IMG Test plan on Immersive communication systems

2023-06 – Sony Interactive Entertainment (San Mateo, USA)

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Pablo Pérez (Nokia, Spain)

Motivation

- How to test a bi-directional immersive communication system:
  - Evaluate effect of technical factors in QoE (e.g. variations of latency / bitrate / etc.)
  - Compare with other systems / experiments
- Background:
  - **ITU-T P.920** - Interactive test methods for audiovisual communications
    - Some tasks proposed to evaluate effect of technical factors: e.g., one of the subjects shows and describes a plastic building block and the other one is required to reproduce it.
    - Centered on video-conference (05/2000).
  - **ITU-T P.1301** - Subjective quality evaluation of audio and audiovisual multiparty telemeetings
  - **ITU-T P.1320 (P.QXM)** - QoE Assessment of eXtended Reality (XR) Meetings
    - Best practices, factors and constituents for QoE assessment of telemeetings with XR elements.
    - Not to the detail of proposing evaluation tasks or methodologies.
  - Overview, Taxonomy and Good Practises (article*)
    - Characterize types of systems and identify evaluation tasks.

* Pablo Pérez, Ester González-Sosa, Jesús Gutiérrez, and Narciso García, *Emerging Immersive Communication Systems: Overview, Taxonomy, and Good Practises for QoE Assessmen*t, Frontiers in Signal Processing, vol. 2, article 917684, pp. 1-22, Jul. 2022

Work item ITU-T P.IXC

- VQEG-IMG and ITU-T SG12 are working on the definition of a new **recommendation** for subjective assessment of eXtended Reality (XR) communications:
  - A **methodology** to describe the test design: which system influencing factor to test, how to control context and human influencing factors, which QoE constituents to address. The methodology should cover two types of designs:
    - systematically control an independent variable and observe the effects on QoE.
    - test complete “blackbox” systems without exploring individual variables.
  - A reduced set of communication-based **interactive tasks** that are suitable for testing XR in communication systems.
    - 4 tasks: audio communication, visual communication, object manipulation, and environment exploration.
    - Not covering all possible use cases or XR systems but maximizing the coverage provided by only a few tasks.
  - A subset of relevant **measures**: behaviour analysis, questionnaires regarding QoE constituents, physiological measures
    - Objective is to recommend a few measures which can be applicable to a wide range of use cases and systems

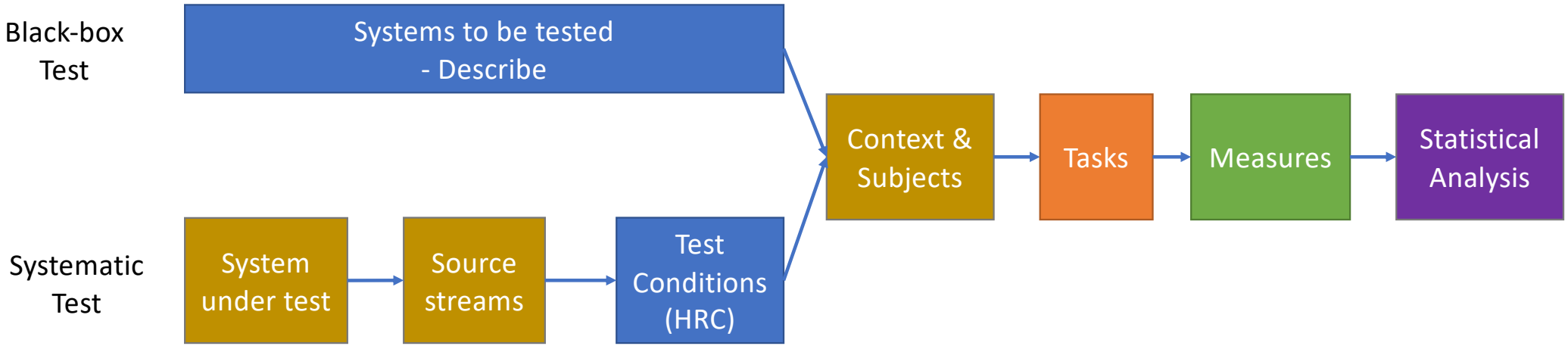
Call for participation

- **Objective**: To look for laboratories which would like to perform subjective assessment tests based on the protocol defined for the Recommendation, so that we can validate the method itself before proposing it to ITU-T.
- Published in May 12th, 2023.
- Important dates and (tentative) schedule:
  - May 23, 2023: Declaration of interest.
  - June 16, 2023: Submission of the form and a 1 to 3-slide presentation describing your test.
  - June 29, 2023: Presentation of the slides in VQEG F2F Meeting (Hybrid).
  - July – December 2023: Each lab executes the test and (common) results are shared in agreed format
  - December 2023 (TBD). Presentation of the results in VQEG F2F Meeting (Virtual).
  - December 2023 – May 2024:
    - Evaluation of the test methodology based on results → common paper, ITU contribution
    - Evaluation of each individual experiment → each lab will exploit their results.

Methodology

Hypothesis

Variations in the **independent variable** have **significant effect** on a **QoE Constitutent** when user execute a basic **communication task** under controlled **conditions**



Tasks

- **Audio**-communication task: Survival Task
- **Visual**-communication tasks: Charade / Physiotherapy
- **Object**-based communication tasks: Block building
- **Environment**-based communication task: Treasure Hunt

Tasks

Audio-communication task: Survival Task

- Based on the one described in the **ITU-T Rec. P.1301**
- **Aim**: to get a compromise in ranking a set of items in terms of necessity under a discussion
- **3 stages**:
    1. Each participant is given up to 5 minutes to prepare, which involves analysing a list of items, contemplating them, and forming arguments for discussion.
    2. During the discussion, participants collaboratively create a ranked list of these items. Single measures, such as ACR, may be employed at this stage.
    3. Participants complete comprehensive questionnaires addressing broader aspects.

These stages can be repeated for other scenarios, and each scenario can be conducted under varying conditions.

Tasks

Audio-communication task: Survival Task

- Other features of the task are listed in the following table:

Task	Feature	Participants	DoF	Performance / success measure	Beyond VR	Confederate	Symmetric
Survival game	Audio	2-10+ 3-6	-	Items_ranked/time Not success	Lots of users	No	Yes

Tasks

Visual-communication tasks: Charade / Physiotherapy

- **Goal**: to perform a task that involves visual-only, or visually-predominant, communication from the participants.
- **Examples:** using sign language to perform the conversation, or conducting a physical training session.
- Depending on the DoF (i.e., how free they are to move around the space), we define **two subtasks**:
  - 3DoF (the participants are seated and can move their upper body): Charade.
  - 6DoF (the participants are free to move around the space): Physiotherapy training session

Tasks

Visual-communication tasks: Charade / Physiotherapy

- The success is measured by the number of times the task is performed (words or movements) in the fixed amount of time.
- Other features of the task are listed in the following table:

Task	Feature	Participants	DoF	Performance / success measure	Beyond VR	Confederate	Symmetric
Charade	Visual	2-10+	3DoF	words/time	-	No	Yes
Physiotherapy	Visual	2+	6DoF	movements/time	Haptics	yes (either)	No

Tasks

Object-based communication tasks: Block building

- **Goal**: to perform a task that involves audio-visual communication for remote collaboration that implies the manipulation of objects.
- Users will be able to see representations of themselves, other users and cubes (their own and others).
- Users will be able to manipulate the cubes in two ways:
  - Instructor: will be able to manipulate a construction composed by cubes.
  - Builders (rest of the users): have to replicate the construction of the instructor following his/her verbal indications.
- Task is designed to be performed sitting in front of a table → 3DoF.

