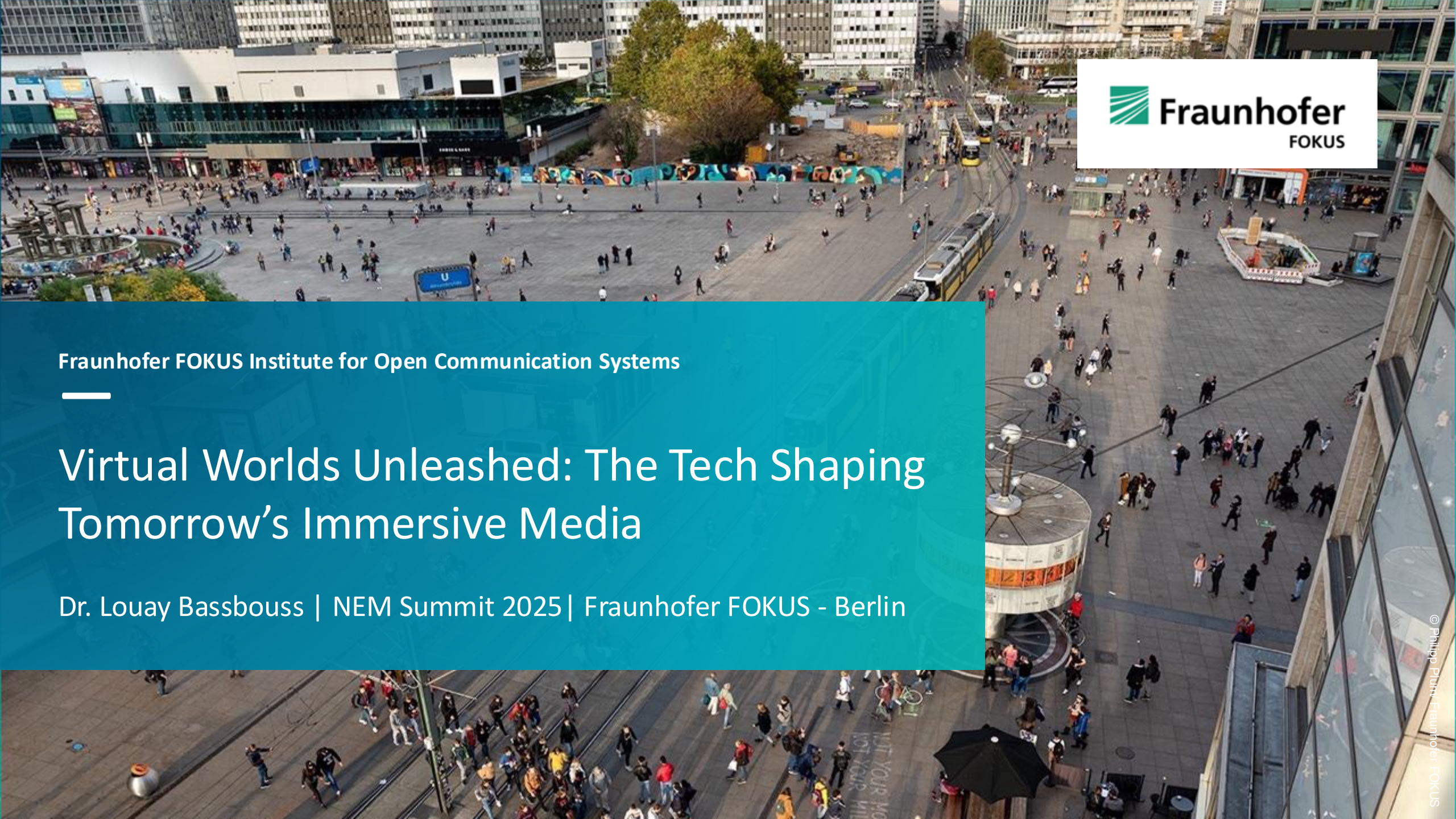


Fraunhofer FOKUS

Fraunhofer FOKUS Institute for Open Communication Systems

Virtual Worlds Unleashed: The Tech Shaping Tomorrow’s Immersive Media

Dr. Louay Bassbouss | NEM Summit 2025| Fraunhofer FOKUS - Berlin

Agenda

1. Virtual Worlds Introduction
2. Virtual Worlds for Media & Entertainment
3. Virtual Worlds Enabler Technologies
   - Devices
   - XR Platforms
   - Spatial Computing
   - Computation
   - Photorealistic Assets & Capturing
   - Avatar Animations

1 - Virtual Worlds Introduction

Virtual Worlds

- *“**Virtual Worlds** are persistent, immersive environments, based on technologies including 3D and extended reality (XR), which make it possible to blend physical and digital worlds in real-time, for a variety of purposes such as designing, making simulations, collaborating, learning, socialising, carrying out transactions or providing entertainment”* - EU Web 4.0 & Virtual Worlds initiative .

