



# Introduction to Enabling Metaverse project R&D

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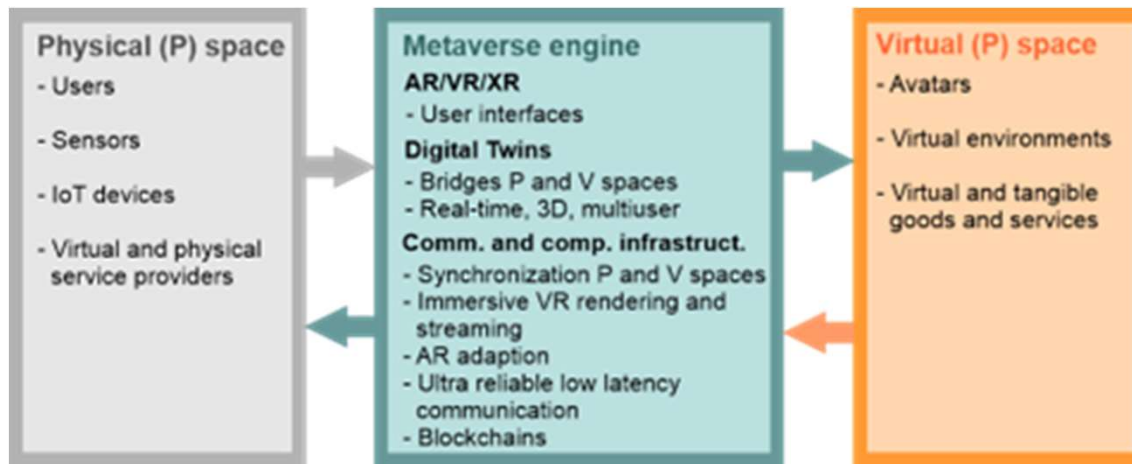
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# Scope



- **Metaverse** integrates seamlessly virtual and physical living spaces by enabling control of physical space resources from virtual space, utilization of virtual space resources from physical space and sharing of the same experiences through virtual and physical participation



# Goals

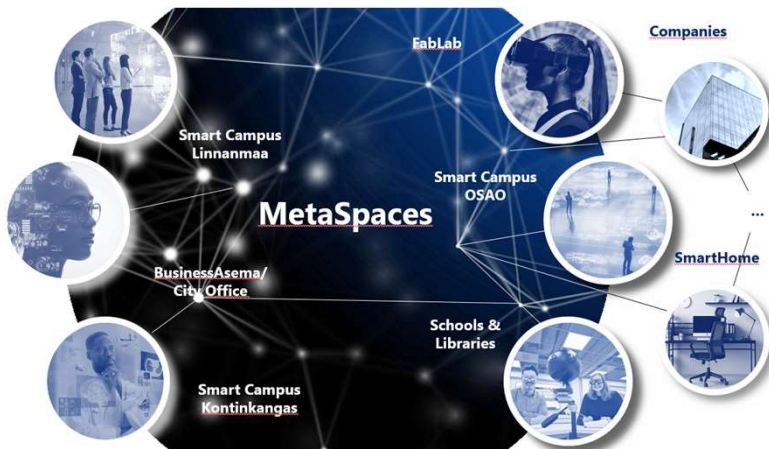


**Main goal:** to improve understanding about practical metaverse ICT (Information and Communication Technology) requirements and develop 5G Evolution/Advanced, Digital Twin, XR/AR/VR and blockchain technologies based test environments and PoC's (Proof-of-Concept) for smart building/space use cases

<b>Specific objective</b>	<b>Expected R&amp;D results</b>
Metaverse system specification	<ul style="list-style-type: none"><li>• Key features, use cases and PoC's for smart buildings/spaces</li><li>• ICT requirements</li><li>• System architecture</li></ul>
Communication and computing infrastructure	<ul style="list-style-type: none"><li>• 3D multimedia communication system</li><li>• Communication system for real-time synchronization of physical and virtual worlds</li><li>• Multi access edge architecture with computing mapping into terminal-edge-cloud infrastructure</li></ul>
Digital twin	<ul style="list-style-type: none"><li>• Concepts, and methods to utilize drones as a platform for additional modelling</li><li>• Real-time, multi-user, and scalable 3D metaverse model of smart building/space</li><li>• Game engine based metaverse implementation</li></ul>
XR technologies and solutions	<ul style="list-style-type: none"><li>• AR/VR/XR solutions and preliminary testing</li><li>• Blockchain / NFTs based user identification, transactions, transparent management/purchase of properties and assets as well as access control</li></ul>
Experimentation	<ul style="list-style-type: none"><li>• Integration of test environments</li><li>• PoC's design and implementation</li><li>• Large scale pilot specification for next phase (year 2026-&gt;)</li></ul>



