# 6G-XR Impact Day

## Advancing Immersive Connectivity for the 6G Era

28 October 2025 | Madrid, Spain

Co-funded by the European Union

6G SNS

# Opening statement by the South node hosting partners

**Aurora Ramos**

*Capgemini Engineering*

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# Agenda (updated version)

| Time | Session title |
|---|---|
| **9:00 - 9:30** | Welcome coffee and networking |
| **9:30 - 9:40** | Opening statement by the South node hosting partners<br>**Aurora Ramos** *Capgemini Engineering* |
| **9:40 - 10:00** | 6G-XR Impact Statement: Project Overview and the Road Ahead<br>**Jussi Haapola** *University of Oulu/6G-XR Project Coordinator* |
| **10:00 - 11:15** | *Panel discussion "**Immersive 5G/6G Connectivity Across Vertical Industries**"*<br><br>Moderator: **Aurora Ramos** Capgemini Engineering<br><br>**Francisco Javier Martinez Borreguero** *Telefónica Tech/UC3M*<br>**Diego Mallada** *Gestamp*<br>**Dirk Trossen** *Datacom Industry Association*<br>**Luis Manuel Díaz de Téran** *Capgemini Engineering*<br>**Jesús Luque Muriel** *MediaPro* |

# Agenda (updated version)

| Time | Session title |
|---|---|
| **11:15 -12:15** | Demo Session – PART 1 |
| **12:15 - 12:30** \| Coffee break & demo group session switch | |
| **12:30 - 13:30** | Demo Session – PART 2 |
| **13:30 - 14:30** \| Networking Lunch | |
| **14:30 - 15:45** | *Workshop "**Standards and Policy Frameworks – Future-proofing Immersive 6G Connectivity**"*<br><br>Moderator: **Chathura Sarathchandra** *InterDigital*<br><br>**Ana García Robles** *Big Data Value Association*<br>**Jordi Joan Gimenez** *5G-MAG* |
| **15:45 - 16:00** | Closing remarks |

# Netiquette | FOR THE ONES PARTICIPATING ONLINE

**Mute your microphone**

**Turn off your camera**

**Raise your hand**

# What is to 5Tonic?

## Open Lab for co-creation and innovation in 5G and 6G technologies

# 5Tonic Members and Collaborators

## Members

Driving all lab activities and contribute to their sustainability

**Telefónica**

**IMDEA Networks**

**Ericsson**

**University Carlos III Madrid**

**Capgemini Engineering**

**InterDigital**

## Collaborators

Non-exhaustive list...

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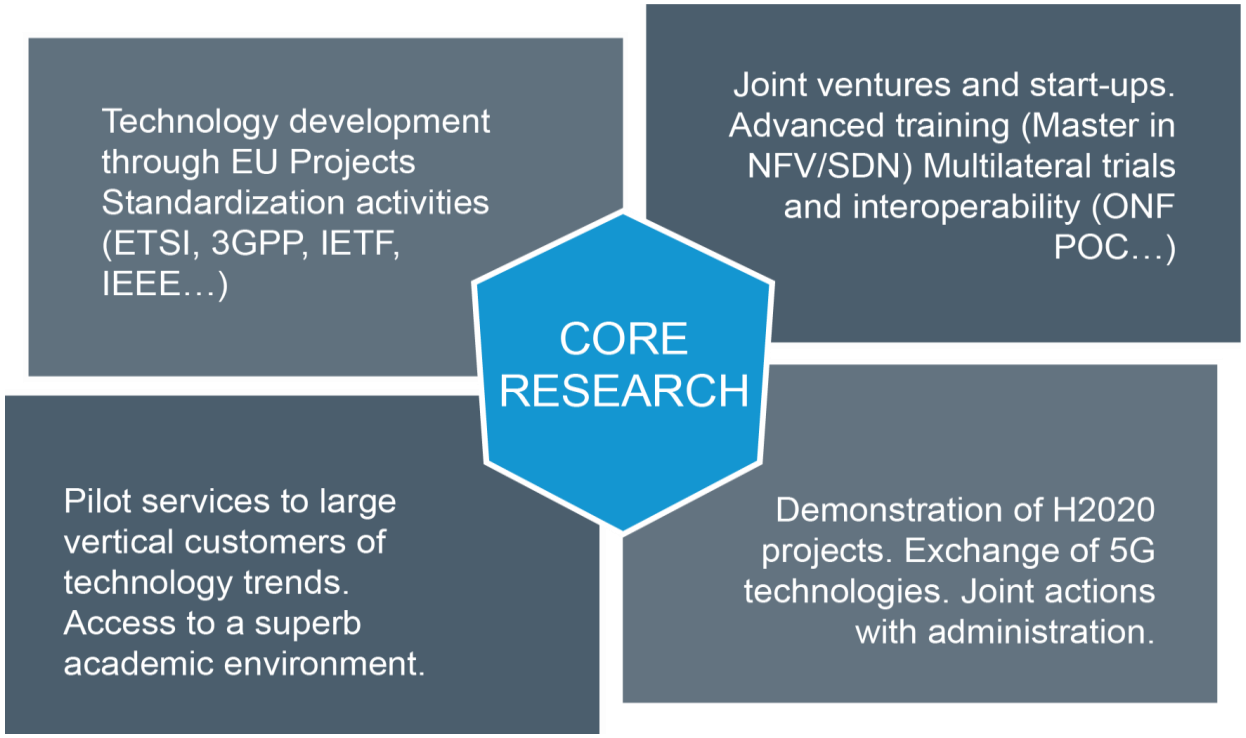
# 5Tonic Objectives




- 5G/6G technology components validation
- 5G/6G use cases evaluation
- Technical activity related with R&D+i Projects
- Pilot services to verticals

# 5Tonic approach for Vertical Industry cases

- To involve final users in the applications and services development that make use of 5G/6G technologies to ensure to provide a real value for them.
- To ensure that implementation is based, whenever possible in comercial/precommercial equipment
- To involve different partners in the use cases implementation
- To emulate realistic operational conditions.
- To find synergies with other activities in 5Tonic such as the participation in R&i European Projects.

# Research projects involving 5Tonic

5G PPP
The 5G Infrastructure Public Private Partnership

6G SNS

UNICO I+D

5GXCrosshaul
5GEX
5G NORMA
5GDIVE
5GTRANSFORMER
5G coral
5GROWTH
AI@EDGE
5G-VINNI
5Genesis
5G EVE
5G INDUCE
Hexa-X

DESIRE6G
HEXA-X-II
PREDICT-6G
6G-XR
TRIALSNET
MULTIX
SUSTAIN 6G

- 6G-DATADRIVEN
- 6G-EDGEDT
- 6G-INTEGRATION
- 6G-openversoNET
- 6G Blur
- 6G Dawn
- Adv6GTwins
- ...

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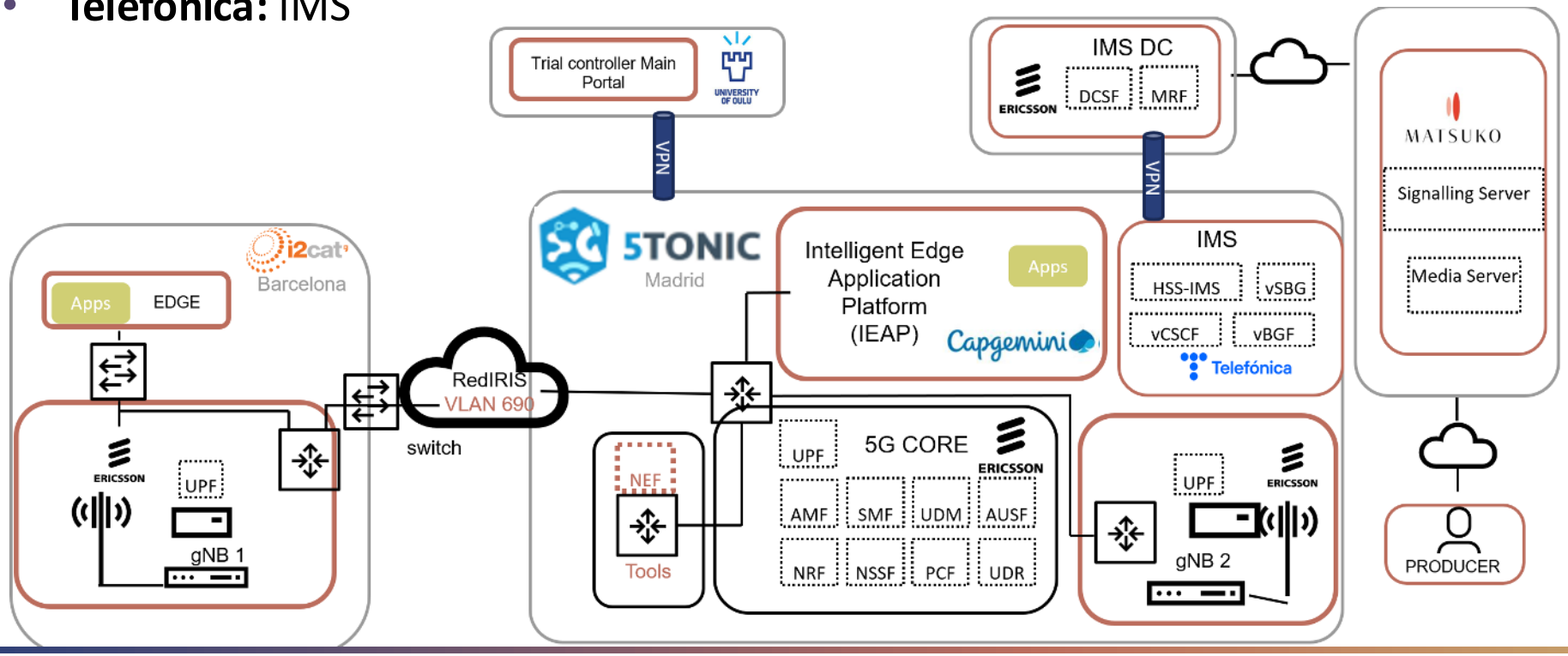
# 5Tonic role in 6G-XR

- **Ericsson:** Network enablers 5G Core (+NEF and Network Exposure APIs)
- **Capgemini:** Compute enablers - IEAP + edge infrastructure + Edge-Cloud API CAMARA compliance
- **Telefonica:** IMS




- 5 Open Call Projects
- 3 end-end holographic services use cases

# 5Tonic will be NEXTONIC!



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# 6G-XR Impact Statement: Project Overview and the Road Ahead

**Jussi Haapola**

*University of Oulu*

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# 6G-XR Impact Statement: Project Overview and the Road Ahead

**Jussi Haapola**

*University of Oulu*

**6G-XR Impact Day**

*Madrid, November 28th, 2025*

Co-funded by the European Union

6GSNS

www.6g-xr.eu

# 6G-XR Project Overview

**Full name:** 6G eXperimental Research infrastructure to enable next-generation XR services

**Stream:** Horizon Europe – SNS JU Phase 1 Stream C – SNS Experimental Infrastructures

**Objective:** Strengthen European leadership in 6G technologies by enabling **next-generation XR services and infrastructures** that will provide beyond-state-of-the-art capabilities **towards the 6G era.**

**15** *partners*

**8** *countries*

**36** *months*

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Contents

- 6G-XR in a nutshell
- 6G-XR goal
- Use Cases and FSTP
- Key Achievements
- 6G-XR Demos

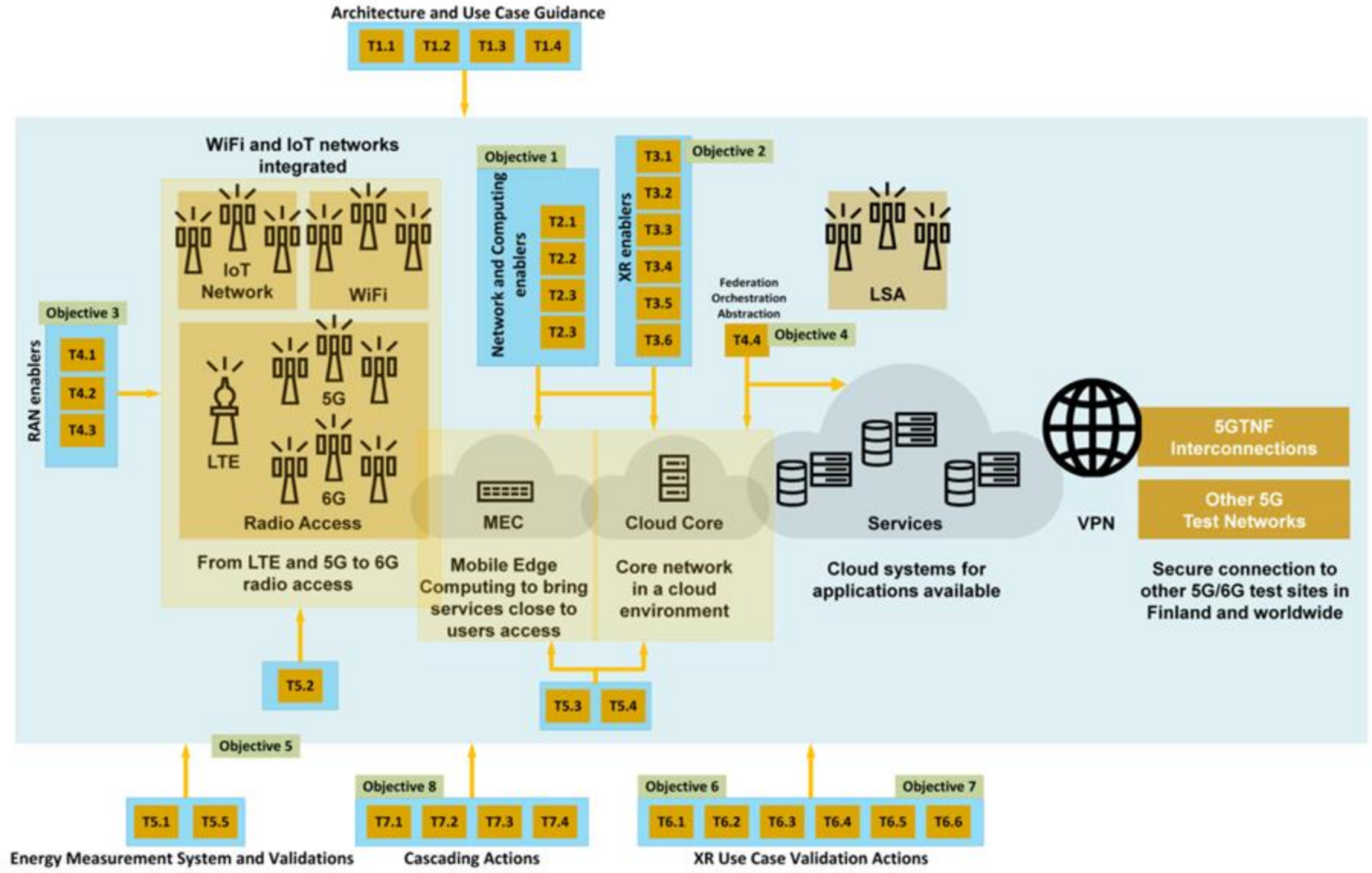
## Project Key Objectives:

- **Build a multisite Research Infrastructure (RI)** that can provide validation platform for multitude of foreseen (extreme) 6G use cases by developing enablers for networking and computing, radio access technologies beyond 5G, enablers for XR services with in-build federation, trial management, abstraction tools as well as energy measurement framework.

- **Validate multi access edge computing scenarios** and their integration into a complete cloud continuum, support innovative use cases with vertical actors, beyond 5G capabilities, and support showcasing events.

- **Demonstrates and validates performance of innovative 6G applications** with a focus on demanding immersive applications such as holographics, digital twins, and XR/VR.

# Methodology



# Use Cases – Objective 6: Develop and deploy holographic validation environments

## South Node


## Real-time Holographic Communications


**UC1:** Resolution Adaptation or Quality on Demand

- Detect cell congestions and adapt XR resolutions or XR traffic priority

**UC2:** Routing to the Best Edge

- Select and make use of the most appropriate Edge based on specific goals

**UC3:** Control Plane Optimizations

- Integrate holographic communications to the network control plane

**Expectation:** Real-time holographic communications bring the promise to become a dominant social interaction and communication medium in the years to come.

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## – Objective 5: Develop and deploy E2E energy measurement capability and energy conservation technologies

### North Node


### Digital Twins

**UC4:** Collaborative 3D Digital Twin-like Environment

- Enable real-time collaboration and control of physical assets in virtual reality

### Energy Consumption

**UC5:** Energy Measurement Framework for Energy Sustainability

- Measure and optimise end-to-end energy consumption in mobile networks

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# 6G-XR Open Calls - General overview

6G-XR provides a wide set of innovative, modular and disruptive network, cloud continuum and XR enablers deployed or deployable over reference and consolidated (toward) 6G research experimentation infrastructures.

- **Third Parties** have been invited through Open Calls to develop, test, and trial applications and functions specifically driven by AR/VR/XR realms and metaverse.
- **30 projects** were selected in three waves.
- Third party projects duration: 6 months.
- Total budget: **1.800.000 EUR**, ~ 60,000 EUR per project.
- Mentorship and guidance to third parties by consortium partners.

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# 6G-XR Open Calls - General overview

## 3 waves:

- ✓ **6G-XR OC1: 6G-XR Platform and Network Enablers:** targeting development and extension of 4 research infrastructures: i) Networking and Computing enablers; ii) XR enablers; iii) RAN enablers; iv) Sustainability enablers **(Implementation timeframe February – July 2024)**

- ✓ **6G-XR OC2: Stream B enablers** targeting accepted targeting proposals with thematics supported by SNS JU Stream B. Some topics: system architecture, wireless communication technologies and signal processing, communication infrastructure technologies and devices. (**Implementation timeframe September 2024 – March 2025)**

- ✓ **6G-XR OC3: Vertical Replicability enablers** to allow third-party agents to leverage 6G-XR's enablers, infrastructure facilities and testbeds to deploy, replicate and validate the verticals of their interest. (**Implementation timeframe April - October 2025)**

# Funded cascading actions

**OPEN CALL 1: Platform and Network Enablers**

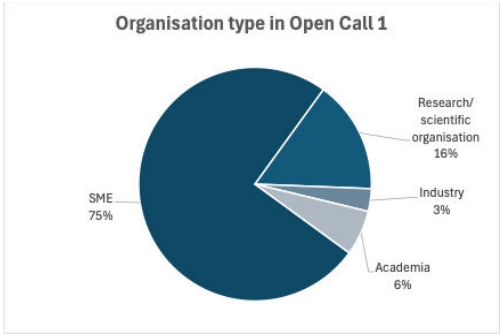
- **6G-SLICE** Allbesmart LDA
- **BANQ** Kaitotek
- **ExCalibAR** Karlsruhe University of Applied Sciences (HKA)
- **FALADIN** Finwe
- **METAPHOR** Brainstorm Multimedia
- **MST** Quanta & Qualia
- **OpenCAMARA** Neutroon Technologies
- **REQUIEM** TKI - Támogatott Kutatócsoportok Irodája

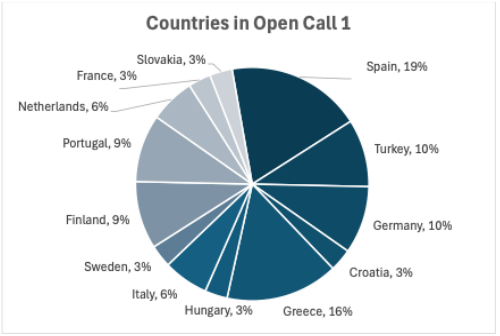
**OPEN CALL 2: Stream B Enablers**

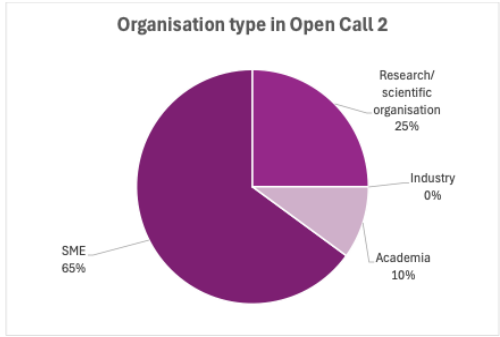
- **5G-slAIce** Gradiant
- **6G REMIX** Fraunhofer FOKUS
- **DYNAMICON** E-Lighthouse Network Solutions
- **EMSEOS** IKERLAN
- **StreamAnalyzer For5GSlicing** Lamda Networks
- **AI4EE** Nissatech
- **ENORMOUS** Universidad de Málaga
- **OPTICALRAN** Peta Optik
- **TrustNet** WINGS ICT Solutions
- **xDRL-RCS** iThermAI

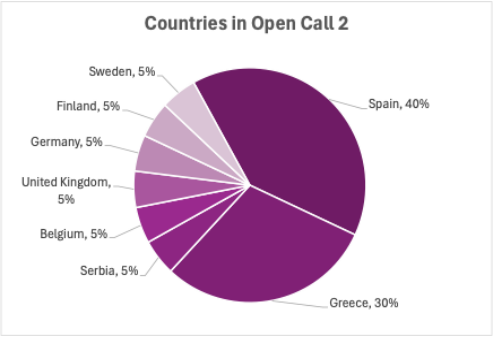
**OPEN CALL 3: Vertical Replicability Enablers**

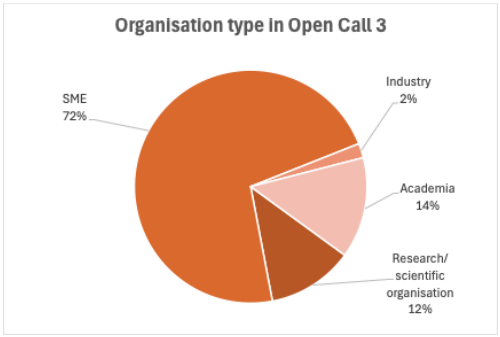
- **LCEVC-6G-XR** Fluendo S.A.
- **EMASS** GRIDNET
- **EVIT** Parity Platform P.C.
- **IMMVIEX** Universidad Politécnica de Madrid
- **6G4proQ** Nissahub
- **FSXR** Luxembourg Institute of Science and Technology
- **AViD-NMP** AUEB-RC
- **MechEye** INESC TEC
- **SafeDriveXR** AviSense.ai
- **LEARN-6G** Universidad Politécnica de Madrid
- **RACE-6G** Buontech Solutions srl
- **DREAMS** Future Connections España Soluciones de Conectividad SL

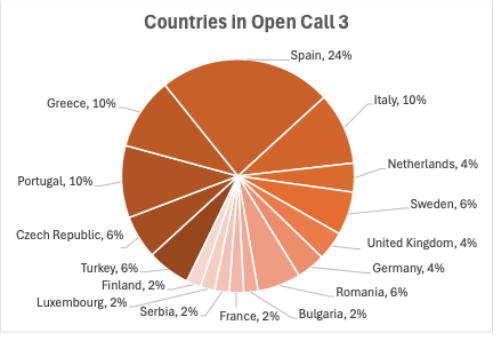



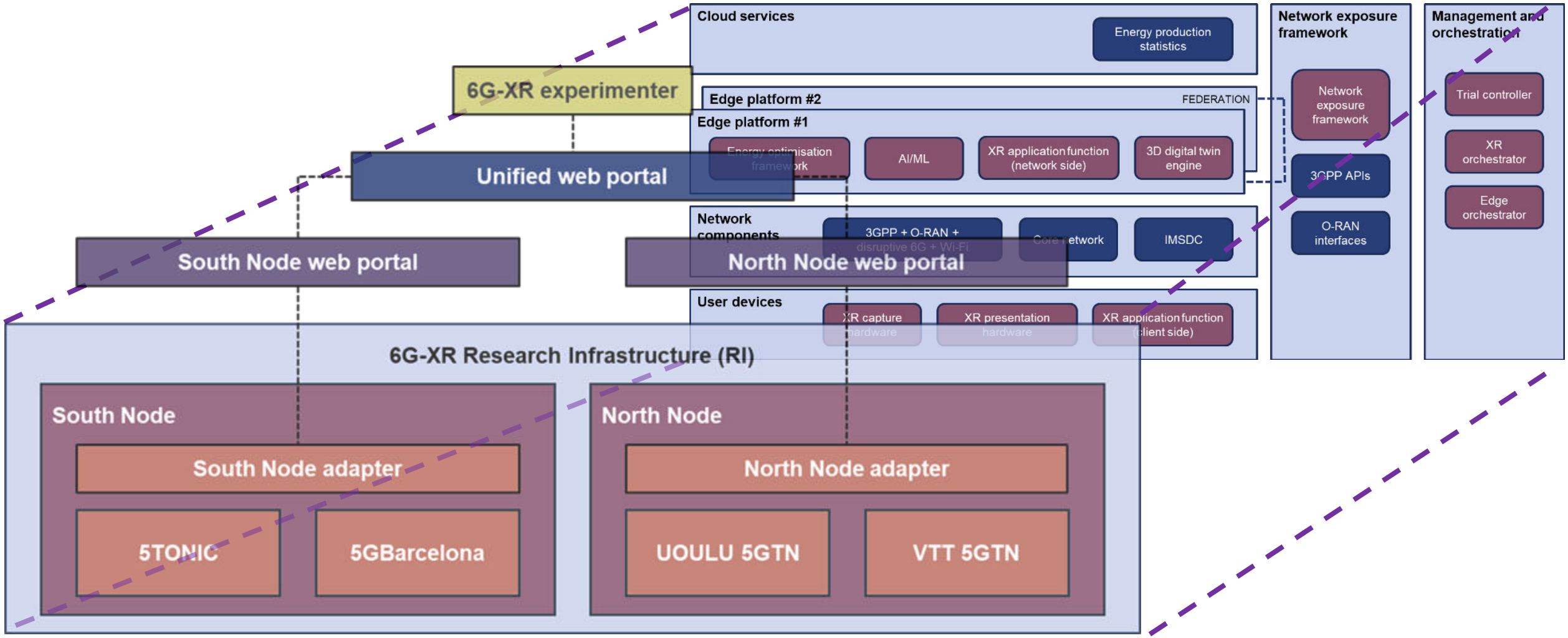



# Key achievements - Trials

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# **Key achievements -** Two different pipelines for holographic communications integrated into 6G-XR testbed

The 6G-XR project successfully developed and integrated two distinct real-time holographic communication pipelines in the project test facilities:

- **Augmented Reality (AR) via IP Multimedia System (IMS):** The AR content, specifically 3D holograms, are delivered over the IMS data channel. Thanks to the integration of IMS with the 5G network, the hologram is received directly on a smartphone native dialer, without requiring third-party applications.