Tasks

Object-based communication tasks: Block building

- Users:
  - Minimum: 2 → 1 instructor and 1 builder.
  - Number of builders can be increased.
  - Instructor role can be assumed by a confederate participant.
- Task performance:
  - Ratio between the number of constructed figures and the time spent in constructing them.
- Other features of the task are listed in the following table:

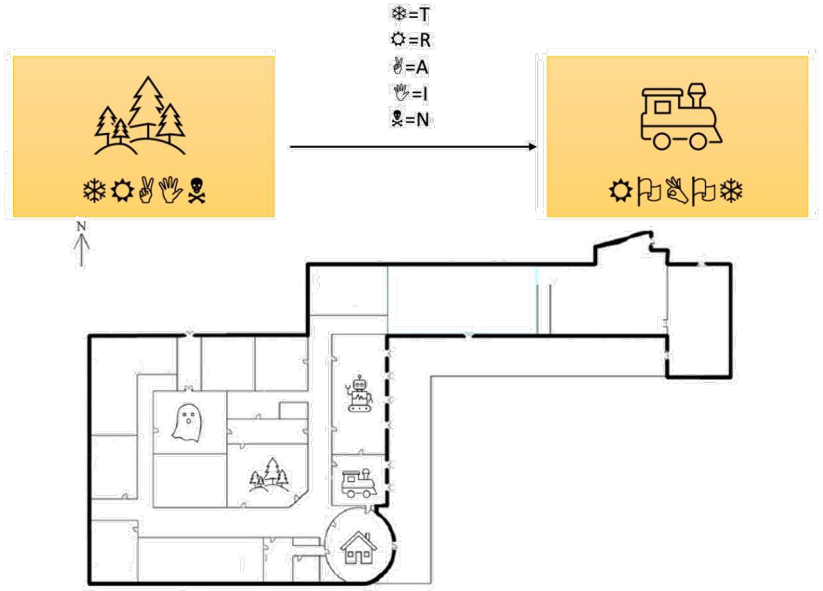
Task	Feature	Participants	DoF	Performance / success measure	Beyond VR	Confederate	Symmetric
Building Blocks	Object	2+	3DoF	figure/time	AR Haptics	yes (instructor)	No

Tasks

Environment-based communication task: Treasure Hunt

- Task focused on the exploration of the environment either in a symmetric (collaboration) or asymmetric (remote support) way.
- The remote support person may provide additional knowledge about the task or the environment to the local operators.

- Treasure Hunt game:
  - Participants have to solve **clues** based on **cards** hidden in the space (virtual or real world).
  - Each **card** contains a symbol (representing the card) and a **clue** indicating the symbol of the next card, encrypted with a simple substitution code.



Tasks

Environment-based communication task: Treasure Hunt

- Three possible roles are defined:
  - **Search the cards**: The user is able to navigate in the environment and find the cards.
  - **Decode the cards**: The user has a dictionary to read the clues. Depending on the type of code used, the clues can be auditory (e.g. only reading the card is needed, as in a Caesar code) or visual (symbols are abstract).
  - **Guide the navigation**: The user has a map with the location of the cards.
- The game can be carried out in two types of :
  - VR: all participants are in the same environment so all of them can search the cards, but one of them has the dictionary and other the map.
  - Mixed-technology mediated: there are local participants that share the same physical location and remote attendants that have additional tools to help to complete the task (dictionary and map).

Tasks

Environment-based communication task: Treasure Hunt

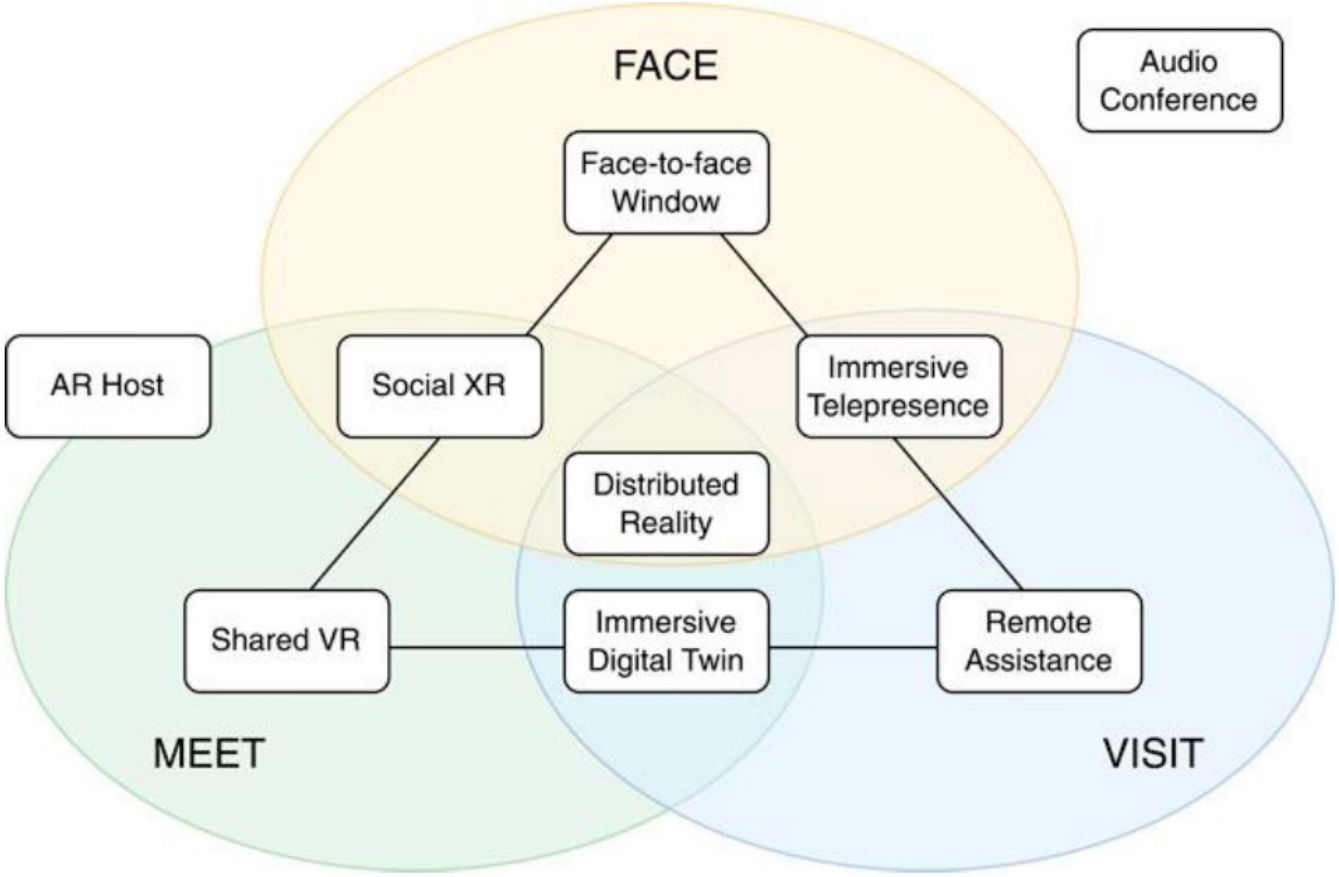
- Other features of the task are listed in the following table:

Task	Feature	Participants	DoF	Success measure	Beyond VR	Confederate	Symmetric
Treasure Hunt	Environment	1-4	6DoF	cards/time	AR, locomotion	Yes (either)	No

Communication Systems

- Immersive communication systems:
  - Enable immersive, remote, and synchronous communication.
  - Immersive systems are characterized for creating the illusion of “being there” (a “sense of presence”), in a remote location and/or with remote people.
- Target systems that has at least one of the following features:
  - Transmit in real time a realistic, real-size visual representation of the other person (**Face**): This element enables visual communication.
  - Transmit in real time a visual representation of the surroundings of the other person (**Visit**): This enables remote presence: seeing the physical environment of the other person and being able to operate and discuss it.
  - Represent the other person in the same (virtual or physical) space as the user (**Meet**): This enables shared immersion.