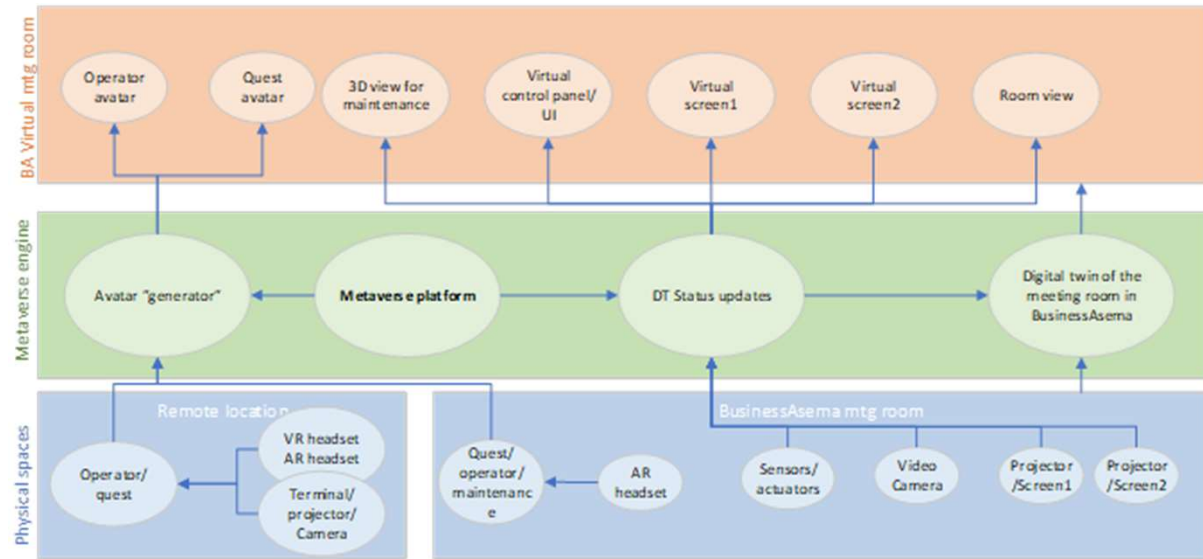
# R&D - System specifications



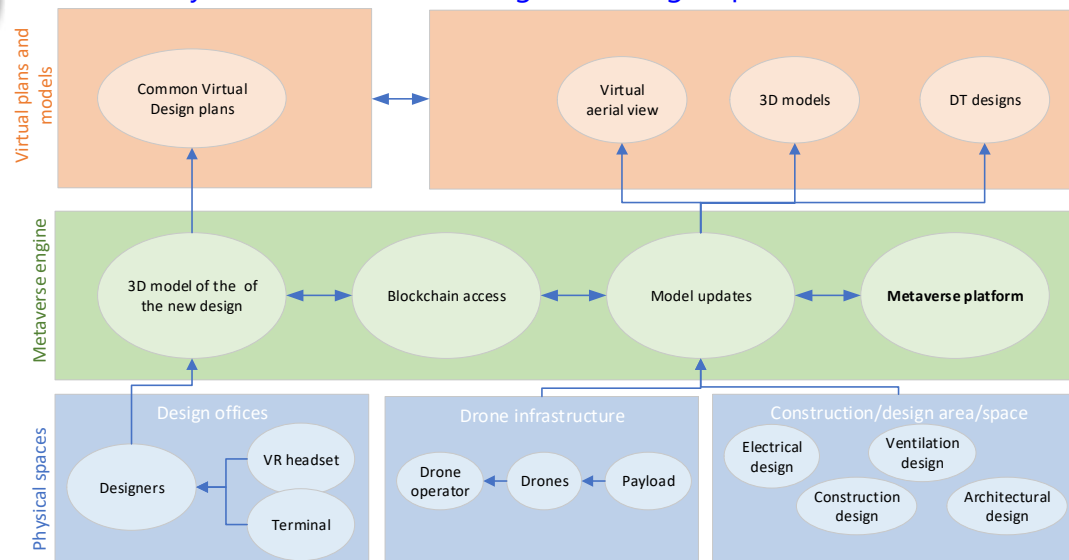
Metaversum with interoperable MetaSpaces/Metaverses

Focus on two use case groups:

- Virtual meeting
- Virtual design

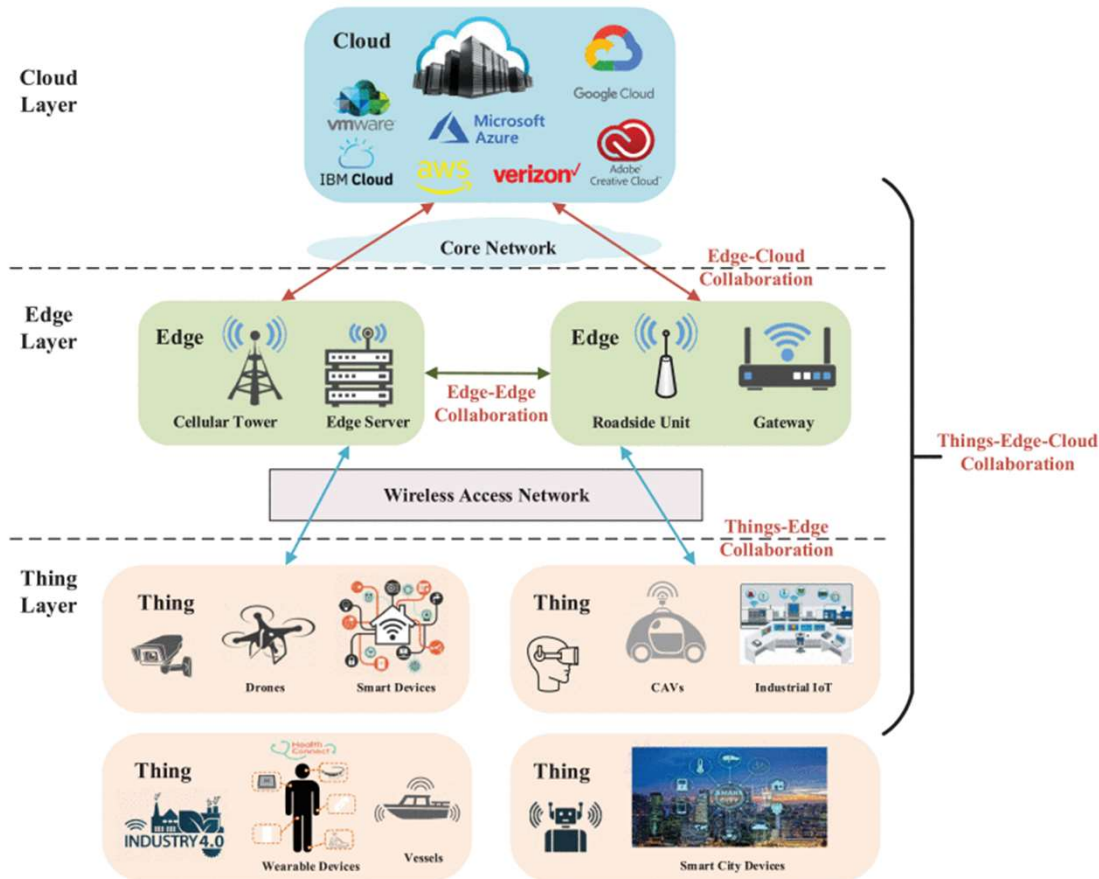


Key elements of virtual mtg use case group



Key elements of virtual design use case group

# R&D - communication and computing infrastructure



## Interactive streaming of 3D digital twin - requirements:

- Bandwidth min. 80 Mbit/s – 1 Gbit/s
- E2E network RTT: max 8 – 20 ms
- Motion-To-Photon (MTP) latency: max 20 ms, the latency between the physical movement of a user's head and the updated picture in the VR headset.
- the operations latency: max 100 ms, includes cloud rendering and streaming latency, latency caused by the secondary rendering on terminals, and latency caused by asynchronous time warping and screen refreshing
- B. Siniarski et al., "Need of 6G for the Metaverse Realization." arXiv, Dec. 28, 2022. doi: 10.48550/arXiv.2301.03386



## R&D – Digital Twin

- Concepts, and methods to utilize drones as a platform for additional modeling
  - Description of process and tools to produce (semi)regular 3D-model updates to be included in Digital Twin in virtual platform.
  - Testing and demonstrating of related PoC of 3D model updates of a limited part of the digital twin model
- Real-time, multi-user, and scalable 3D metaverse model of smart building/space
  - Open multi-platform approach – Oulun OMA
  - Definition of virtual platforms to be used as a digital twin platform. Main aim is to utilize open platform(s), which would enable fluent use parallel platforms
- Game engine based metaverse implementation
  - Implementation of the defined metaverse models on selected platforms
  - Implementation of defined PoCs