- **Virtual Reality (VR) through Over-The-Top (OTT) approach:** The VR content, including VR scene and 3D holograms, is processed using an Over-The-Top (OTT) media service approach. To improve scalability and accessibility, edge nodes are employed to instantiate several multimedia processing functions, e.g., Session manager and Remote Renderer.

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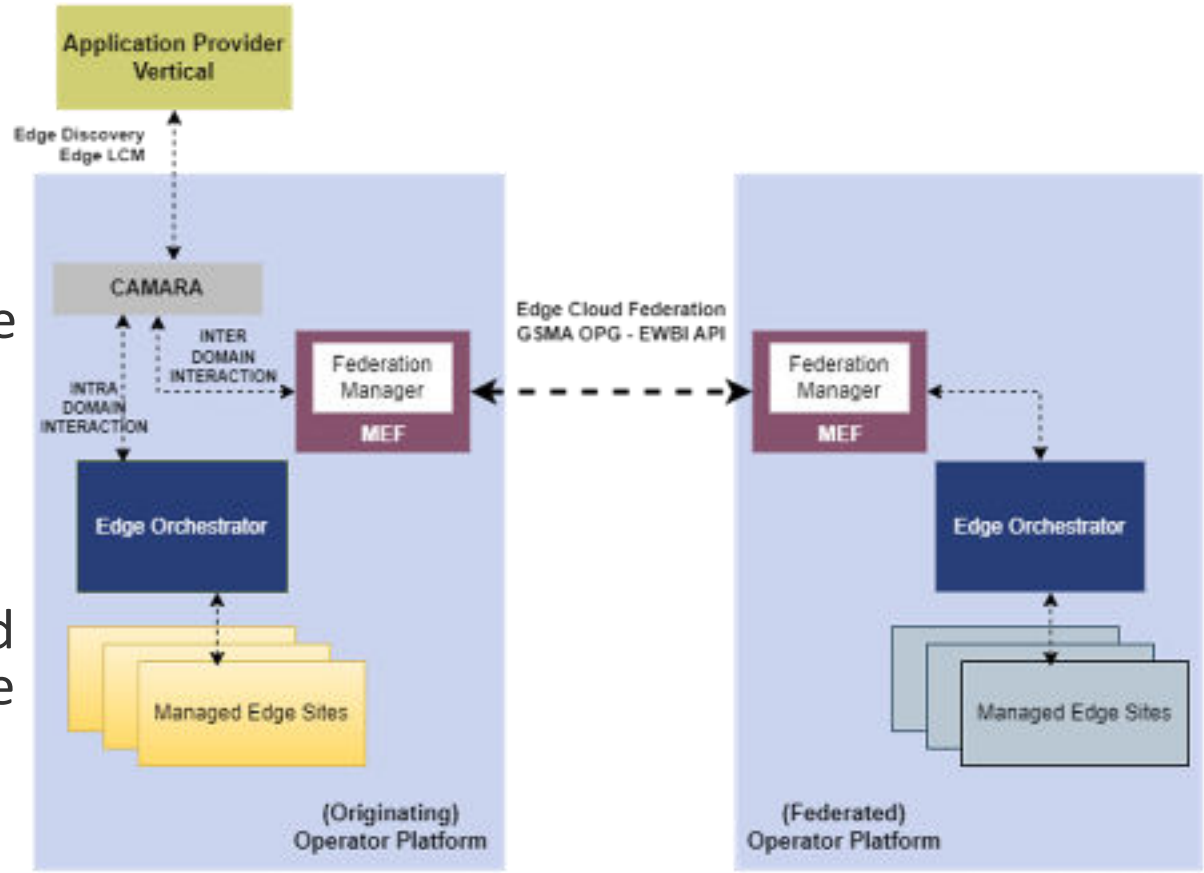
# Key achievements – Multidomain federation + NBI API

6G-XR has successfully federated the two testbeds located in Madrid and Barcelona respectively.

- it has been done based on GSMA Operator Platform specification but overcoming its current limitations.
- This has result on integrated testbed that can be offered to 3rd party experimentaters that can perform multidomain deployments or either choose one testbed or the other.
- Besides, at the NorthBound interface, CAMARA API have been implemented, such as Edge-cloud API, which enablers to offer automatically to the vertical/application the closest edge in a given time, among the overall edge infrastructure, considering both Madrid and Barcelona, optimizing the service performance.

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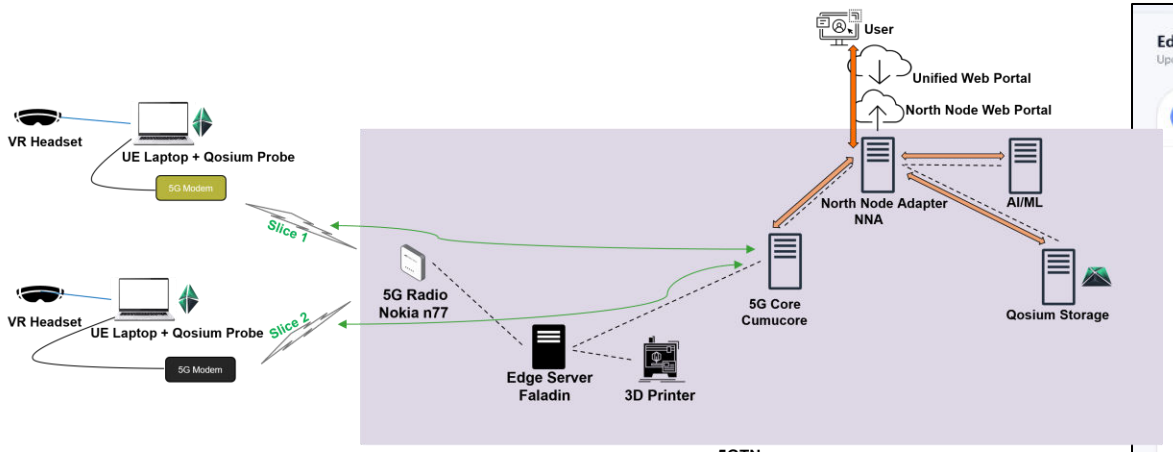
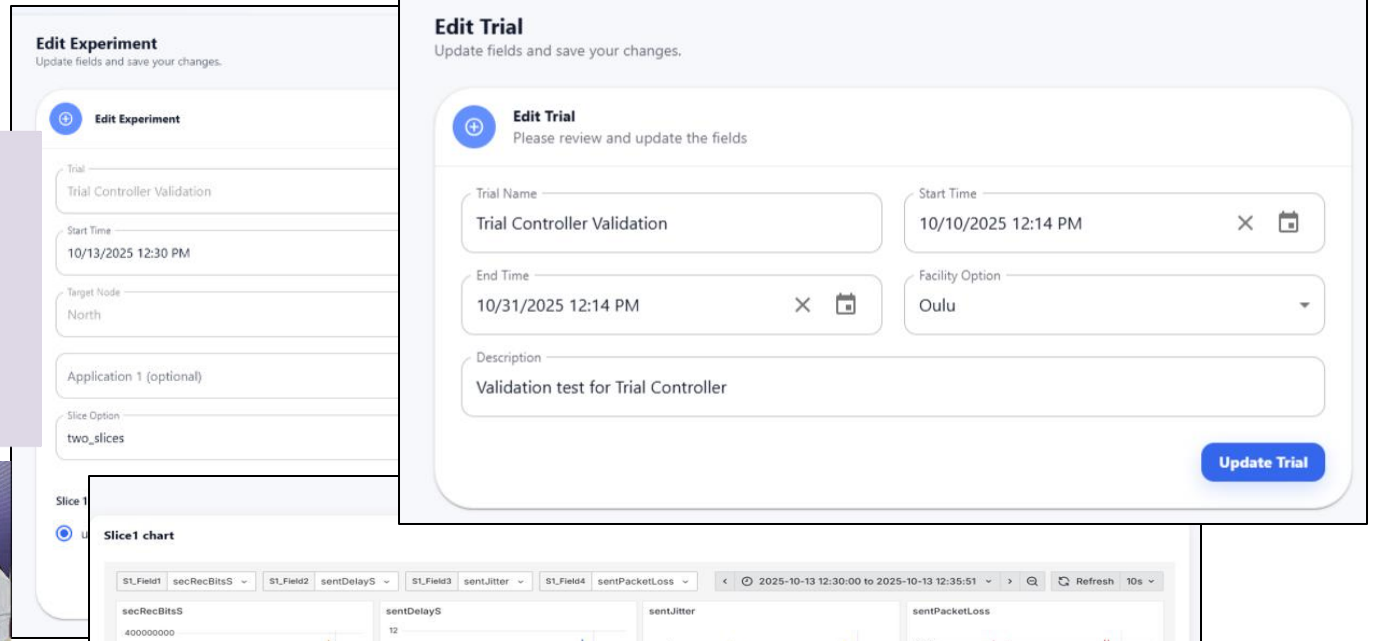
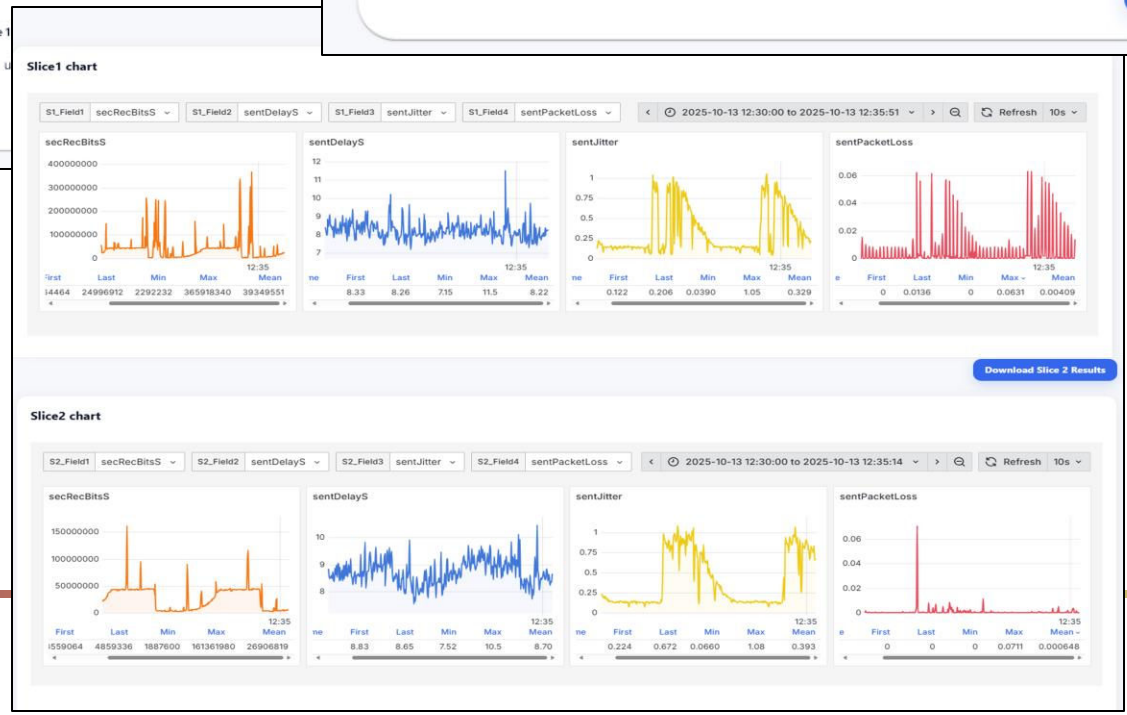
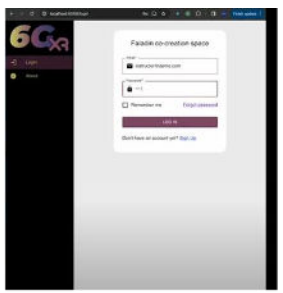
# Key Achievements – Collaborative 3D digital twin end-to-end system validation utilizing trial controller