Communication Systems



* Pablo Pérez, Ester González-Sosa, Jesús Gutiérrez, and Narciso García, *Emerging Immersive Communication Systems: Overview, Taxonomy, and Good Practises for QoE Assessmen*t, Frontiers in Signal Processing, vol. 2, article 917684, pp. 1-22, Jul. 2022

User Feedback

- 3 types of measures:
  1. Task performance and conversation analysis:
     i. Task success rate (e.g. number of guessed items per unit of time).
     ii. Post-hoc analysis of the conversation (e.g. turn taking, interruptions between speakers, requests for repetition, etc.).
  2. System performance questionnaires:
     i. Single-item or short questionnaires targeted to analyze the effect of a test condition in user quality (e.g. ACR in P.913).
     ii. These are applicable only to systematic tests.
  3. Human factors / QoE constituents, e.g. simulator sickness, immersion, presence…
     i. targeted to explore the influence of the system in different QoE factors.
     ii. These will depend on the specific research question, and they will be mainly applied in black-box tests (or in systematic tests with some limitations).

Call for participation

- We asked for:
  - A Research Question
  - Type of test: systematic or black-box.
  - System Influence factors to test.
  - (Immersive) Communication system(s) to be used.
  - Task to be used.
  - Specific QoE factors to measure and how to do it.

Results of the Call for Participation:

12 proposals

Proposals

1. Universidad Politécnica de Madrid (Spain) - **UPM**
2. Nokia (Spain) - **NOK**
3. CWI (The Netherlands) - **CWI**
4. AGH University of Science and Technology (Poland) - **AGH**
5. University of Padova (Italy) - **PAD**
6. University of Roma 3 (Italy)- **UR3**
7. TU Ilmenau (Germany) - **TUI**
8. University of Surrey (UK) - **UoS**
9. University College London (UK) - **UCL**
10. Texas State University (USA) - **TSU**
11. Keysight Technologies & University of Malaga (Spain) – **KUM**
12. Lulea University of Technology (Sweden) - **LUT**

Universidad Politécnica de Madrid

Jesús Gutiérrez – jesus.gutierrez@upm.es
Carlos Cortés – carlos.cs@upm.es
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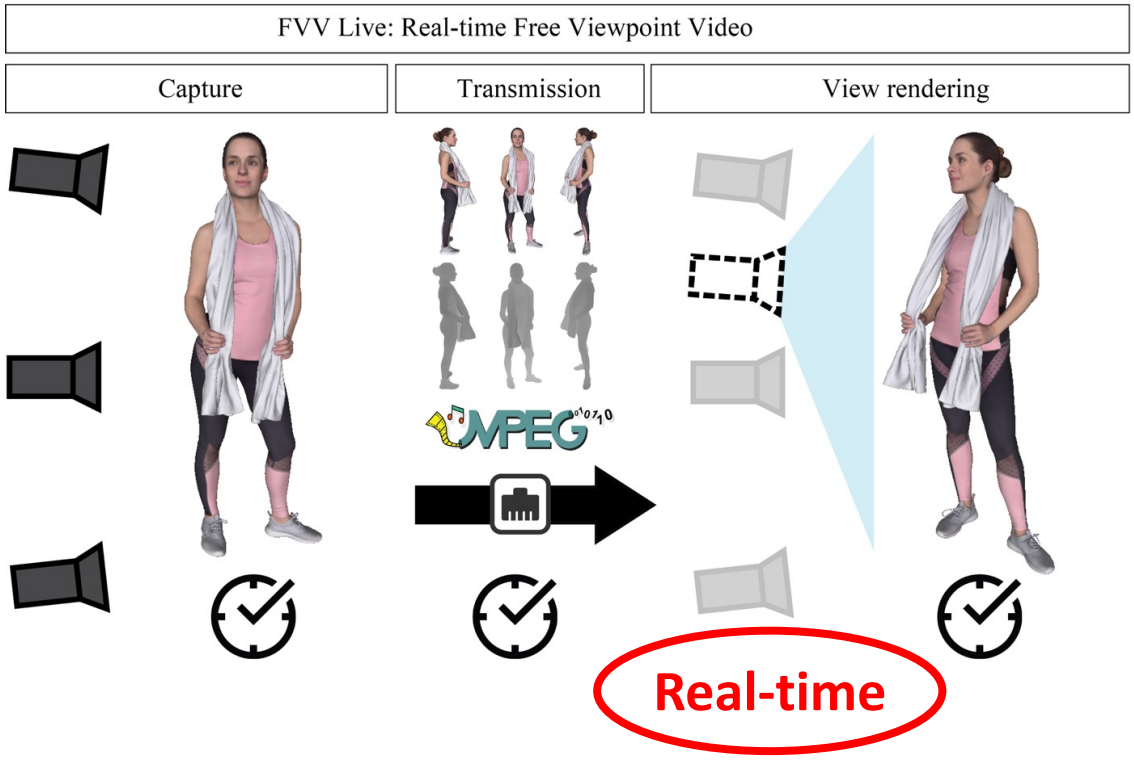
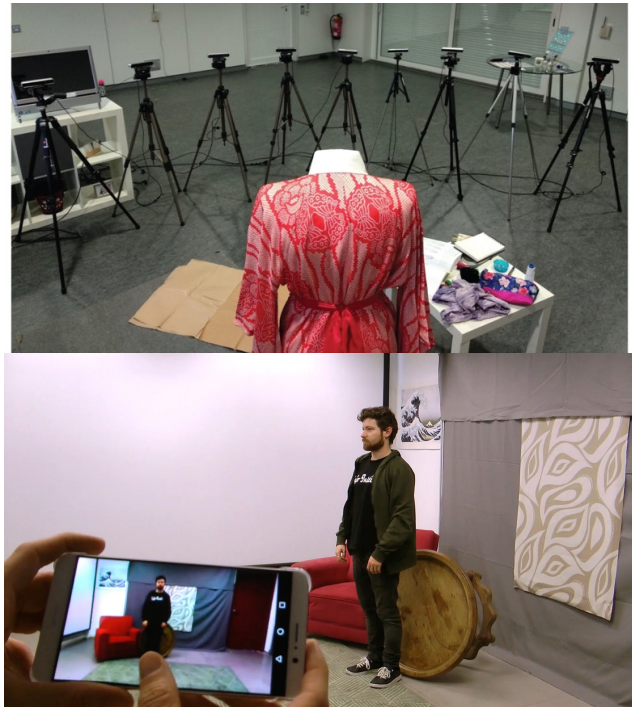
UPM Proposal

- **RQ:** How technical parameters of the **FVV Live system** impact the QoE of the users during communication scenarios?