## R&D – Digital Twin

- List of analysed tools and environments:
  - Finpeda virtual space, Opensimulator, Sitowise, Room, Covince, Journee, Sansar, Duet, Fectar, Sweco, Cesium, Virbela, Somnium, Engage, CityJSON, CtiGML, Xamk ProRak
  - CityZenith, Sine Space, Neos metaverse, High Fidelity, Sandbox, Crypto Voxels, Esri, rarerooms, Mozilla hubs, VR chat, Secondlife, Sketchfab, Immerse, Openwebglobe
- Analysed features: VR, AR, XR, sensor values, sensor settings, avatars, sounds from and to location, over 100 participants, own models, unity models, unreal models; any standard models, alarm from sensors, realtime 3D planning, moving between metaverse spaces/locations, meetings, Events, ...
- Tools used in the first year demos: Unity (elementary tests), Sweco and Xamk ProRak



# R&D – XR technologies and solutions



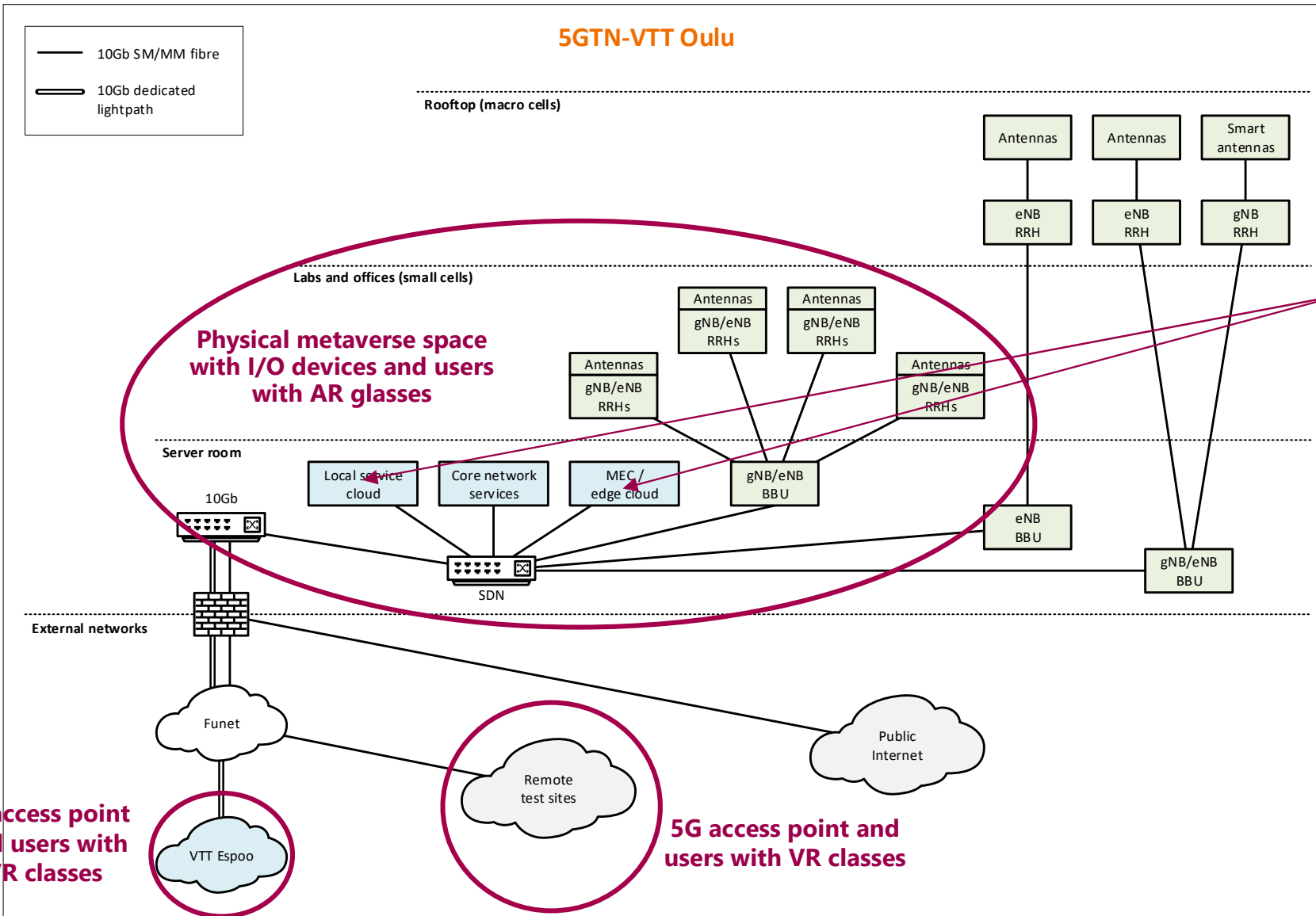
- AR/VR/XR solutions and preliminary testing
  - Best practice solutions for AR/VR/XR, positioning and security technologies for
    - Optimal performance
    - Interoperability
    - Usability
    - User experience
    - Different user interfaces (handheld, wearable, fixed devices)
  - AR/VR/XR preliminary testing
    - Service concepts
    - PoCs
- Blockchain/NFTs based user identification, transactions, transparent management/purchase of properties and assets as well as access control
  - Utilization of blockchain technologies for user identification, access control, transactions / payments and antipiracy