- Key Aspects:
  - *Persistence*: worlds continue and evolve between sessions
  - *Interactivity*: objects/environments respond in real time
  - *Immersion*: 3D visuals + spatial audio (and haptics, smell, …)
  - *Multi-user*: built for co-presence and collaboration

AI-generated graphic

Domains and Use Cases

Consumer Domain

Virtual Worlds designed for individual users, focusing on entertainment, social interaction, and lifestyle.

- Social Interaction
- Gaming & Entertainment
- Virtual Shopping
- Education & E-Learning
- Health and Wellness

Enterprise Domain

Virtual Worlds aimed at businesses to improve collaboration, productivity, and customer experiences.

- Remote Collaboration
- Training & Upskilling
- Customer Engagement
- Professional Trainings
- Prototyping & Design

Industrial Domain

Virtual Worlds for heavy industries, focusing on operational efficiency, simulations, and safety.

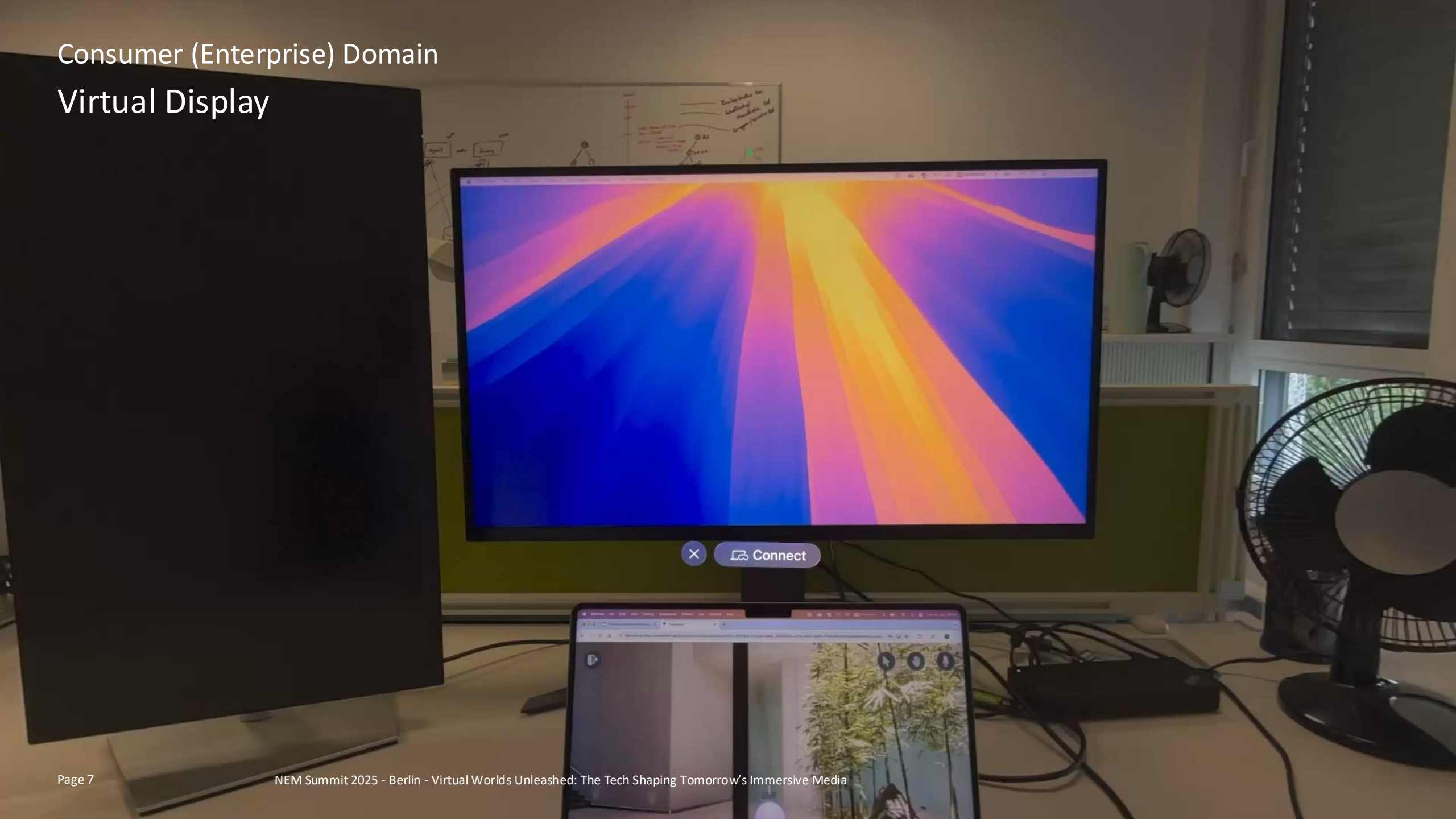
- Digital Twins
- Industrial Training
- Simulation & Testing
- Maintenance & Monitoring
- Synthetic Data

