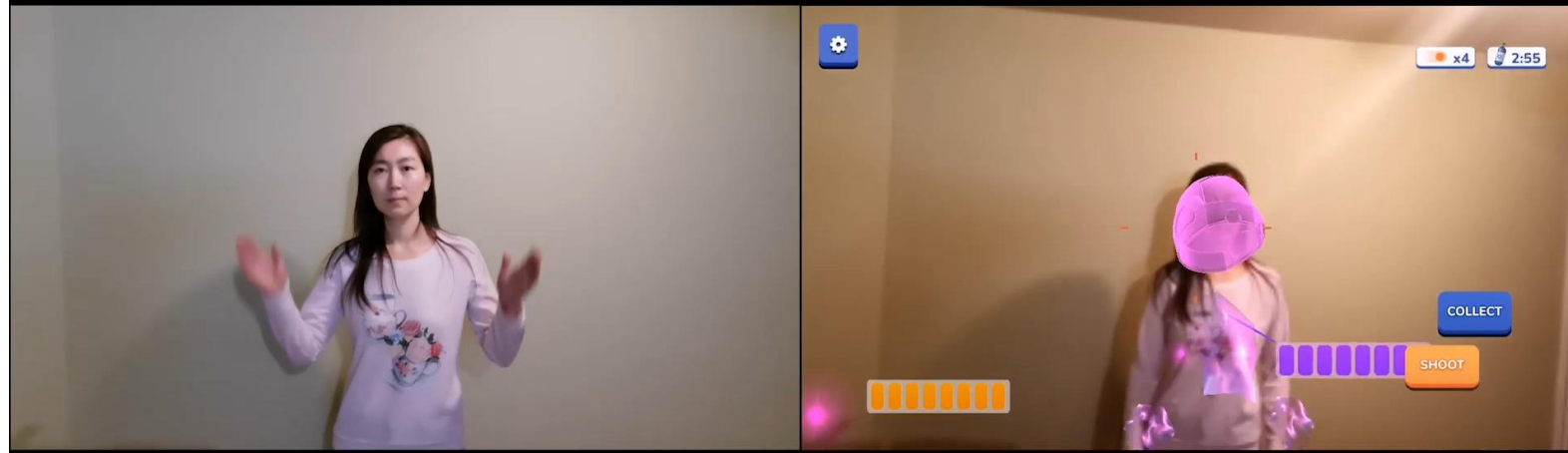
Confirmed the data analysis via game play testing within the ETC project team. When the V-Light server components were deployed in the Cloud, the game was unplayable.

Let's take a look...Gameplay

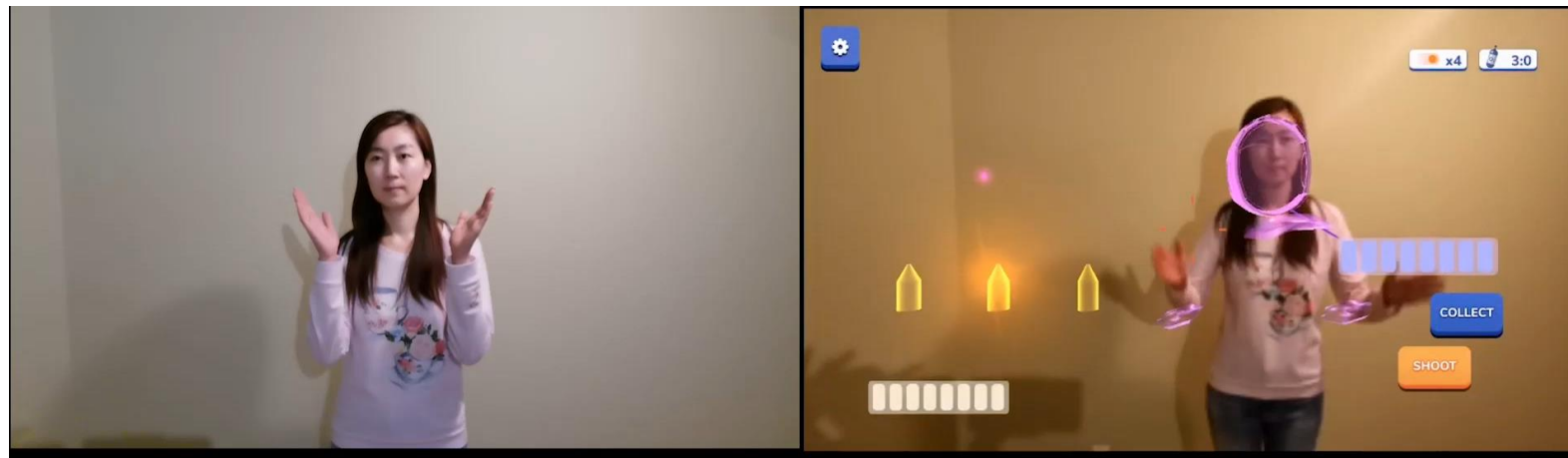


Let's take a look...Edge vs. Cloud

Edge
Play Test



Cloud
Play Test



V-Light Discussion

Implications for Game Design

- Edge-Native enables novel types of computational complexity for new gameplay
- Allows for rethinking existing game genres using the edge-based resources