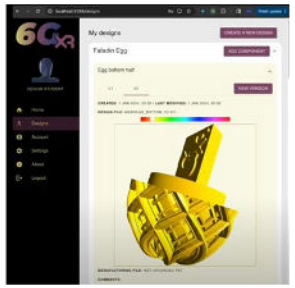


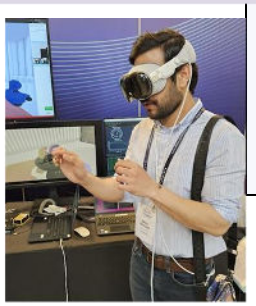



User registration

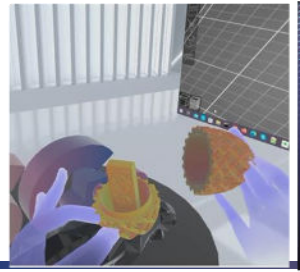


3D object file upload

Spooned Avatar

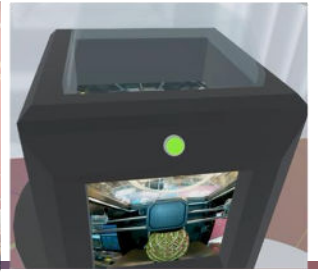


Synchronized with motion



3D review with hand tracking

Remote controlled 3D Printer



Side-view video rendering

Printed physical objects

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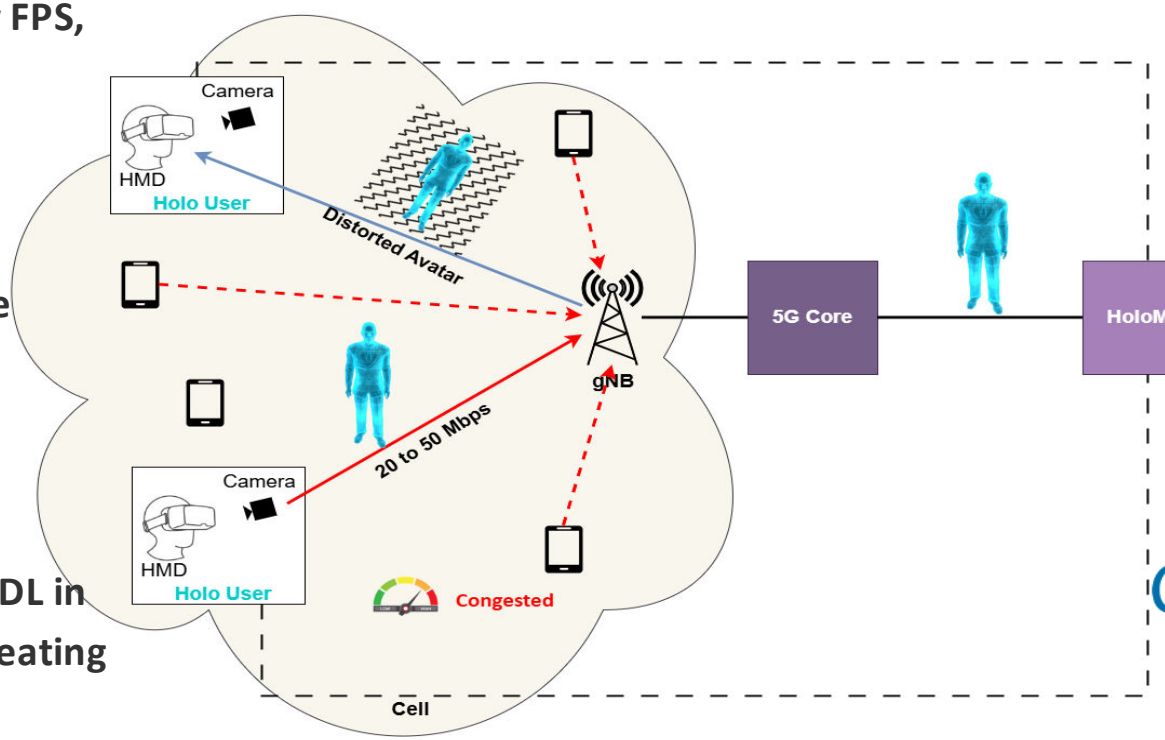
# 6G-XR demos – Today: Demo 1A: Optimizing immersive XR experienc with automated network congestion detection in 6G

## The Problem

**Uplink congestion disrupts immersive holo-XR**, causing **low FPS, stalls, delays, jitter, and reduced video quality** that break presence and immersion.

## Why this happens:

- **Holo-capture demands a high, stable bitrate to preserve motion and geometry.**
- **Real-time point clouds flood the uplink with massive, continuous data streams.**
- **Public 5G network are downlink-biased (More slots for DL in the TDD pattern), leaving limited uplink capacity and creating bottlenecks.**



# 6G-XR demos – Today: Demo 1B: Optimizing immersive XR experiences with automated edge resources allocation in 6G

- ✓ The problem: **interactive media services are very latency-sensitive**, this get worse as end-user is on its move from one location to other.
- ✓ This demo showcases how **dynamic edge resources allocation** contributes to enhance the performance of a **multiuser holoportation services** involving remote rendering.
- ✓ The service makes use automatically of the **optimal Edge node across the compute continuum to comply minimum delay** requirements based on changing end - user mobility.

- ✓ 6G-XR results involved
  - XR enablers: Holo orchestrator, Selection Forwarding Unit, Remote Render
  - Edge computing enablers: Edge orchestration, Edge federation, and Edge-Cloud Discovery API
  - Network enablers: NEF, and Monitoring event (3GPP) API

# 6G-XR demos – Today: Demo 2: Holographic Call via IMS Data Channel - Native Dialer Integration for Real-Time 3D Communication

**Live Cross-Platform Holographic Call: iPhone → Android**

**A glimpse into the future of human communication.**
**Our demo shows how two smartphones — an iPhone and an Android device — connect through mobile networks to share real-time 3D holograms**, powered entirely by the IMS Data Channel.

**What Happens Behind the Scenes**

- **From Call to Connection** – The iPhone user starts a regular call… that instantly becomes a holographic one.
- **Intelligent Network Orchestration** – The IMS system automatically routes the session to the best edge or cloud node for ultra-low latency.
- **Volumetric Magic** – The iPhone captures and reconstructs the caller's 3D image in real time.
- **Hologram Appears on Android** – The Android user answers in their native dialer and sees the live hologram — with voice carried over standard IMS audio.

**Who Benefits**

- **End Users:** lifelike, face-to-face presence anywhere
- **MNOs:** new monetization for 5G & IMS infrastructure
- **Developers:** open APIs for holographic communication apps
- **Enterprises:** next-gen telepresence & remote collaboration
- **Research & Standards Bodies:** advancing cross-platform interoperability

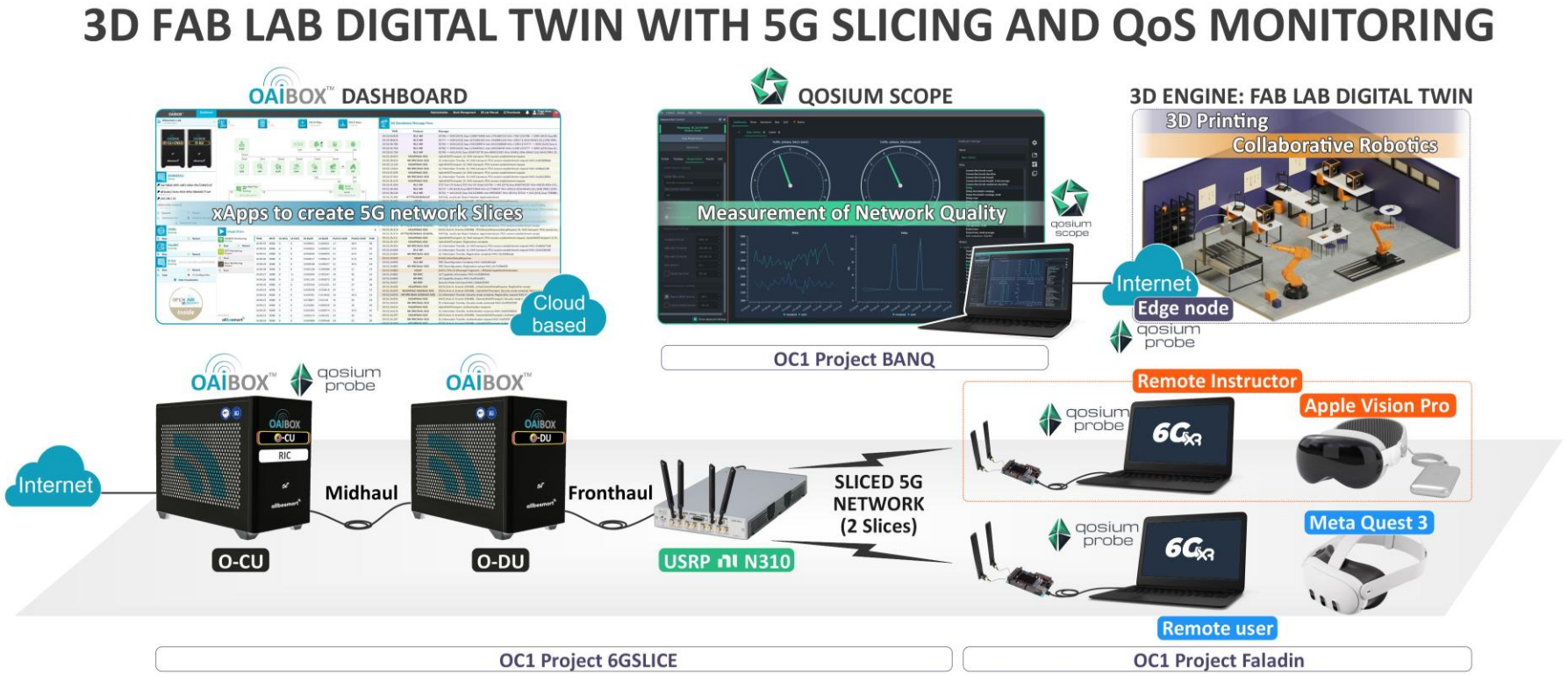
Telefónica

MATSUKO

ERICSSON

**The demo proves:** holographic communication is ready for real networks, real devices, and real users.

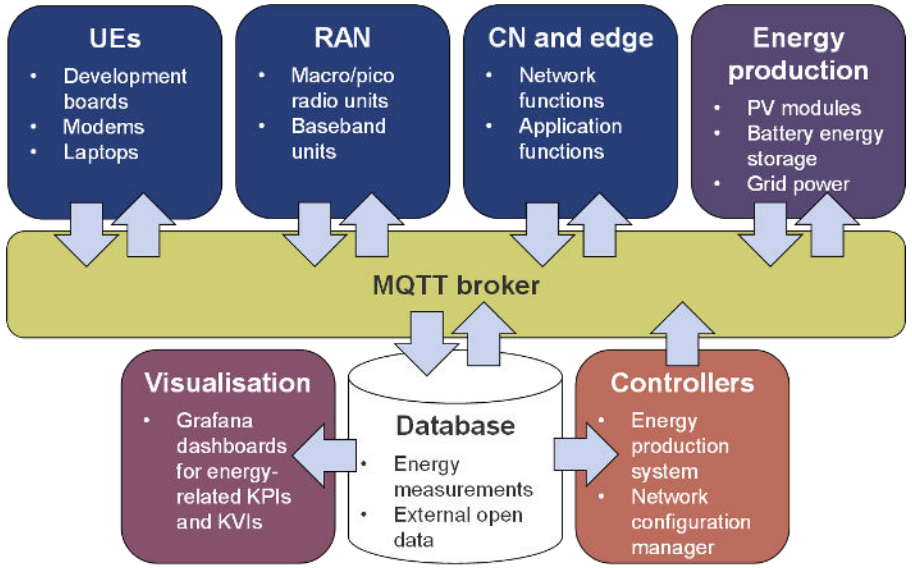
# 6G-XR demos – Today: Demo 3: Co-creative Cyber Studio in a sliced 5G O-RAN network

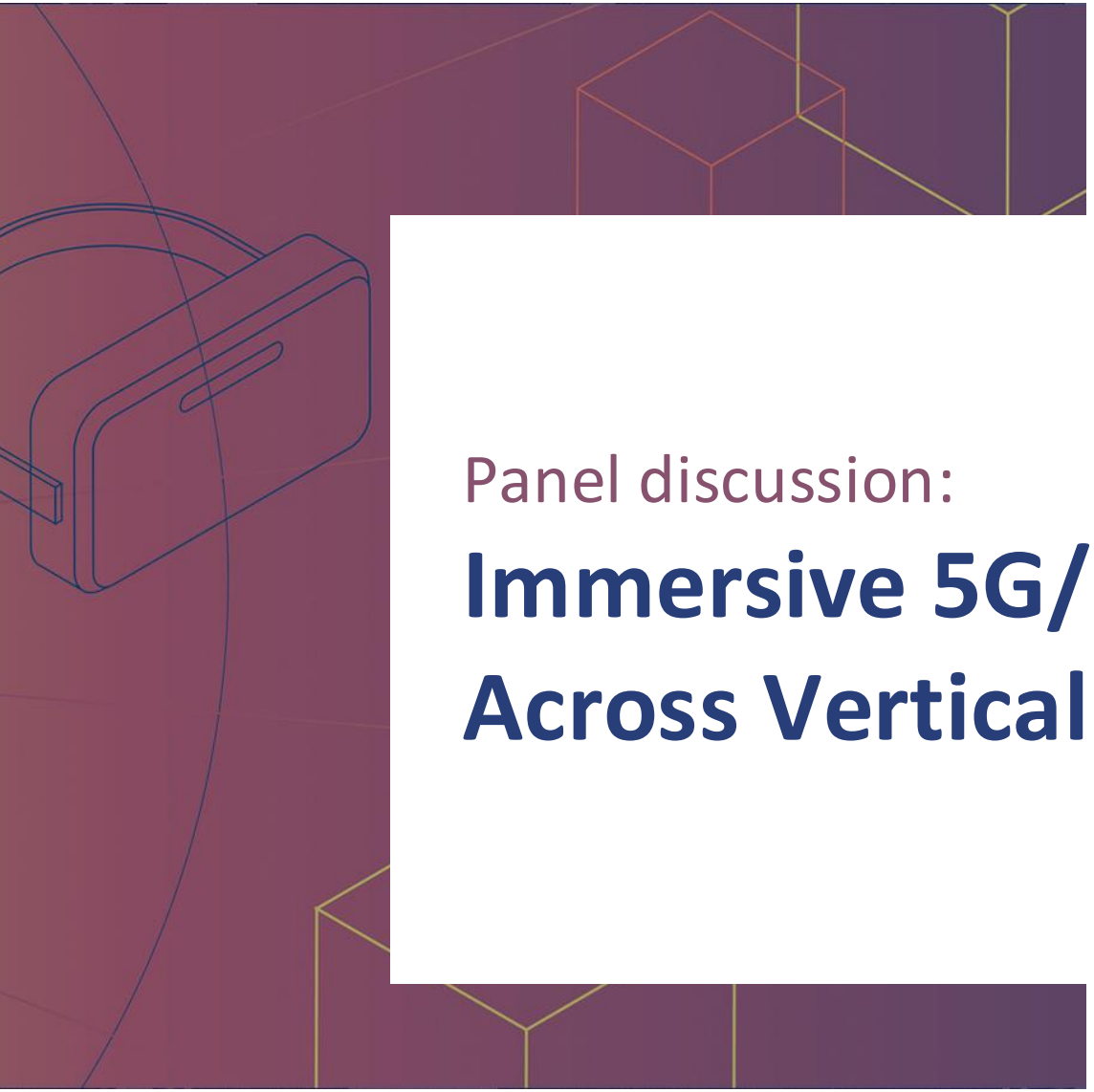



- ✓ 6G-XR results involved:
  - OAI-based sliced 5G SA O-RAN system.
  - Three Open Call 1 projects integrated together.