UPM Proposal

SIF
(Independent variables)

Display technology (HMD, mobile phone, screen+joystick)
Compression (color and depth)
Segmentation
Latency, transmission errors, etc.

QoE factors
(Independent variables)

Visual quality → MOS
Interaction → QoI
Subjective performance → TBD
Task performance → Duration, activity time
Task load → NASA TLX, Psychophysiological signals
Cybersickness → Vertigo or VRSQ
Exploration behavior → sensors, trajectories, …

Tasks

Priority:
- Visual-communication: Charade / Physiotherapy

Extension1:
- Audio-communication: Survival Task
- Object-based communication tasks: Block building

Extension 2:
- Environment-based communication task: Treasure Hunt

Participants

- 2 users each time (one remote and one local). Maybe more than one in local?
- Total number of participants > 30

eXtended Reality Lab (XR Lab)

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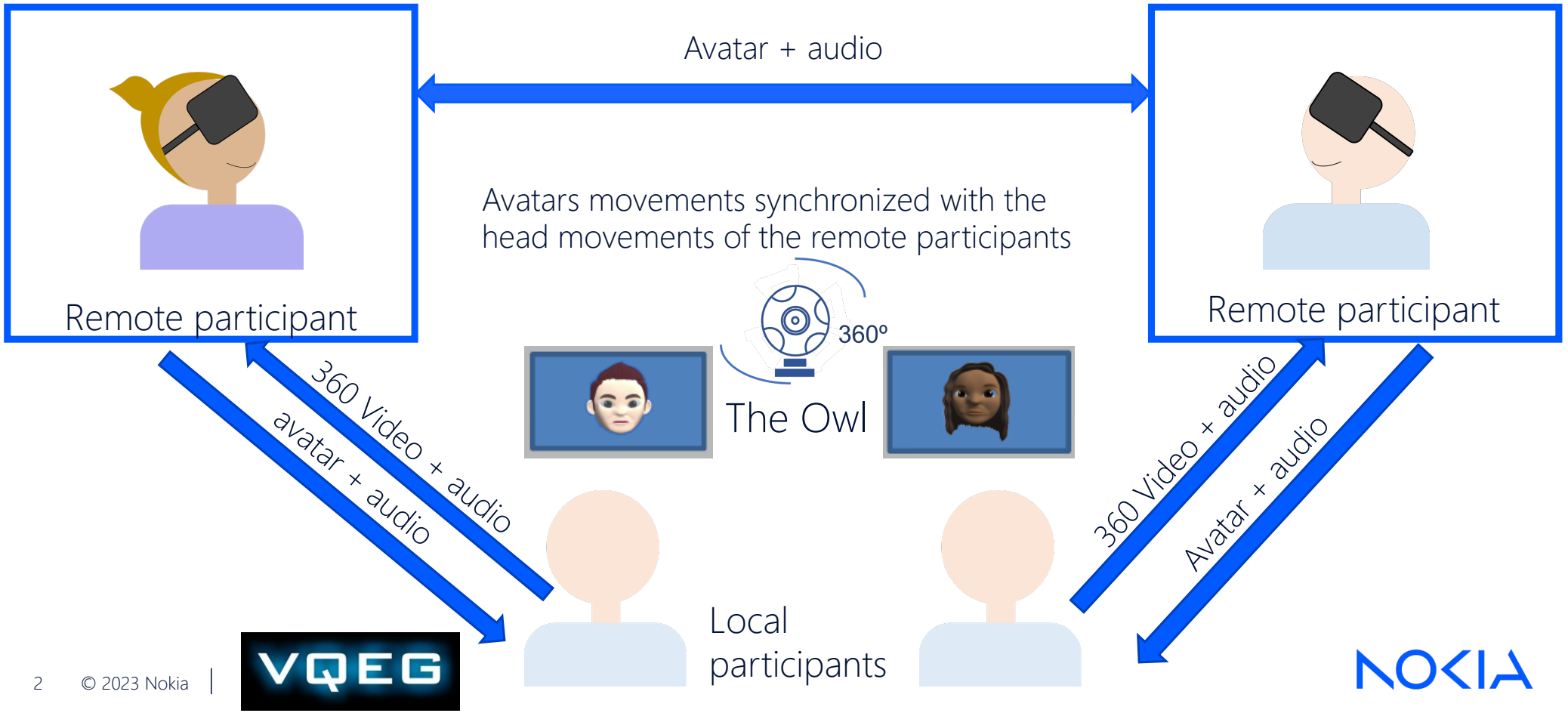
Pablo Pérez, pablo.perez@nokia.com

  | VQEG

System

The Owl



VQEG
NOKIA

Tasks

Environment-based communication task: Treasure Hunt

- 2 Local participants that share the physical location → search the cards
- Remote participants that have additional tools to help to complete the task
  - 1 remote participant has the dictionary
  - 1 remote participant has the map

Audio-communication task: Survival Task

2 local participants + 2 remote participants

Conditions and measurements

Conditions:

- Latency
- Video quality
- Audio quality

Evaluation of

- technical aspects (latency and video and audio quality)
- socioemotional aspects (presence, emotions, connection between participants, etc.)

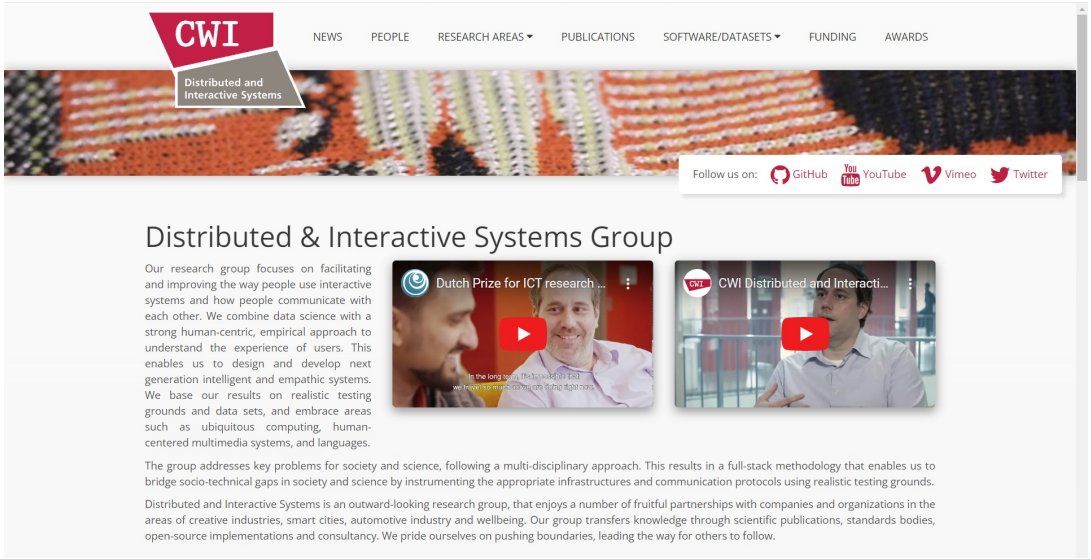
in a systematic way along the session with questionnaires that have been used in previous experiments

RQ: impact of latency, video and audio quality on interactive immersive communication