## R&D – Experimentations



- Integration test environments for implementation PoC's in VTT, OU and OAMK laboratories
- Design and implementation of PoC's for Business Asema Oulu
- Specification of large scale metaverse pilot for 2. phase of the project (2026 ->)
- Technologies in the first year 2023 demo's
  - Connectivity: 5G test network in VTT and Oulu university
  - A set of AR and VR headsets (Meta Quest 2/Pro, Oculus Pro, ...) to allow local and remote users to join the virtual services and the space.
  - Mobile phones, which are tuned to the system so that their user position within the space can be tracked and their presence or absence can be detected
  - A computers offering local services for the metaverse and remote users
  - Digital Twin development tools and environments: Unity, Sweco, ...

# R&D - Experimentation with VTT's 5G Test Network



**Digital twin and metaverse engine**

**5G access point and users with VR classes**

**5G access point and users with VR classes**

## R&D – PoC's schedule



GROUP A – VIRTUAL MEETING	Schedule					
	Y1 H1	Y1 H2	Y2 H1	Y2 H2	Y3 H1	Y3 H2
<i>UC A.1 Control of BusinessAsema physical resources from digital twin based virtual space</i>						
<i>UC A.2 Management of virtual BusinessAsema room/space related assets from physical space through AR user interface</i>						
<i>UC A.3 Meeting between participant in digital space/room and physical meeting participants inside BusinessAsema</i>						
<i>UC A.4 Support to multiple users</i>						
<i>UC A.5 Maintenance of a meeting room</i>						
<i>UC A.6 Mobile case with 5G and beyond – attending a hybrid meeting from a remote / mobile location</i>						
GROUP B – VIRTUAL DESIGN						
<i>UC B.1 Sharing of dimensionally accurate 3D model</i>						
<i>UC B.2 Model update of built environment</i>						
<i>UC B.3 5G-A/pre6G radar based real-time indoor digital twin</i>						
<i>UC B.4 Real-time drone sensor data analysis outside fast 5G network regions</i>						
GROUP C - ADVANCED						
<i>UC C.1 Ambient IoT</i>						
<i>UC C.2 Massive real time data</i>						
<i>UC C.3 Interaction between MetaSpace instances</i>						

## International and national co-operation

- to share information about the latest EMETA research results (features, requirements and system specification, key technologies and solutions, experimentation environments, plans and results)
- To receive from co-operation activities knowledge for guiding implementation of EMETA R&D activities and access to the existing connectivity, digital twin and AR/VR/XR test environments.
- Co-operation is implemented by arranging regular joint technical workshops twice a year.
- International co-operation with Hexa-X II, 6G-XR, ...
- National co-operation 5G/6G Test Network Finland (6GTNF), Radio Park Oulu, ...

## Consortium

- Research partners
  - VTT: coordinator, communication and computing infrastructure, experimentation
  - Oulu University: digital twin, communication and computing infrastructure, experimentation
  - Oulu Applied University of Sciences: digital twin, XR and blockchain/NFT technologies, experimentation
  - Research partner work volume = 20 py (person years)
- Companies
  - Nokia, Telia, Elisa and MediaTek, Haltian - connectivity technologies and solutions
  - Sweco, Sitowise, ISTEKKI and Finpeda – Digital twin technologies and services
  - Carelia Forest Consulting, Anarky Labs and Nordic Drones – drones for creation and management of digital twins
  - Augumenta – AR/VR/XR technologies and solutions
  - SRV and City of Oulu – smart buildings and living spaces