# 6G-XR demos – Today: Demo 4: E2E application and 5G RAN optimization based on green energy availability

- The demonstration implements functionalities from UC5: Energy Measurement Framework for Energy Sustainability.
  - Objective: Develop and deploy E2E energy measurement capability and energy conservation technologies.
- Technology enablers from 6G-XR WP5: **Energy Self-sustainable Network and Base Station with 3GPP gNB** , developed in collaboration between VTT, University of Oulu and Nokia.





Panel discussion:

# Immersive 5G/6G Connectivity Across Vertical Industries

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# Immersive 5G/6G Connectivity Across Vertical Industries

**Jesús Luque Muriel**

*MediaPro*

**Francisco Javier Martinez Borreguero**

*Telefónica Tech & University Carlos III of Madrid*

**Dirk Trossen**

*Datacom Industry Association*

**Diego Mallada**

*Gestamp*

**Luis Manuel Díaz de Téran**

*Capgemini Engineering*

**Moderator**

**Aurora Ramos**

*Capgemini Engineering*

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# Demo session
# PART 1 (11h15-12h15)

2 groups:

Group Red

Group Green

**Group Red (approx. 30-35 people) splits in 2 smaller groups**

**Demo 1A**: Optimizing immersive XR experiences with automated network congestion detection

**Demo 1B**: Optimizing immersive XR experiences with automated edge resources allocation

25'-30'

Location Room: X3

Room switch halfway

**Demo 2**: Holographic Call via IMS Data Channel - Native Dialer Integration for Real-Time 3D Communication

25'-30'

Location:
Room 1S4 (main building)

**Group Green**

**Demo 3:** Co-creative cyber studio in a sliced 5G O-RAN network
(30')

**Demo 4:** E2E application and 5G RAN optimization based on green energy availability
(30')

Location: Room Turing (ground floor near main building entrance)

Followed by coffee break and group switch

# Coffee break & demo group session switch

# Demo session
# PART 2 (12h30-13h30)

2 groups:

Group Red

Group Green

**Group Green (approx. 30-35 people) splits in 2 smaller groups**

**Demo 1A**: Optimizing immersive XR experiences with automated network congestion detection

**Demo 1B**: Optimizing immersive XR experiences with automated edge resources allocation

25'-30'

Location Room: X3

Room switch halfway

**Demo 2**: Holographic Call via IMS Data Channel - Native Dialer Integration for Real-Time 3D Communication

25'-30'

Location: Room 1S4

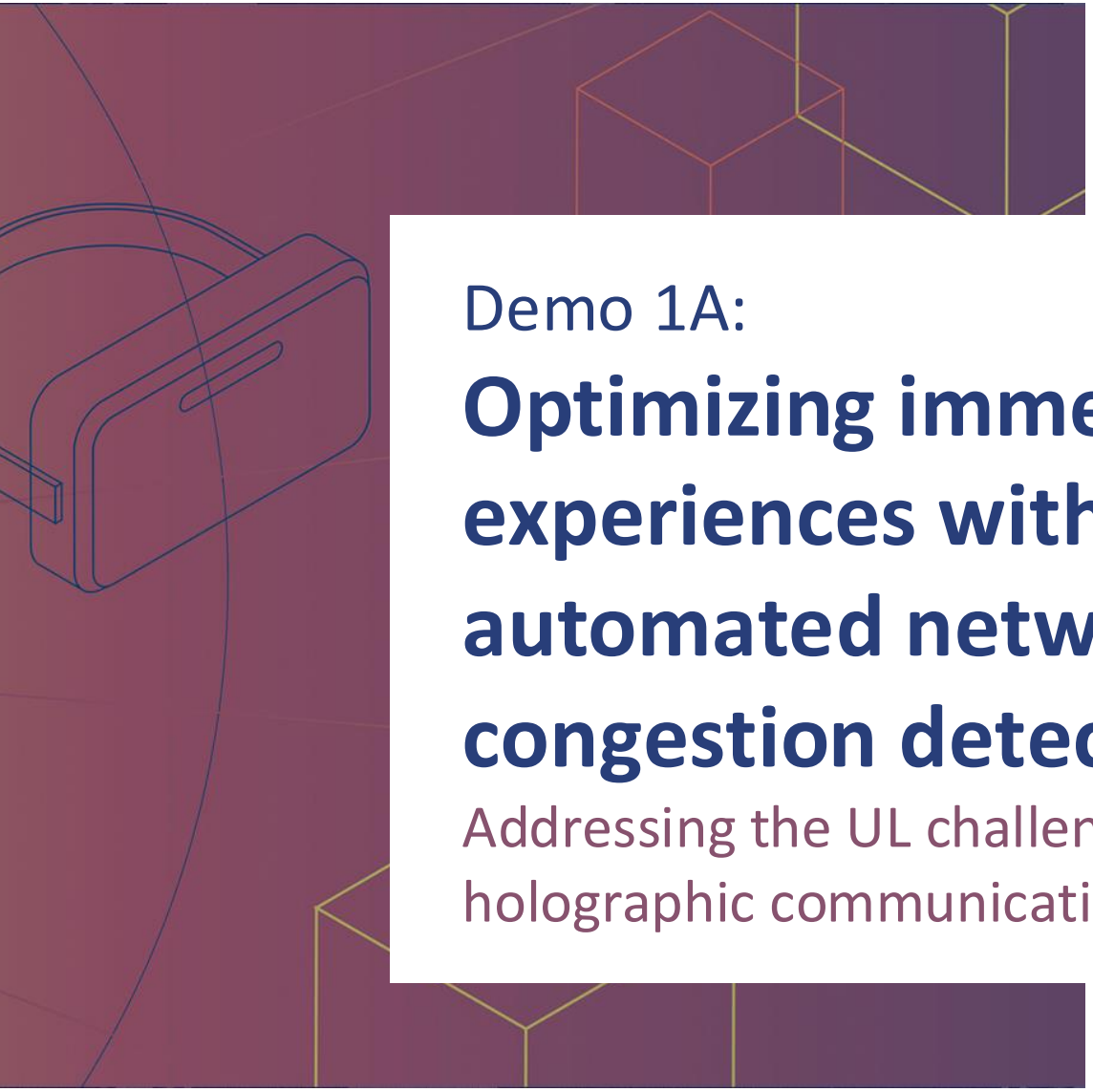
**Group Red (approx. 30-35 people)**

**Demo 3:** Co-creative cyber studio in a sliced 5G O-RAN network (30')

**Demo 4:** E2E application and 5G RAN optimization based on green energy availability (30')

Location: Room Turing (ground floor near main building entrance)

Followed by lunch break (back of auditorium)



Demo 1A:

# Optimizing immersive XR experiences with automated network congestion detection in 6G

## Addressing the UL challenge in holographic communications

- Objective of the demo and UC
- 6G-XR enablers and partners
- Demo setup overview
- Steps of the demo

 | 


# UC1: Optimizing immersive XR experiences with automated network congestion detection in 6G

## *Addressing the UL challenge in holographic communications*

**Amr AbdelNabi**

*I2CAT*

**Impact Day**

*Madrid, 28th October 2025*

Co-funded by the European Union

6GSNS

www.6g-xr.eu

# Problem Statement

## The Problem

**Uplink congestion disrupts immersive holo-XR,**

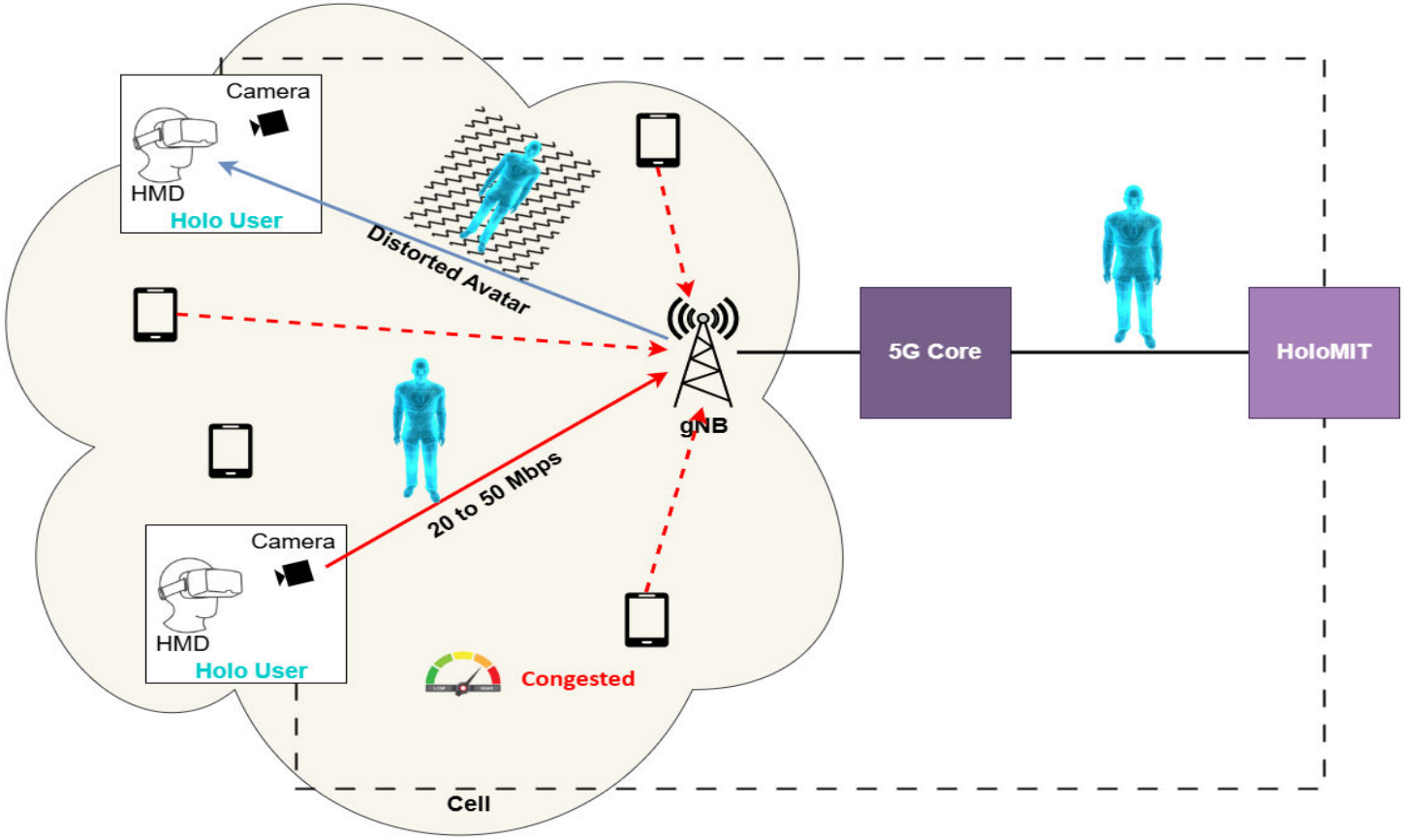
causing **low FPS, stalls, delays,**

**jitter, and reduced video quality**

that break presence and immersion.