Research institute for mathematics & computer science in the Netherlands

Introducing DIS Group @CWI

- **User-Centric Interactive Systems:** Focus on enhancing user experience and communication in interactive systems, combining data science and a human-centric approach
- **Intelligent and Empathic Systems:** Aims to design and develop next-generation intelligent systems with a focus on empathy, leveraging realistic testing grounds and datasets
- **Multidisciplinary Approach:** Address key societal and scientific challenges through a multidisciplinary approach, bridging socio-technical gaps and utilizing appropriate infrastructures and communication protocols



https://www.dis.cwi.nl/

CWI
Research institute for mathematics & computer science in the Netherlands

Test Plan

Research Question: Impact of Latency and Desynchronization on XR Communication

- **System Factors:** Latency will be introduced in Audio and Video
  - Finding acceptable limits of delay value for audio and video for smoother and immersive XR experience

- **Task:** Physiotherapy
  - In our experiment, we will include a confederate user who will play the role of an experimenter while interacting with the other test participants

- **System:** VR2Gather [1] (Systematic)

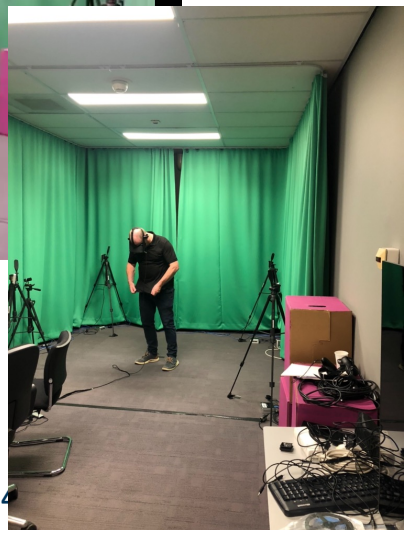
[1] I. Viola, J. Jansen, S. Subramanyam, I. Reimat and P. Cesar, "VR2Gather: A collaborative social VR system for adaptive multi-party real-time communication," in IEEE MultiMedia

Test Plan

- **Factors:**
  - Visual Quality
  - Quality of Interaction
  - Presence/Immersion
  - Cybersickness
  - Task/Cognitive Load
  - Task Completion Time

- **Contributors:** Ashu, Irene, and Pablo

Labs & Test Set Up



MediaScape: https://youtu.be/I7kY1cMZyD0

Norway grants

Survival task (not only) for XR communication systems

AGH University of Krakow, Institute of Communication Technologies Krakow, Poland

AGH

Advantages of adjusted survival task

Adjustable length of the experiment

Adjustable number of participants

Designed for both Experience Sampling Methods and longer questionnaires

Possibility to change experimental conditions between sessions

Testing efficiency of the task and time duration

Stage I: Pre-test of the task on groups of 2-5 people. On this stage we do not introduce any technology.

Stage II: Measurement of time for groups of 2-5 people using ”standard” 2d videoconferencing systems.

Stage III: : Measurement of time for groups of 2-5 people using XR communication.

Collaborative labyrinth

Sara Baldoni, Federica Battisti
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University of Padova

Key points

Research question: Impact of the amount of information available to the users on their interaction, and correlation between data volume and the quality of the interaction.

Type of task: Environment-based communication

Type of system: Black box, Mozilla Hubs, Agora SDK

Type of immersive communications system: Meet: the other person is represented in the same (virtual or physical) space as the user

QoE factors to be measured: accomplished tasks/time, movements, relation between accomplished tasks/time and movements, volume of traffic data (if available)

User feedback: task performance, conversation analysis and human factors

Simultaneous participant number: 2

Minimum number of planned tests: 30

Detailed task description

The user in the virtual environment (U1) is in a labyrinth and his/her final goal is to reach a pre-defined point. U1 will move from the starting to the end point through intermediate positions in which he/she will have to perform a simple task (e.g., understand the instructions to reach the following point).

The user outside the virtual environment (U2) can communicate with U1 to give him/her instructions.

The labyrinth shape changes increasing to make the task of finding the exit harder (e.g. multiple turns on the same side, corridors length, reduced time for completing the tasks).

We foresee two interaction modalities between U1 and U2:

- U2 can see where U1 is.
- U2 cannot see where U1 is, but U2 has a map of the labyrinth.

We will evaluate the variation of success rate for task completion in the different interaction modalities and by varying the task complexity. We will evaluate also the impact of the lack of synchronism between the instructions given by U2 and the actions of U1 on the task success rate. If traffic data will be available we will analyze the network latency and verify its impact on the task performance.

Collaborative block building

Anna Ferrarotti, Marco Carli
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Roma Tre University

Key points

Research question: **Impact of the amount of information available to the users on their interaction, and (if possible) correlation between data volume and the quality of the interaction.**

Type of task: object-based communication

Type of system: black box, Mozilla Hubs, Agora SDK

Type of immersive communications system: Meet: the other person is represented in the same (virtual or physical) space as the user.

QoE factors to be measured: accomplished tasks/time, movements, relation between accomplished tasks/time and movements, volume of traffic data (if available)

User feedback: task performance, conversation analysis and human factors.

Simultaneous participant number: 2

Minimum number of planned tests: 30

Detailed task description

The first user (U1) is in the virtual environment and has to build 3D objects following the instructions given by the second user (U2) who is located outside the virtual environment. U1 can use blocks of different sizes and colors.

Different scenarios will be considered:

- U1 and U2 can use audio and video
- U1 can see and hear U2, U2 can only hear U1
- U1 can hear U2, U2 can see and hear U1
- U1 and U2 can only hear each other

We will evaluate the variation of success rate for task completion in the different scenarios and by varying the task complexity (block number, shape complexity, time).

The Effect of Audio Spatialization on Plausibility in a Virtual Reality Communication Scenario

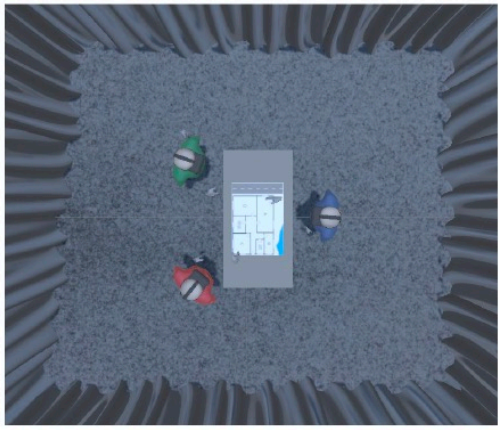
VQEG-IMG

Felix Immohr, Chenyao Diao, Alexander Raake

Audiovisual Technology Group, Institute for Media Technology
Technische Universität Ilmenau

Study Design

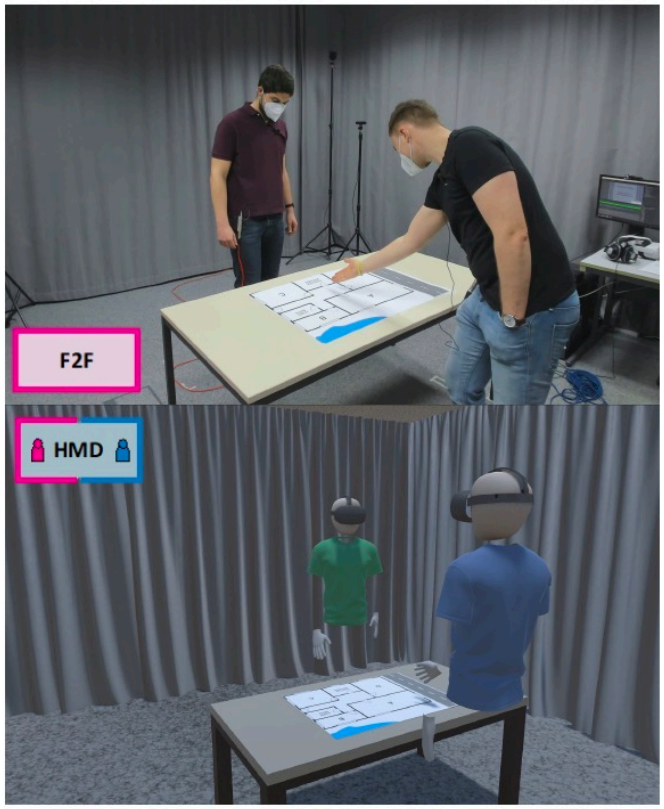
- Interactive audio-visual communication test with 3 participants
- **Research Question:**
  Effect of spatial audio reproduction on social presence and user behavior in multi-party VR communication?
- **System:** symmetrical Unity-based multi user SocialVR system
- **System factors** (Independent variables):
  - Auralization method (diotic, position-dynamic binaural synthesis)
  - ‚Communication medium' (VR, face-to-face)
- **3 Conditions, within-subject design:**
  - VR with **binaural spatial audio**
  - VR with **diotic audio**
  - Face-to-face interaction