Consumer Domain

Social Interaction in Virtual Worlds

Consumer (Enterprise) Domain

Virtual Display



Enterprise Domain

Professional Trainings (VR Fire Tainer)

source: https://www.youtube.com/watch?v=OxksXpJ776Q

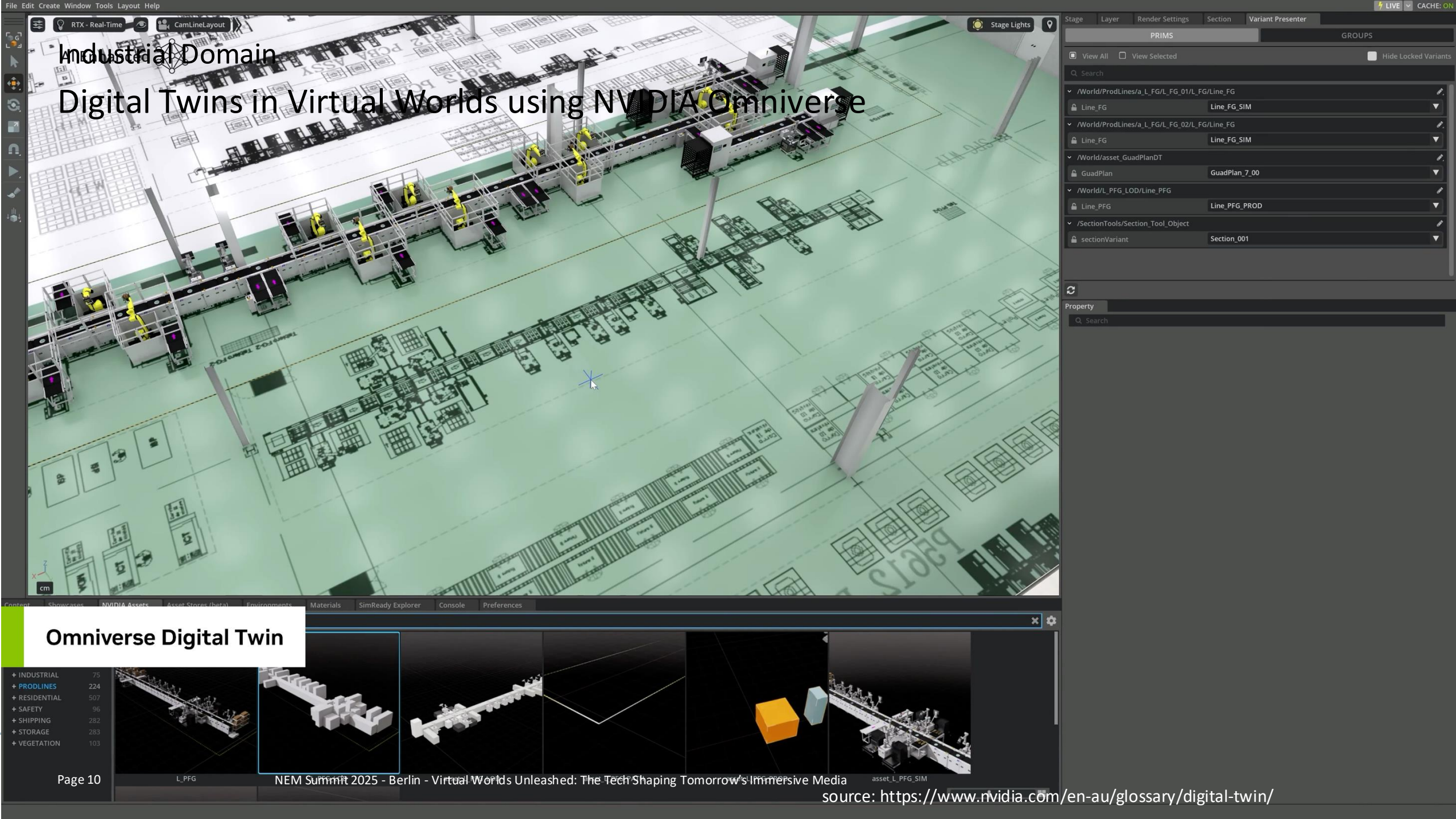
Enterprise Domain

Remote Collaboration in s using Apple Vision Pro

source: https://developer.apple.com/videos/play/wwdc2025/101/

Industrial Domain

Digital Twins in Virtual Worlds using NVIDIA Omniverse



source: https://www.nvidia.com/en-au/glossary/digital-twin/

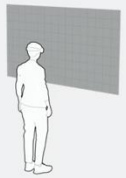
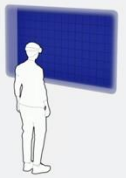
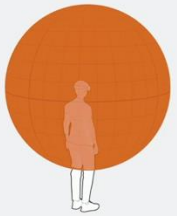
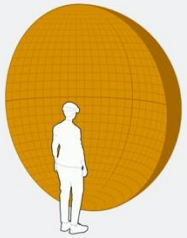
2 - Virtual Worlds for Media & Entertainment

AVP: Shared Movie Watching Experience

- Enjoying movies together in immersive virtual spaces via **SharePlay /Share Nearby**
- **SharePlay**: Watch movies in sync with friends or family, even when apart:
  - Share a virtual cinema-like environment with spatial audio and large-scale visuals.
  - Real-time reactions and interactions enhance the social experience.
- **Share Nearby**: Instantly connect with nearby Apple Vision Pro to co-watch content:
  - Seamless setup: just bring devices close together.
  - Great for spontaneous shared viewing in the same physical space.
- Apps: Disney+; Apple TV; ARD; Arte;
  - YouTube, Netflix only in Browser