## Why this happens:

- **Holo-capture demands a high, stable bitrate to pre**
- **Real-time point clouds flood the uplink with massi**
- **Public 5G network are downlink-biased (More slot**




 | 

# How 6GXR addresses the UL congestion problem

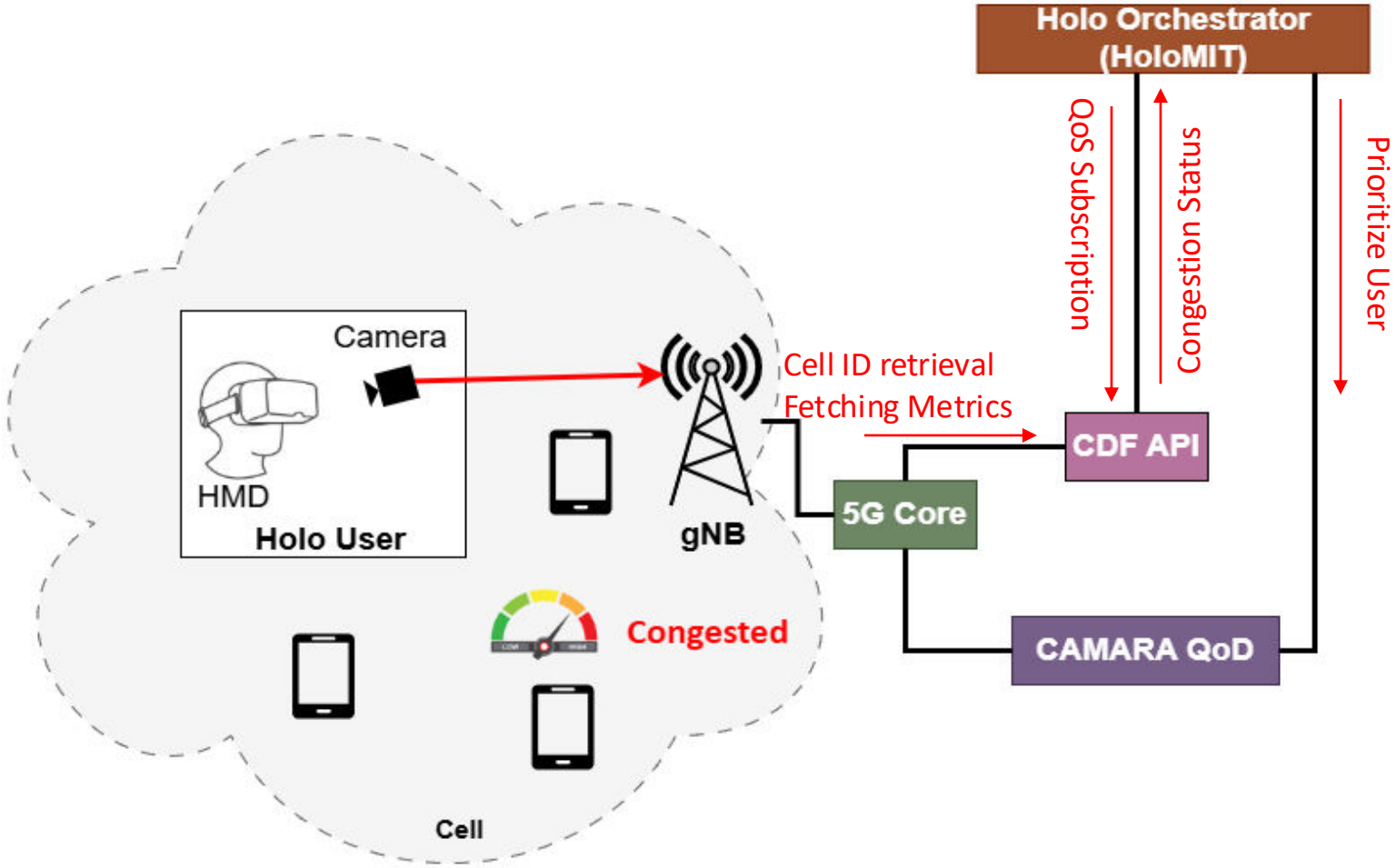
**Congestion Detection Function (CDF)**

- It is an API that monitors the serving cell'
- If PRB utilization goes above 80%, it trigg flag.

**CAMARA QoD**

- The Holo Orchestrator calls the QoD API with the target user ID and desired profile.
- Selecting the "High" profile gives the user's flow higher priority compared to "Low" profile traffic.

"Low"-> "priorityLevel": 10, "5qi": 9,
"High"-> "priorityLevel": 5, "5qi":6.

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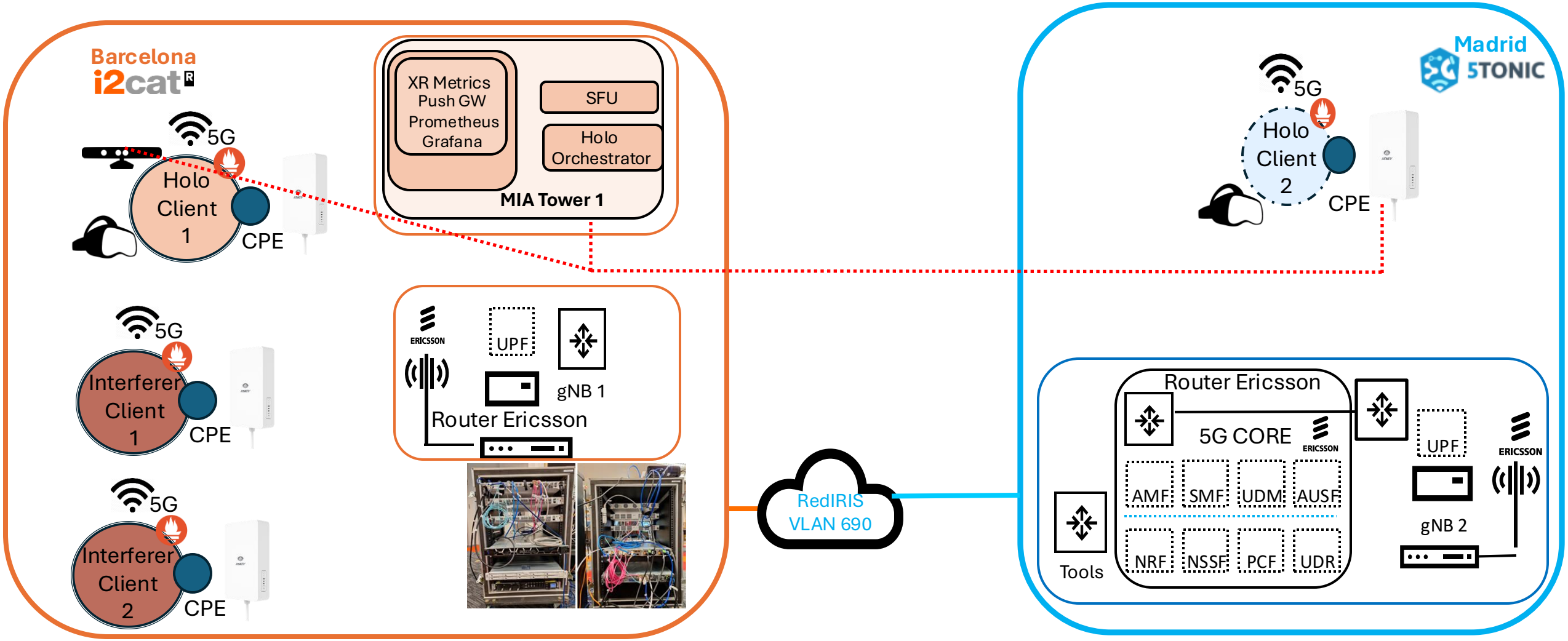
# Demo Setup



# Demo dashboard


- Per User UL Throughput
- Aggregated UL Throughput
- Application FPS
- Application Latency

 | 



(*) Use an image with all the KPIs. We can get it tomorrow

# Discover the Consortium















# 6G-XR

# Thanks

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Co-funded by the European Union

6GSNS

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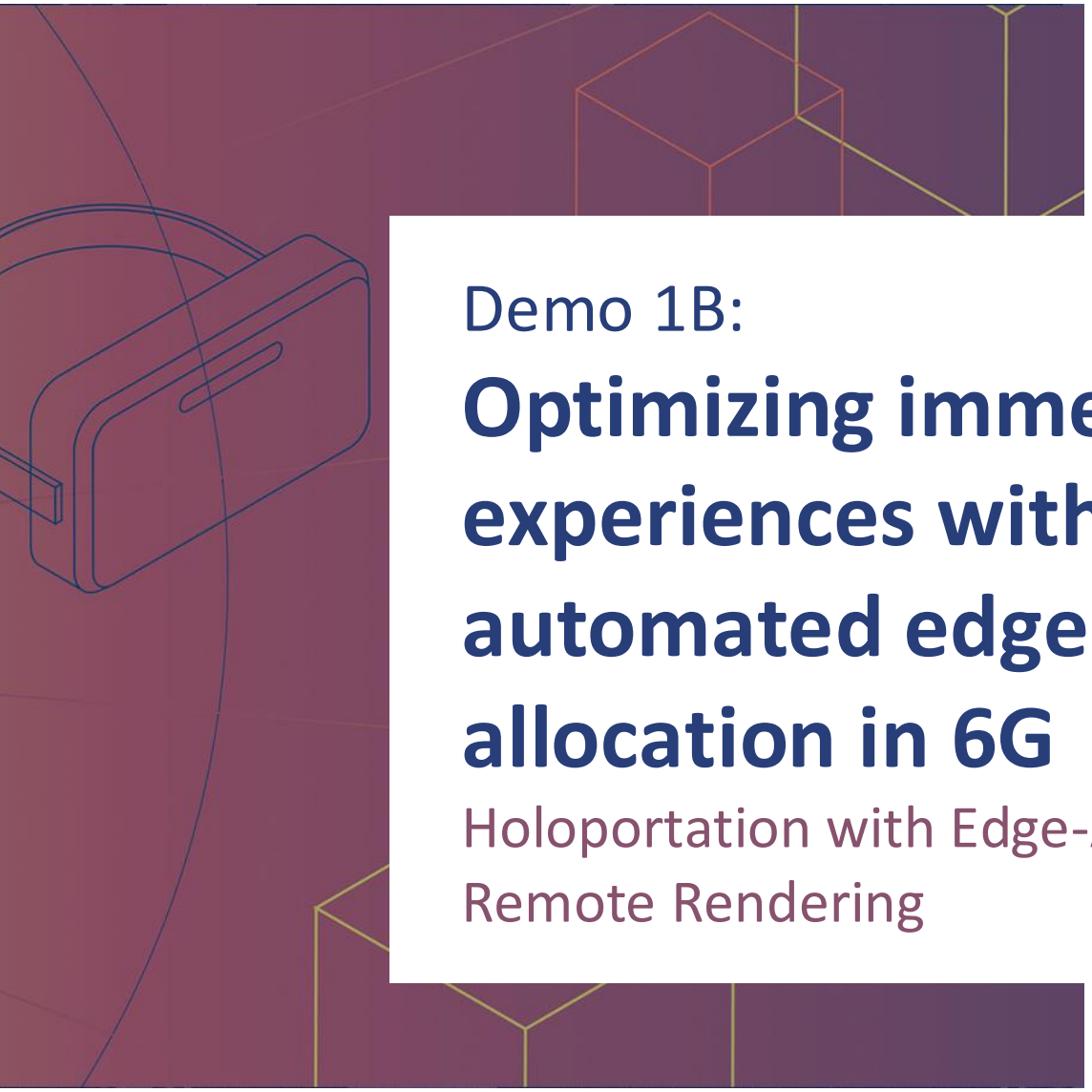


Demo 1B:

# Optimizing immersive XR experiences with automated edge resources allocation in 6G

## Holoportation with Edge-Aware Remote Rendering

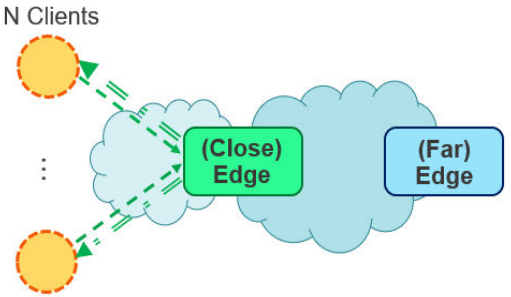
- Objective of the demo and UC
- 6G-XR enablers and partners
- Demo setup overview
- Steps of the demo

 | 

# Demo 1B: Holoportation with Edge-Aware Remote Rendering

- ✓ The problem: **interactive media services are very latency-sensitive**, this gets worse as end-user is on its move from one location to other.

- ✓ This demo showcases how **dynamic edge resources allocation** contributes to enhance the performance of a **multiuser holoportation services** involving **remote rendering** for lightweb clients in terms of delay.
  - The application can use of **different Edge nodes across compute continuum** for XR processing offloading e.g., cloudlet selection within different edge orchestrators in multiple domains as the end user moves.
  - **Optimal Edge allocation** takes place based on specific goal, minimizing delays by selecting the closest Edge to deploy the remote rendering components to route the user plane traffic.