Study Design

- **Evaluation** (dependent variables):
  - **Subjective** assessment through questionnaires:
    - Social presence/plausibility
  - **Objective** assessment: conversation and behavioral analysis
    - Task performance
    - Conversation analysis (turn-taking behavior)
    - Behavioral analysis (movement)

- Multi-party extension of [1] with survival task



Example study scene

[1] Immohr, F., Rendle, G., Neidhardt, A., Göring, S., Rao, R. R. R., Arboleda, S. A., Froehlich, B., Raake, A., „Proof-of-Concept Study to Evaluate the Impact of Spatial Audio on Social Presence and User Behavior in Multi-Modal VR Communication", ACM Int. Conference on Interactive Media Experiences, Nantes, France. | https://doi.org/10.1145/3573381.3596458.

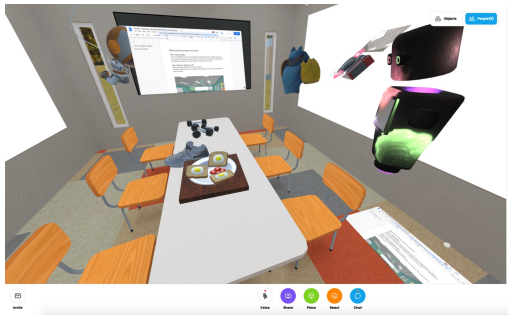
IMPACT OF PACKET LOSS ON IMMERSIVE COMMUNICATION VS CONVENTIONAL VIDEOCONFERENCE

MOZILLA HUBS VS TEAMS/ZOOM

FEMI ADEYEMI-EJEYE

UNIVERSITY OF SURREY

SYSTEMS BEING EVALUATED



Mozilla Hubs (HMD)

Teams/Zoom (Conventional Video Conferencing)

- Both are Blackbox systems

FACTORS TO CONSIDER

System Influencing Factor (SIF)

Packet loss: Emulating random packet loss patterns

QoE Factors being considered

Visual Quality

Simulator sickness

Immersion

Presence

University College London

System: Ubiq

- Open-source toolkit for building social VR
- Variety of platforms (Quest, WebXR, desktop, etc.)
- Avatars, Scene Management, Object Spawning, Interactions, Voice Chat, Logging
- Embedded VECG experiences and student demos
- Supporting academic research, teaching

Research question

- R1: What are the effects of **collaboration style** on user experiences in a collaborative block building task?
- R2: What are the effects of individual **roles** assignment and **responsibilities** on collaboration outcomes in a collaborative block building task?
- R3 : What are the effects of the **level of immersion** on collaboration outcomes in a collaborative block building task?

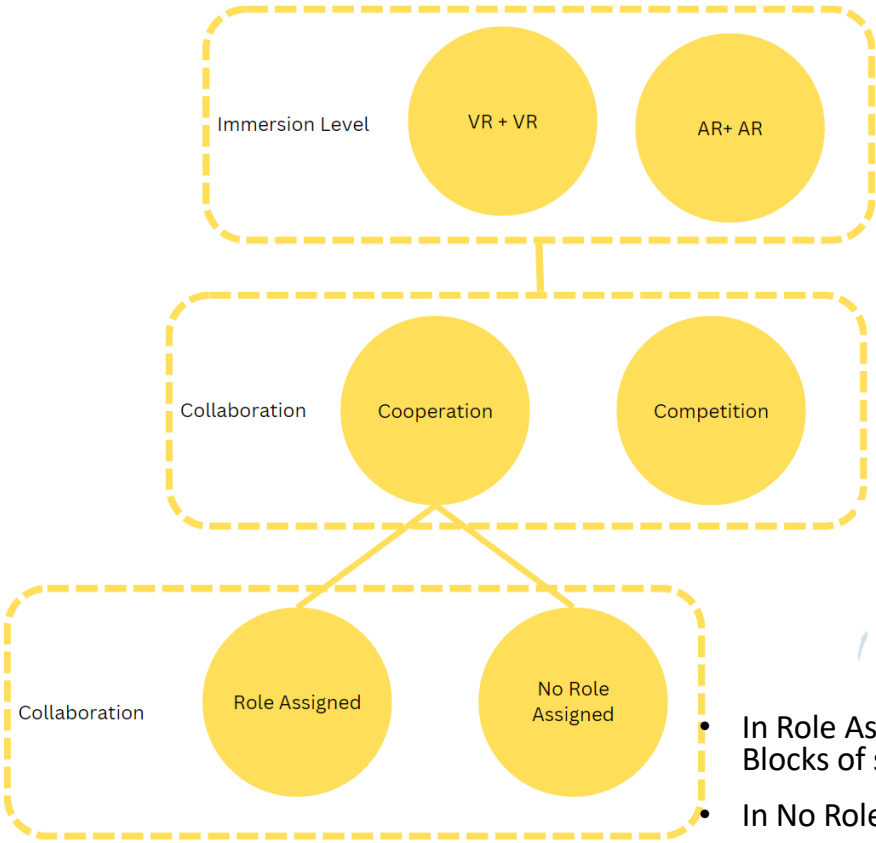
Task

- Object-based communication tasks: **Block building**
  - 1 recorded instructor gives the instructions
  - 2 builders need to build the structure either against or together

Method

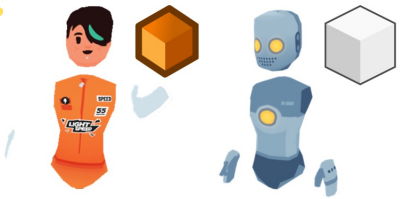
- Participants
  - 2 builders
- Design
  - Within method (all participant experience all the balanced conditions)
- Independent variables (system factors)
  - Immersion Mode (VR group or AR group) : 2 conditions
  - Collaboration mode (Competition or Cooperation) : 2 conditions
  - Role mode when in Cooperation mode (Assigned or Not Assigned) : 2 conditions
- Dependant variables (factors to measure)
  - Objective Measures (completion time for a set number of figures to make or round, speaking duration, turn taking, task activity, request for repetition, avatar head, hands position and rotation)
  - Subjective Measures using questionnaire about VR experience (embodiment, presence, social presence, object interactivity) and User Experience (enjoyment, talkativeness, leadership, trust, confidence in partner ability) after each round

Experimental Design



- 2 VR Participants using HMD
- 2 VR Participants using AR HMD

- In Competition mode the fastest Participants to complete figure wins
- In Collaboration mode the Participants should complete figure in shortest time working together