Application Outside of Game Design

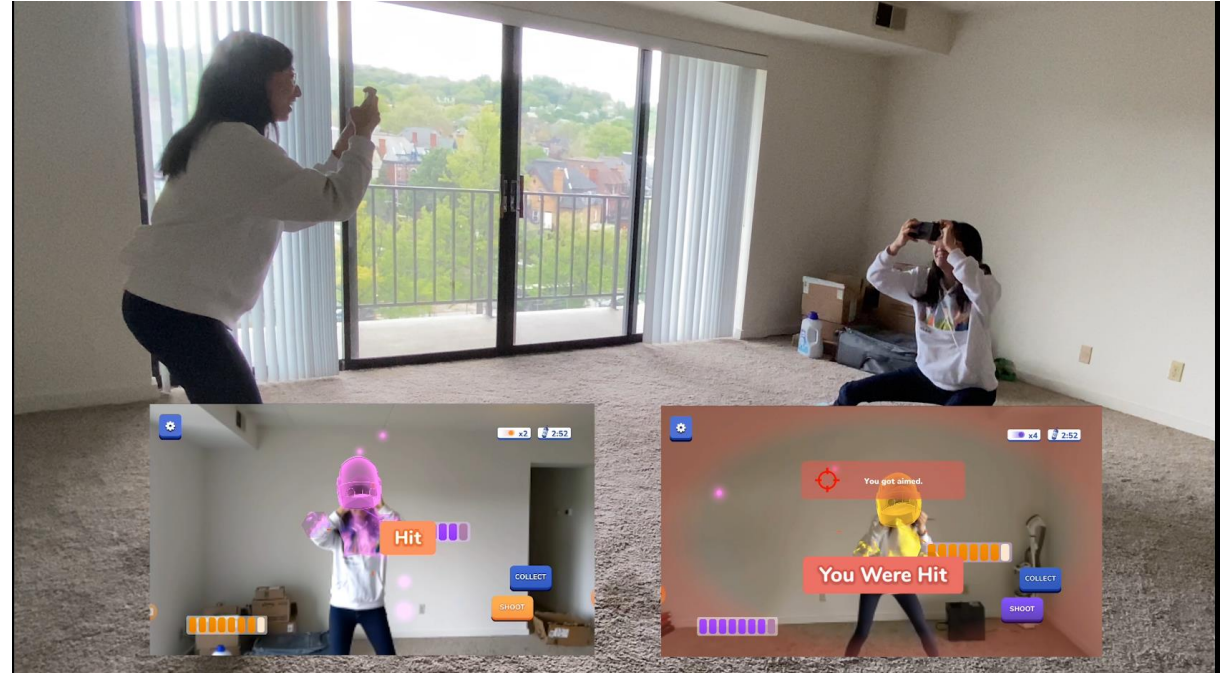
- Non-game edge-native multi-user mobile augmented reality applications
- Education – instrumented classrooms allow for AI-based improvements to educational material and presentation
- Co-robotics – robots share space with humans and work together to complete tasks
- Prototyping of new user experiences involving more than just vision

Edge as a moving target

- What & where is the edge (premise edge, telco edge, hyperscaler, etc.)?
- What computational resources and capabilities are required?

Conclusions + Future Work

- mAR experiences require trade-off between on-device computation with remote compute latency.
- V-Light leveraged edge computing to create a room-scale mAR game.
- We demonstrated the V-Light experience is indeed Edge-Native, pushing boundaries that enable new mAR experiences.
- ETC team will open-source the V-Light code.
- Future work:
 - Full immersion
 - Multi-player tracking
 - 3D pose detection



Thanks to everyone involved...

V-Light Project Team



OH LAB



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Hammer



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Computer
Interaction
Institute



Noor Hammad



Erik Harpstead



Prof. Satya

Carnegie Mellon University
School of Computer Science



Tom Eiszler



Bob Gazda



John Cartmell