The demo will show two main features:

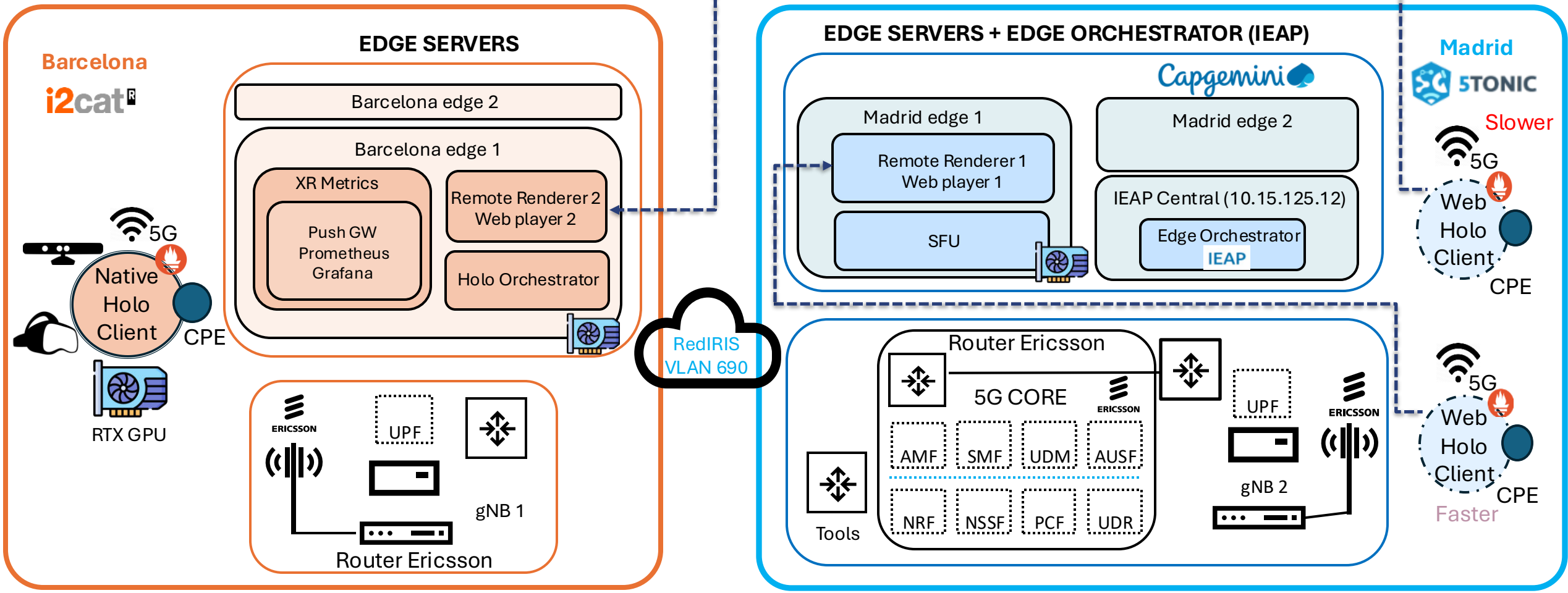
- how the instantiation of **Interactive Remote Rendering functions** on the Edge allows the participation of lightweight client devices in resource-intensive XR services.
- how a **dynamic selection of the optimal Edge** server to manage the multiuser XR communications helps to **mitigate network degradations, like high delays**.

 | 

# 6G-XR enablers and partners involved

- **End-to-end holoportation platform**: holographic capture + SFU (Selection Forwarding Unit) + Holo Orchestration
- **Remote Rendering** Solution
- Edge orchestration solution (***Intelligent Edge Application Platform***) + **Edge-cloud CAMARA** compliance APIs
  - **Edge Discovery** API will enable to dynamically select the optimal edge based on serve clients location in order to maxime the holographic call performance, e.g. minimizing the delay
- **5G Network and network APIs** (3gpp compliance) – NEF
- **Edge federation**:
  - The two edge locations between Barcelona-i2cat and Madrid – 5Tonic/Capgemini have been federated within the project following GSMA Operator Platform specification

# Demo setup – testbeds overview

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# Demo Steps

Edge federation mechanisms are implemented so IEAP Edge Orchestrator in 5Tonic Madrid being able to deploy the remote render over Barcelona edge.

1. A native Holo client (with volumetric video capture, GPU capabilities and XR headset) located in Barcelona requests the Holo Orchestrator to create a new Holographic session
2. A new client located in Madrid requests to join the holographic communication session using a lightweight web client connected to a Remote Renderer deployed in Barcelona (for computation offloading due to reduced client capabilities)
3. A second client located in Madrid also requests to join the holographic communication session using a lightweight web client;  the Holo Orchestrator calls the Edge Discovery API (from IEAP) to get the optimal edge based on the user location.
4. The Holo Orchestrator selects a Remote Renderer deployed in Madrid for the second client due to edge discovery automated recommendation.
5. The quality of the session for the two XR clients located in Madrid are compared showing better results for the one that used the 6G-XR “routing to best edge” capability, based Edge Discovery API.

 | 

Demo 2:

# Holographic Call via IMS Data Channel – Native Dialer Integration for Real-Time 3D Communication.

- Objective of the demo and UC
- 6G-XR enablers and partners
- Demo setup overview
- Steps of the demo

 | 

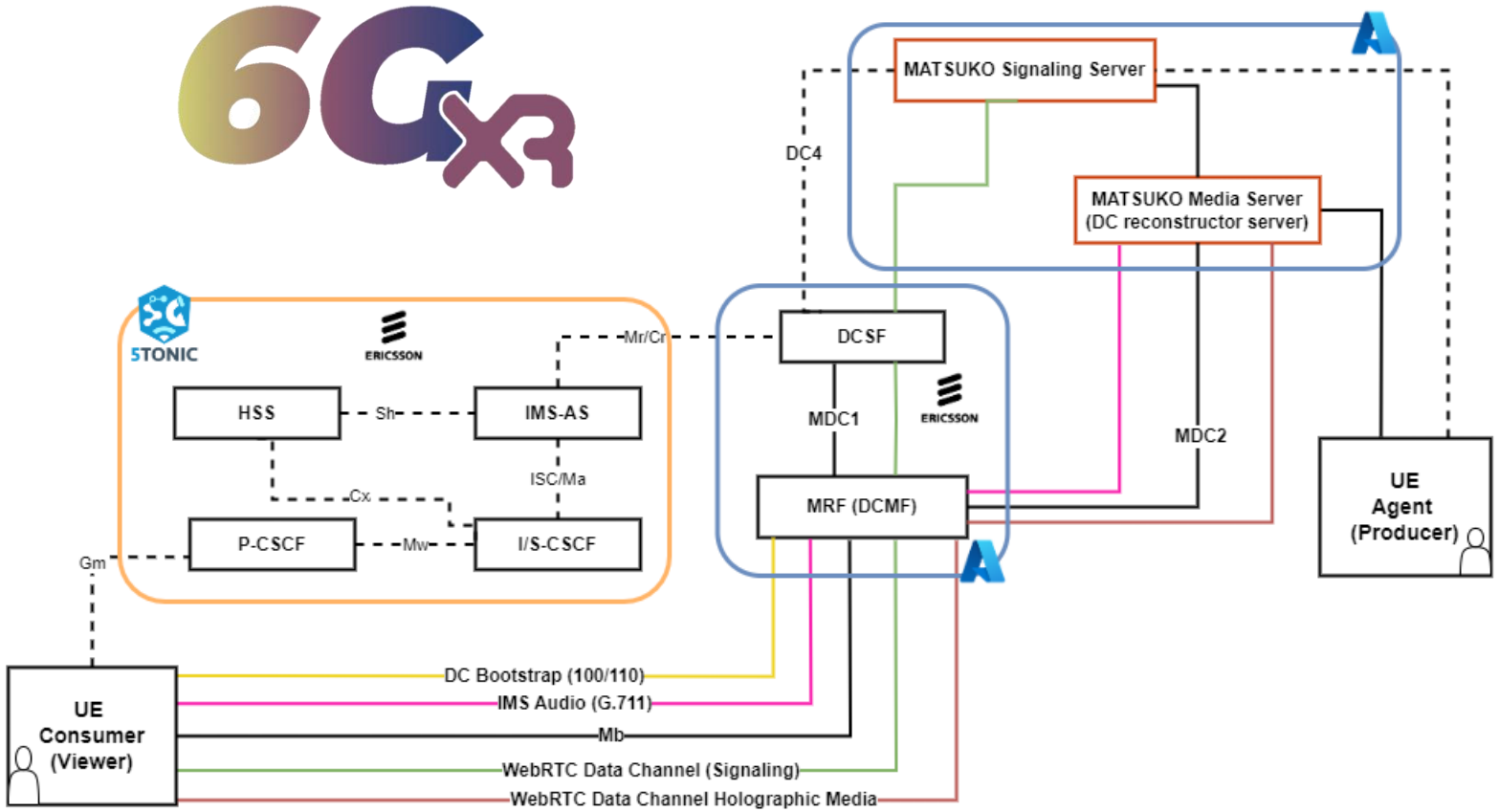
# Demo 2: Holographic Call via IMS Data Channel – Native Dialer Integration for Real-Time 3D Communication.

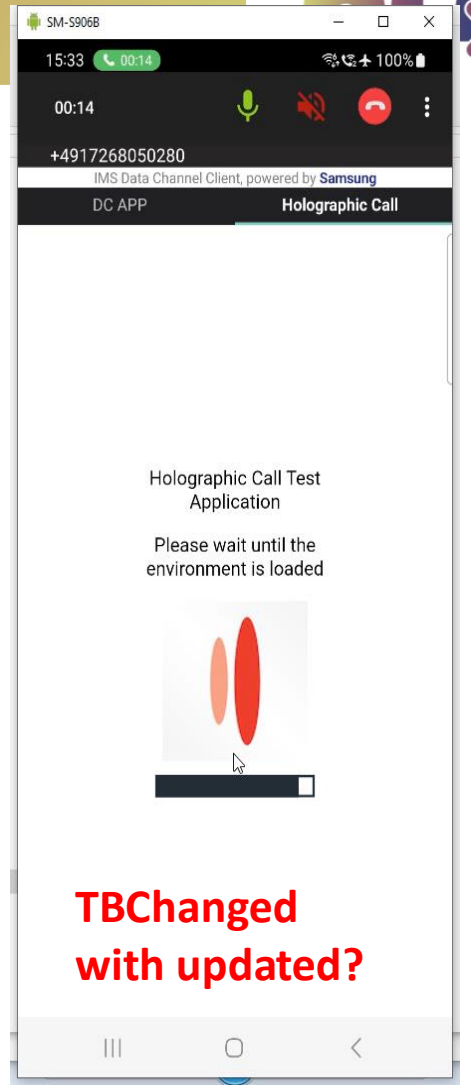
Real-time holographic communications – Key challenges are addressed to successfully deliver real-time multi-party holographic communication services at scale and over heterogeneous environments. 6G-XR will go beyond the state-of-the- art in this field with the goal of increasing the visual resolution of holograms, as well as the performance, scalability, interoperability and efficiency of such services. The envisioned next-generation holographic services will adopt many new features fully compliant with 6G architectural and communication paradigms

**Objectives of the Demo**

- Show real interoperability between iOS and Android platforms using the IMS Data Channel as the transport layer for real-time 3D data.
- Demonstrate native integration of holographic communication within the standard IMS framework, without requiring third-party applications.
- Validate the full end-to-end workflow — from volumetric capture to edge/cloud reconstruction and real-time rendering on the receiving device.
- Prove the coexistence of traditional and advanced media, combining voice over IMS with synchronized 3D data transmission.
- Evaluate system performance and latency under 5G network conditions, leveraging edge computing for real-time responsiveness.

# Reference Architecture & Demo

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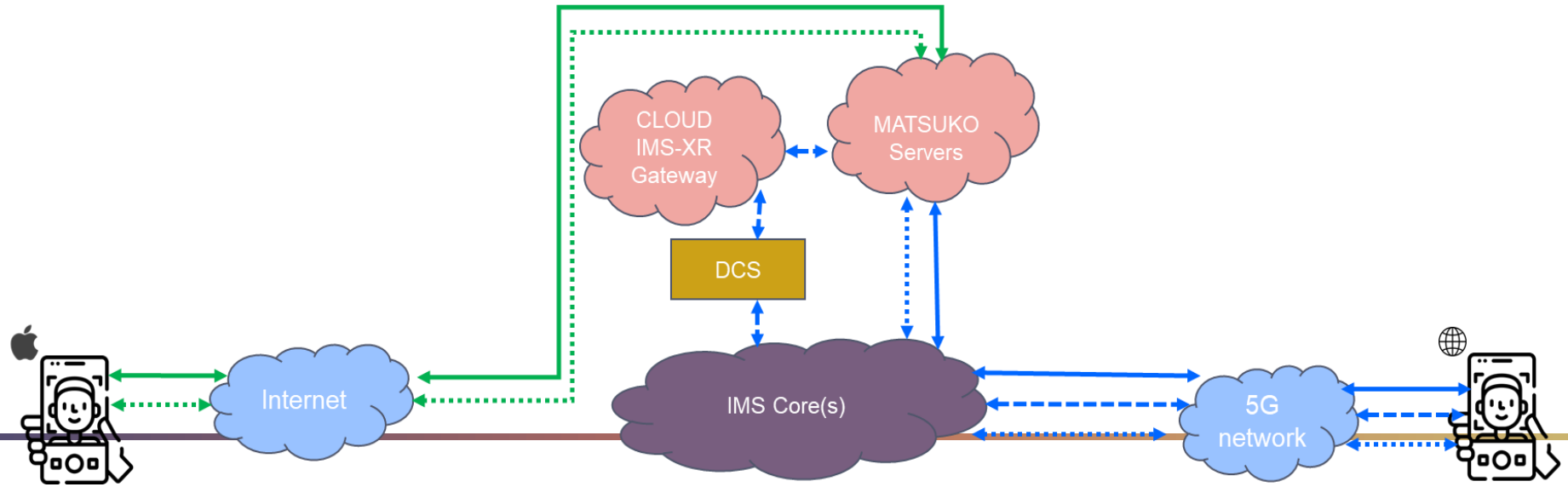
# Demo Steps

The iPhone → Android

- **Call initiation** – The caller uses an iPhone's native dialer to start a holographic call through the IMS Data Channel.
- **Session setup** – The IMS system handles signalling and connects both devices to the optimal cloud/edge reconstruction server.
- **Capture & processing** – The iPhone captures the caller's face and torso; the volumetric data is processed and reconstructed in real time in the edge/cloud.
- **Hologram reception** – The Android smartphone user answers the call in their native dialer and sees the live hologram, while audio is carried over IMS voice.