- In Role Assigned mode Participant of Color (Orange or Gray) can only grab Blocks of same color
- In No Role Assigned Participants can grab blocks of their choice

To notice

- Possibility for us to run one experiment

BUT

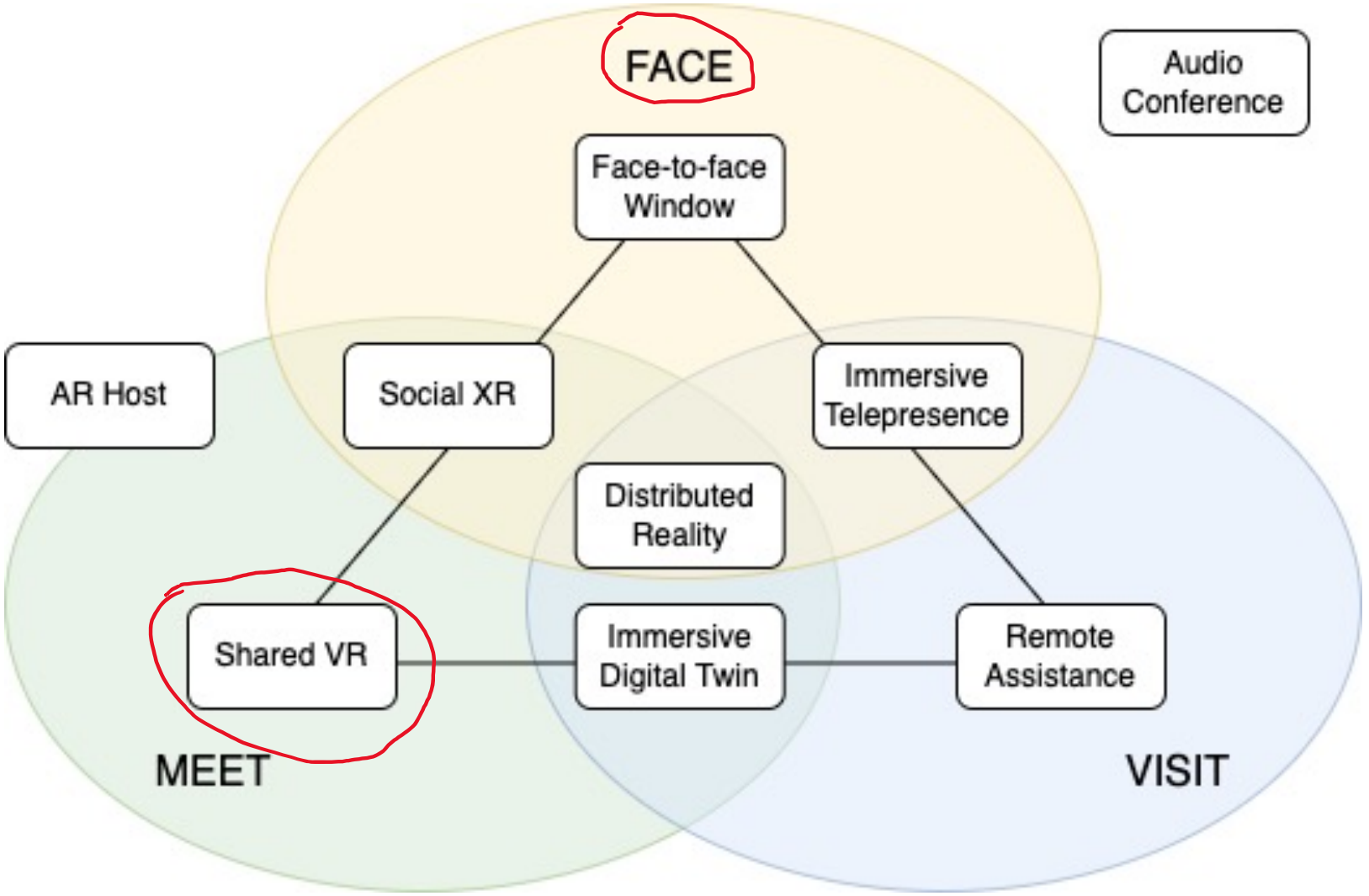
- If there are open assets for the proposed social tasks
- To Implement the tasks and logging software in Ubiq for the other tasks
- Making those tasks available open-source

Realistic Representations or Virtual Reality: Which system are better for communications systems?

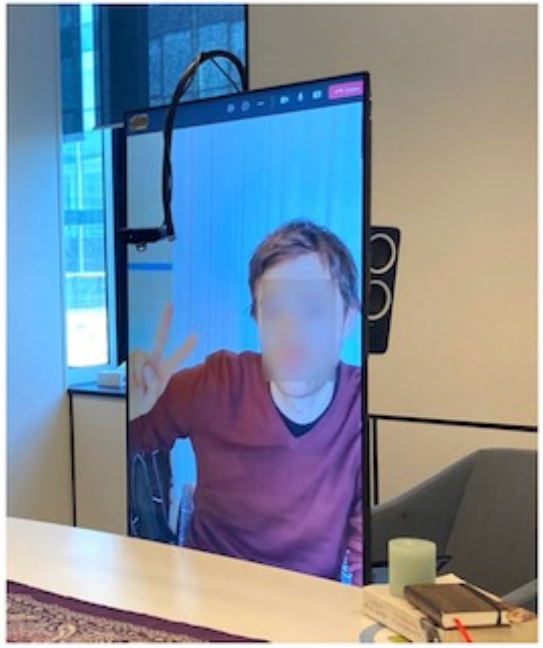
Mylene Farias, mylene@txstate.edu

June 2023

Scenario

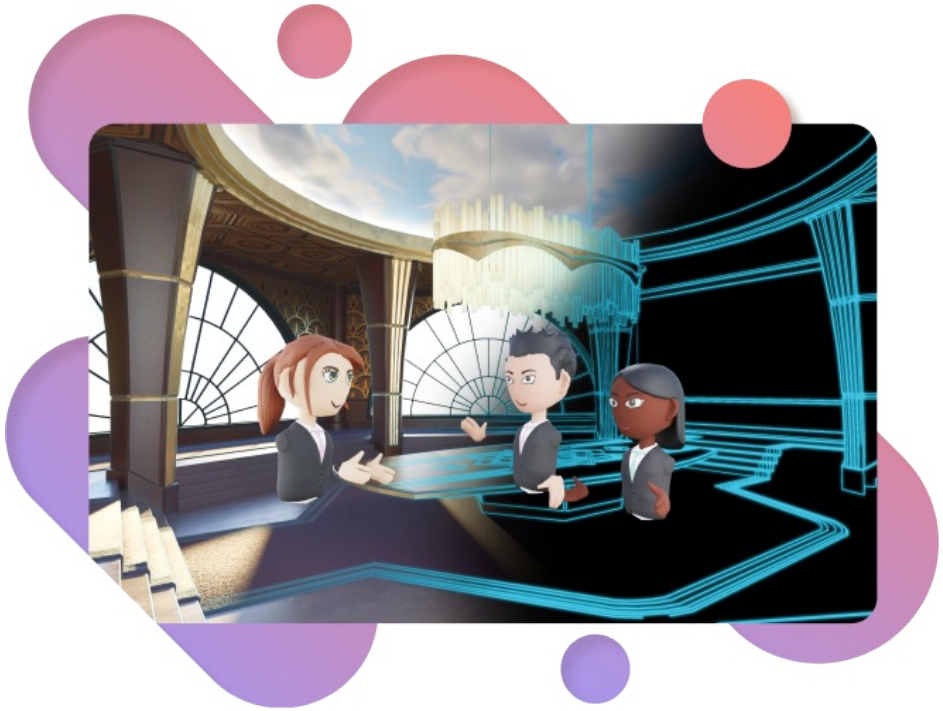

FACE
Audio Conference
Face-to-face Window
AR Host
Social XR
Immersive Telepresence
Distributed Reality
Shared VR
Immersive Digital Twin
Remote Assistance
MEET
VISIT