source: https://www.apple.com/apple-vision-

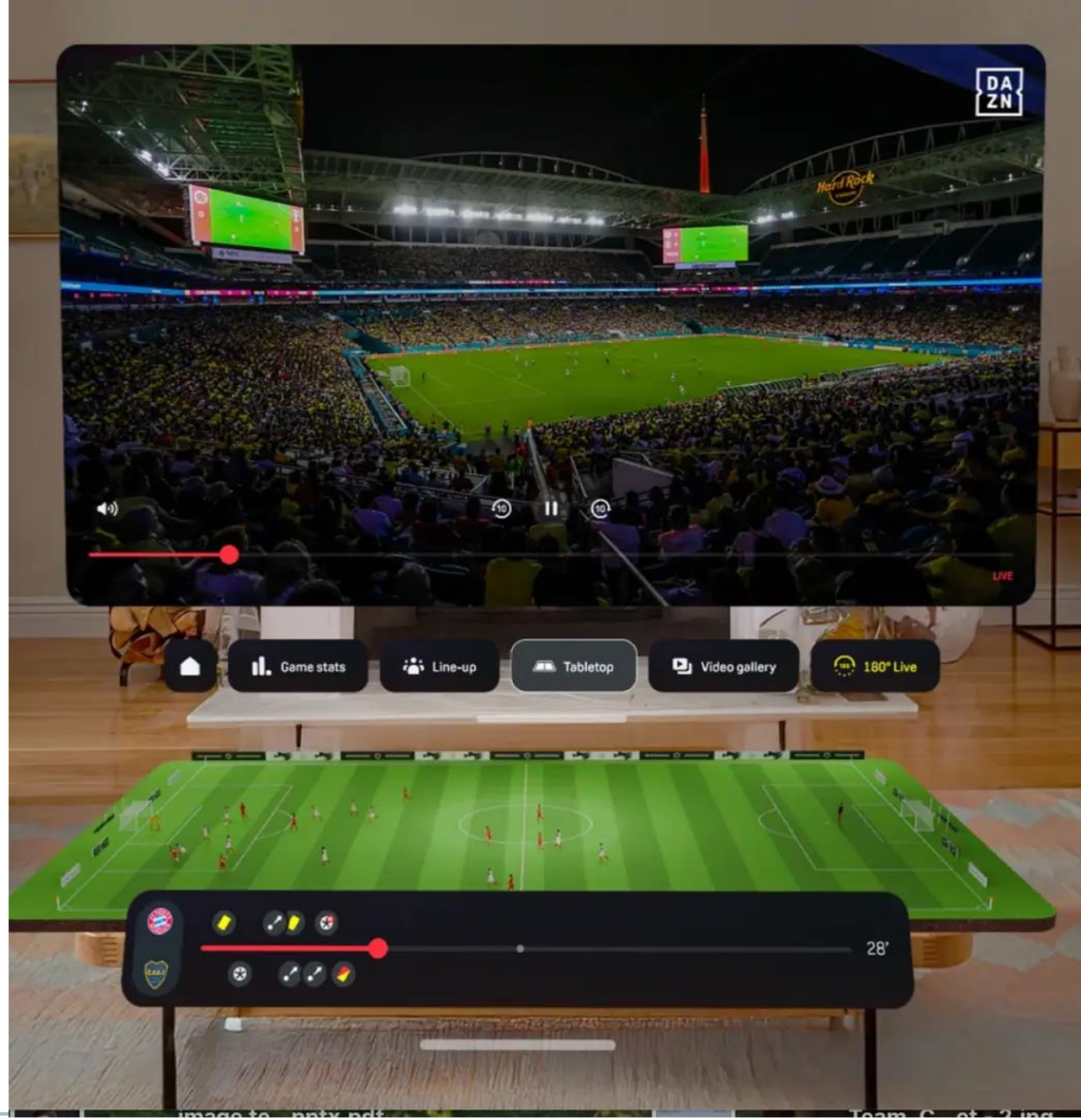
visionOS26 supported video profiles

	 2D	 3D	 Spatial	 180° APMP	 360° APMP	 Wide FOV APMP	 Apple Immersive Video
Presentation	Screen, docked	Screen, docked	Windowed, immersive	Windowed, progressive immersive	Windowed, progressive immersive	Windowed, progressive immersive	Windowed, progressive immersive
High motion detection				✓	✓	✓	
2D embedded playback	✓	✓	✓				
Playback APIs	Quick Look, AVKit, RealityKit, WebKit						

The DAZN: FIFA Club World Cup XR Experience

- DAZN launches XR app on Meta Quest for immersive FIFA Club World Cup 2025 experience in the U.S.
- In partnership with Meta and Immersive.io
- Fans can experience all 63 matches streamed live and in a **3D tabletop format**, with enhanced **180° video** feeds and **360° content** available for the final games.
- Available on Meta Quest
- Enhanced features for sports fans
- Real-time stats and interactive elements
- Exclusive content and behind-the-scenes access

source: https://dazngroup.com/press-room/dazn-launches-xr-app-on-meta-quest-for-immersive-fifa-club-world-cup-2025-experience-in-the-u-s/



Virtual Worlds for Media & Entertainment

Lufthansa x Meta Quest: Immersive In-Flight Entertainment