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Demo 3:

# Co-creative cyber studio in a sliced 5G O-RAN network

- Objective of the demo and UC
- 6G-XR enablers and partners
- Demo setup overview
- Steps of the demo

 | 

# Demo 3: Co-creative cyber studio in a sliced 5G O-RAN network

The demo showcases an AR and VR use case with impact on the real world through digital fabrication.

In the demo remote user wants to print a 3D object using Fab Lab 3D printer. Fab Lab Instructor examines the object and of accepts it for printing in a real 3D printer.

Collaborative 3D digital twin environments builds a mirror world like VR and enhance this environment with remote operation capabilities for robotics and computer mediated collaboration e.g. using private 5G advanced and emerging 6G networks.

A 3D model of the digital fabrication room along with necessary equipment, is created and placed in a DT world using game engine software platform.

Both the instructor and the remote user need to be able to remotely connect to the DT environment and communicate with each other within the virtual world.

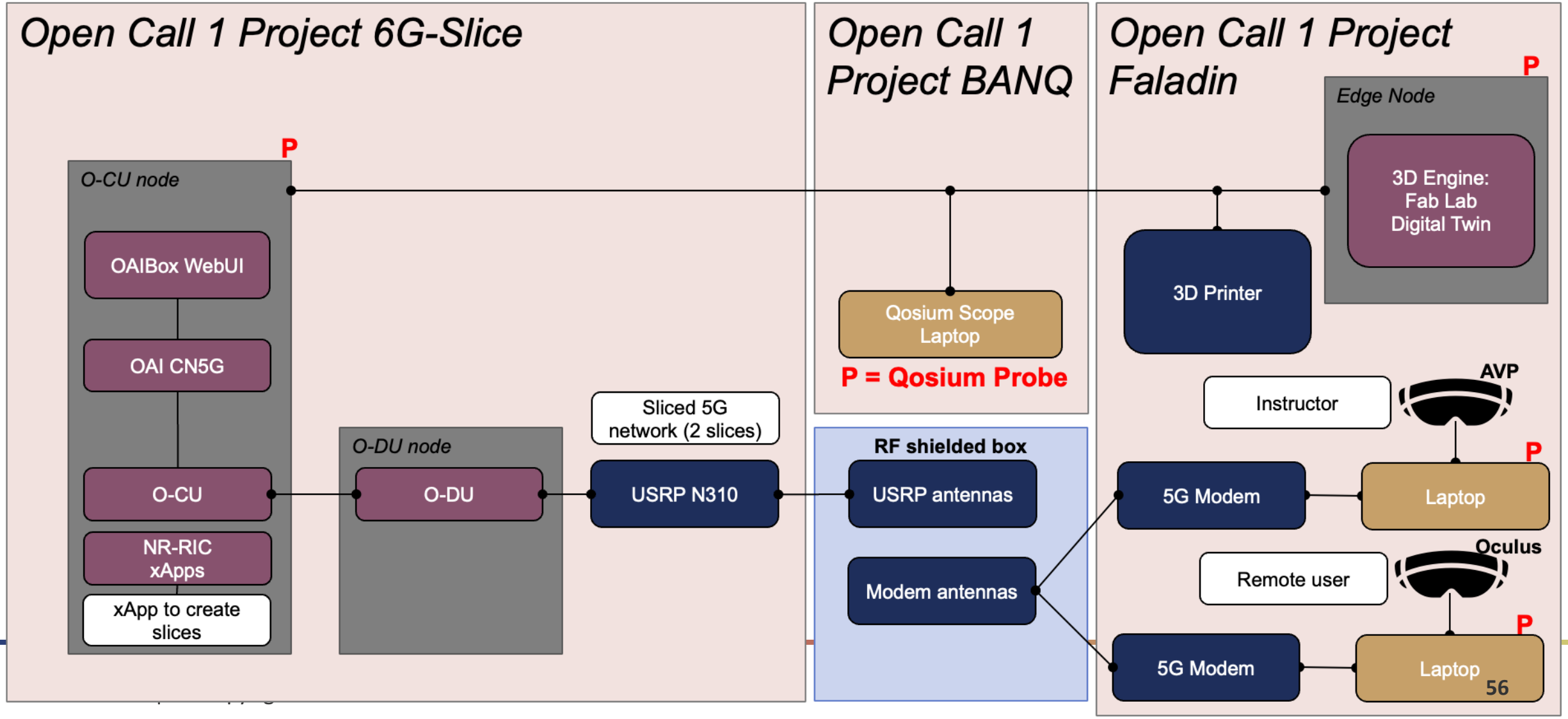
A link between the digital and real worlds must be established to print a 3D object.

5G E2E slicing is utilised in the 3D DT use case as the wireless communication part.

There are two instances that use wireless 5G connection in the demo: Remote Instructor (AR) and Remote User (VR). Remote Instructor and Remote User connect and use different 5G slices of the same test bed.

Wireless communication related requirements, as well as KPIs and KVIs need to be monitored and visualised to understand the use case can be maintained over sliced cellular networ

# Demo 3: Co-creative cyber studio in a sliced 5G O-RAN network



# Demo 3: Co-creative cyber studio in a sliced 5G O-RAN network

Steps of the demo

1. Remote user with 3D object enters the Fab Lab 3D digital twin.
2. Fab Lab instructor joins the 3D digital twin.
3. Remote user presents the 3D object for instructor inspection.
4. User and instructor can jointly edit the object.
5. Instructor approves the final object.
6. Remote inserts the 3D object in the virtual 3D printer and pushes virtual print button.
7. The 3D object printing starts in real world.
8. Real world printing process is streamed in real time to the digital twin using 2 cameras and the user can follow the printing process in digital twin space.

Demo 4:

# E2E application and 5G RAN optimization based on green energy availability

- Objective of the demo and UC
- 6G-XR enablers and partners
- Demo setup overview
- Steps of the demo

 | 

# Demo 4: E2E application and 5G RAN optimization based on green energy availability (1/3)

- The demonstration is built on top of the VTT Oulu test facility uses accurate near real-time network KPI and energy measurement data to dynamically adjust the RAN and video application configurations based on predicted green energy availability.
- Based on the available data, the centralized controller can make decisions to optimize QoS for the video users and use of RAN energy saving features within the limits of energy budget.
- The data collected with the implemented energy measurement framework as well as the related interfaces/APIs for remote connections in the VTT Oulu test facility have also been utilized in two Open Call 2 (AI4EE and ENORMOUS) and two Open Call 3 (DREAMS and EMAS) projects to test and develop AI/ML algorithms for RAN energy consumption optimization and measurement data anomaly detection.

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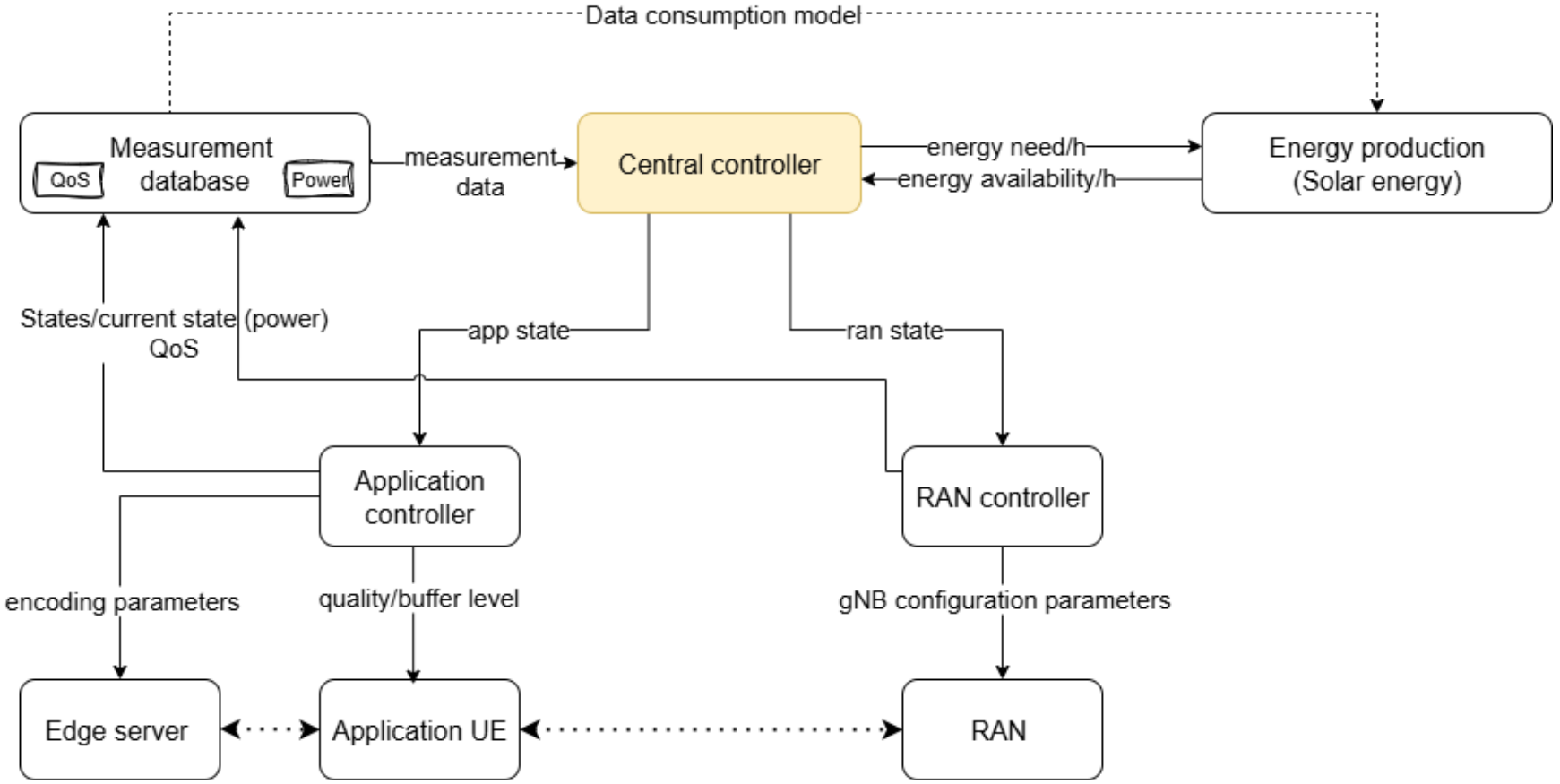
# Demo 4: E2E application and 5G RAN optimization based on green energy availability (2/3)

## Demo setup overview/architecture:

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# Demo 4: E2E application and 5G RAN optimization based on green energy availability (3/3)

**Steps of the demo:**

1. Generate energy budget for the next hour based on the forecasts on solar yield and electricity price as well as the state of charge of the integrated battery system.

2. Decide the RAN state and video resolution for the next hour such that the energy budget is not exceeded.

3. Change the RAN and video states according to the decision.

4. Monitor network energy consumption and KPIs in real-time to identify deviations from the expected behaviour.

5. Adapt the video resolution in case the QoE is not acceptable.

# Networking Lunch

Workshop:

# Standards and Policy Frameworks

 | 

# Standards and Policy Frameworks

**Jordi Joan Gimenez**

*5G-MAG*

**Ana García Robles**

*Big Data Value Association*

**Moderator**

**Chathura Sarathchandra**

*InterDigital*

# Closing remarks

**Jussi Haapola**

*University of Oulu*

 | 

# 6G-XR: From Vision to Realization

## A European Milestone in Extended Reality over 6G Networks

The **6G-XR Project** set out to build an **experimental infrastructure** enabling next-generation XR services through **5G and 6G candidate technologies**.

Over three years, partners from academia and industry **validated immersive communication**, **real-time digital twins**, and **AI-enabled orchestration** across multiple testbeds in Europe.

6G-XR successfully **demonstrated the fusion of advanced networking, edge computing, and XR**, proving that*interactive, high-fidelity experiences* can be delivered with deterministic Quality of Service.

Our work not only advanced scientific understanding but also **laid the foundation for future 6G experimental research** and cross-sector innovation.

## A European Milestone in Extended Reality over 6G Networks

The **European Smart Networks and Services Joint Undertaking (SNS JU)** selected the 6G-XR Key Achievement — "Two different pipelines for holographic communications integrated into the 6G-XR testbed" — among the **Top 10 Key Achievements out of 197 SNS JU projects**.

This recognition celebrates 6G-XR **innovation in holographic communications**, showcasing two end-to-end pipelines:

- **Real-time volumetric capture and rendering**, and
- **Optimized holographic transmission over 5G/6G testbeds, IMS data channel**.

It highlights 6G-XR's contribution to Europe's **vision of human-centric, immersive 6G technologies**. As we conclude the project, our legacy continues through:

- Open-access testbeds and datasets
- Collaboration within the **6G Infrastructure Association (6G-IA)**
- Ongoing innovation toward **Sustainable 6G and beyond**

 | 

*6G-XR has brought holograms to life — and paved the way for Europe's immersive 6G future.*

# 6G-XR

# Thanks

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