2 Systems and 2 Tasks



(a) User's view in condition 1, using MS Team

Versus



Mozilla Hubs

2 Systems and 2 Tasks

- Audio-communication task: Survival Task

Task	Feature	Participants	DoF	Performance / success measure	Beyond VR	Confederate	Symmetric
Survival game	Audio	2-10+ 3-6	-	Items_ranked/time Not success	Lots of users	No	Yes

- Visual-communication tasks: Charade

Task	Feature	Participants	DoF	Performance / success measure	Beyond VR	Confederate	Symmetric
Charade	Visual	2-10+	3DoF	words/time	-	No	Yes

Other aspects

- The Experiment will be run as part of a VR/AR graduate class
- Participants will be mostly members of the Texas State University
- 2 systems x 2 tasks = 4 experimental sessions
  - Each session is performed at a different day
- Survival Task
  - Include Video?
  - ACR QoE mesures
  - Questionnaires
- Charade Task
  - Video and audio, 360 for MH
  - Words/time
  - Questionnaires

KEYSIGHT

VQEG IMG CFP

Keysight Technologies & University of Malaga

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Our capabilities

- User devices: PCs (desktop/laptop), smartphones. No XR equipment
- Telemeeting software: Microsoft Teams
  - No equipment for immersive communication as of now
- Monitors: smartphones, PC screens, TVs
- Testbed
  - 4G and 5G cell emulators (UXM)
  - Indoor 5G-SA pico-cells
  - Outdoor 4G micro cells
  - Outdoor 5G-NSA/SA micro-cells (FR1, FR2)
  - Capabilities to introduce both radio impairments (controlling power and resources) and network impairments (delay, jitter, packet loss, packet reordering, throughput limitations, parallel traffic) to control the experiments
  - Keysight software to monitor performance and automate tests

Experiment structure

- Research question: how do radio and network impairments affect telemeetings QoE?
- Different possibilities for System Influencing Factors (SIFs) need to be explored, e.g.:
  - Emulated networks (4G/5G UXMs): full control and repeatability, but the device needs to stay inside an anechoic chambers. Need to study whether mirroring to a target screen is possible and how performance is affected
  - Live deployments (4G, 5G-SA/NSA, 6G-SANDBOX): less control, but simplifies the interaction with the device under test. Black-box tests can be done among different deployments, although a more controlled systematic approach is preferred, if compatible with human panels
- QoE factors: Overall QoE, Video QoE, Audio QoE, A/V sync QoE
- Tasks: see this slide
- Communication system: MS Teams (not immersive)

Tasks we could perform

Using traditional telemeeting applications

- Not all proposed tasks can be performed in a traditional telemeeting system
  - ✓ Audio-communication task: Survival task
  - ✓ Visual-communication tasks: Charade
  - ✓ Visual-communication tasks: Physiotherapy
- Object- and environment-based communications cannot be directly performed in MS Teams
  - The most similar approach would be using a game/virtual world in parallel with MS Teams
  - The performance of the game could be more or less relevant with respect to the performance of the communication
  - Further discussions are needed to understand whether there could be interest from us and from VQEG to perform these tests as well

QOE MODELLING, MEASUREMENT AND PREDICTION IN IMMERSIVE SYSTEMS

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QoE in Immersive Systems

- Next generation immersive content to to be streamed over wirele ss networks and hosted on centralized clouds or edge nodes
- Cloud/edge and wireless performace is highly stochastic
- **Research questions:**
  - *How to measure QoS and additional factors to determine end-uses QoE in immersive systems?*
  - *How to model relevant factors to determine QoE in immersive syste ms?*
  - *How to build objective models to predict QoE in immersive systems?*

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Current Work

- We are working towards XR, current focus is on:
  - VR
  - Haptic-based tasks

- Plan:
  - S**ystematic** control of independent variable and observe effects on QoE.
  - **Body**-and **object**-oriented tasks such as physiotherapy and block-building

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Overview, discussion and next steps

Overview
Tasks vs. Systems

Task	#Labs	Systems				
		Face2Face Window	SocialVR	SocialXR	Immersive Telepresence	2D Baseline
Survival (conversation)	UPM,NOK, AGH, TUI, TSU, KUM	FVV	TUI-SocialVR. Mozilla Hubs	VR2Gather	Owl	Teams (3)
Movement (body-centered)	UPM, CWI, TSU, KUM, LUT	FVV	Mozilla Hubs	VR2Gather		Teams (2)
Block building (object-centered)	UR3, UCL, LUT	FVV?	UR3, UCL	VR2Gather?		Teams?
Escape Room (environment-oriented)	NOK, PAD		PAD		Owl	

Overview

Tasks vs. QoE Cosntituents and measures

Task	#Labs	QoE Constituents				
		Subjective performance + MOS	**Task performance**	**Fatigue, sickness, etc.**	**Presence, etc.**	**Behaviour**
Survival (conversation)	UPM, NOK, AGH, TUI, TSU, KUM	Visual Quality (ACR), audio quality (ACR), overall QoE (ACR), broader questionnaires	Completion time, activity time, turn taking, etc.	SSQ, VRSQ, Vertigo, NASA-TLX	Social presence, plausability	Movements
Movement (body-centered)	UPM, CWI, TSU, KUM	Visual Quality (ACR), audio quality (ACR), overall QoE (ACR)			QoI, Presence/immersion	Movements
Block building (object-centered)	UR3, UCL		Completion time, activity time, turn taking, etc.		Embodiement, presence, interactivity, enjoyment, talkativeness, leadership, trust, confidence…	Hands position and rotation, movements
Escape Room (environment-oriented)	NOK, PAD	Visual Quality (SSDQE), audio quality (SSDQE), overall QoE (ACR)			Presence/immersion, emotions, connectedness	Movements

Next steps

- Consolidate task definitions and alignment of tasks among labs.
- Alignment among labs on the tasks and measures.
- Agree on:
  - Experiment report (as Table 2 in the draft of P.910)
  - Results format
- Define outcomes:
  - Do the tasks work to validate the methodology?
  - How can we evaluate/measure the tasks?

Next steps

- Schedule:
  - Audio call to align tasks, measures, etc.: July 2023
  - Audio call to coordinate the start of the tests: September 2023
  - Intermediate audio calls to check status: September-December
  - Presentation of results: VQEG meeting in Dec. 2023

IMG Test plan on Immersive communication systems

2023-06 – Sony Interactive Entertainment (San Mateo, US)

Jesús Gutiérrez (Universidad Politécnica de Madrid, Spain)
Pablo Pérez (Nokia, Spain)

EoI for participatiom

Confirmed Labs
Nokia XR Lab
CWI
UPM
AGH
UniPd
UniRM3
TXState
TU Ilmenau
Surrey
UCL
Keysight & Univ. Málaga

Other labs
UGhent
Ericsson
RISE
Wuhan
U. Nantes
TUS
INSA Renes
Mid Sweden University
TNO