Lufthansa has introduced Meta Quest 3 headsets on selected international flights, offering passengers a next-generation entertainment experience → Key Features:

- 🎬 **Virtual Cinema**: Watch movies on a massive screen with spatial audio.
- 🌍 **Virtual Sightseeing**: Explore destinations through immersive 3D.
- 🧘 **Relaxation & Games**: Access meditation apps, interactive games, …
- 🧠 **Meta Travel Mode**: Stabilized VR experience optimized during travel.
- Over 4,000 passengers participated with **overwhelmingly positive feedback**.
- Winner of the 2025 APEX Award for Best Inflight Entertainment.

sources: https://apex.aero/ifsa-apex-award-recipients/
https://www.meta.com/blog/lufthansa-quest-3-travel-mode-cupra-volkswagen-test-drive-in-flight-entertainment/
https://business.lufthansagroup.com/jp/en/news/lh-allegris-meta-quest-3

3 - Virtual Worlds Enabler Technologies

- Devices (HMDs, AI/AR Glasses)

Virtual Worlds Enabler Technologies

Devices

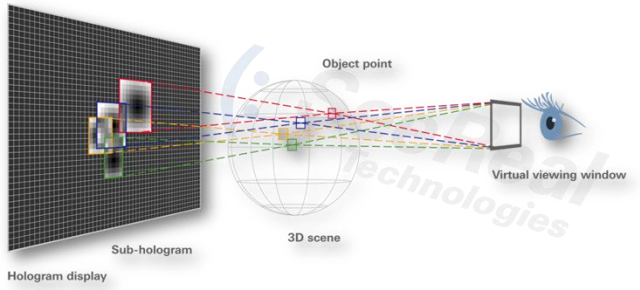
XR Devices

- Worn by the user
- Offer complete immersion
- Used for VR/AR/MR
- VR: Completely virtual
- AR: Real world with virtual overlay
- MR: Real world interacts with virtual objects
- XR: Overall Term for VR/AR/MR

3D Displays

- Displayed images are perceived as three-dimensional
- Mostly stereoscopic, presenting slightly different images to each eye
- Requires either glasses or parallax barrier on the screen

Holographic Displays



- Image is not displayed directly on the screen, but in real space
- No need for glasses or parallax barriers
- Do not require 2 eyes to perceive 3D object

HMDs (selection)

Meta Quest (Quest 3 and 3S)

- **Platform**: Meta Horizon OS
- **Processor**: Qualcomm Snapdragon XR2 Gen 2
- **Tracking**: controller and hand tracking
- **Display**: LCD; 9.1 million pixels; up to 120Hz
- **Price**: affordable (starting price for Quest 3S → $300)

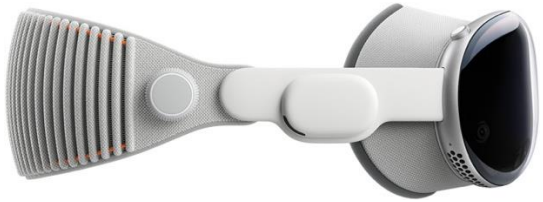
Meta Quest 3

Meta Quest 3S

source: https://www.meta.com/quest/

Apple Vision Pro

- **Platform**: visionOS
- **Processors**: Apple M2 + R1
- **Tracking**: eyes and hand tracking
- **Display**: Micro-OLED; 23 million pixels; up to 100Hz
- **Price**: expensive (starting price → $3500)



source: https://www.apple.com/apple-vision-pro/

Samsung Project Moohan (expected release is today ☺)

- **Platform**: Android XR
- **Processors**: *Expected* Qualcomm Snapdragon XR2+ Gen 2
- **Tracking**: eyes and hand tracking
- **Display**: *Expected* Micro-OLED; ~4K pixels per eyes; up to 120Hz
- **Price**: *Expected* mid-range (~$1000-$1500)

sources: https://www.androidcentral.com/g… reality/samsung-glasses & https://news.samsung…com/global/unlock-the-infinite-possibilities-of-xr-with-galaxy-ai

AR Glasses (selection)

Xreal Air 2 Ultra

- **OS compatibility**: devices with USB-C video output (or via adapter for Lighting & HDMI)
- **Processor**: XREAL X1 Chip
- **Specs**: 83g; 2x Speakers; 2x Mics; 6 DoF Tracking;
- **Display**: 2x Micro-OLED; 1080p/eye; 120Hz
- **Use Cases**: Virtual Display, Gaming, Entertainment
- **Price**: starting at ~$699 (Ultra)

source: https://www.xreal.com/air2ultra

Viture Pro XR

- **OS compatibility**: devices with USB-C video output
- **Processor**: -
- **Specs**: 77g/170g (glasses/ neckband) ; 2x Speakers; 1x Mic; Wi-Fi 6; Bluetooth 5.2;
- **Display**: 2x Micro-OLED; 1080p/eye; 120Hz
- **Use Cases**: Virtual Display, Gaming, Entertainment
- **Price**: starting at ~$400/$299 (glasses/neckband)

source: https://pro.viture.com/

Lenovo ThinkReality A3

- **OS compatibility**: Windows 10/11 PCs and select Motorola smartphones (via USB-C)
- **Processor**: Qualcomm XR1 SmartViewer
- **Specs**: 130g; 8MP Camera; 2x Speakers; 3x Mic;
- **Display**: 2x Micro-OLED; 1080p/eye; 120Hz
- **Use Cases**: Virtual Display, Remote assistance
- **Price**: starting at ~$1500

source: https://www.lenovo.com/thinkrealitya3/

Ray-Ban Meta AI Glasses

- **OS compatibility**: Android/iOS
- **Processor**: Snapdragon AR1 Gen1
- **Specs**: 51g; 2x 12MP Camera; 2x Speakers; 5x Mics; Wi-Fi 6; Bluetooth 5.2
- **Display**: not true AR (AI only)
- **Use Cases**: Live translation, Live AI Assistant, Hands-free communication & Photo/Video Capture, Music, Social Media
- **Price**: starting at ~$299

source: https://www.meta.com/quest/

Smart Glasses Meet Style 😎: Meta & Google's Partnerships with Fashion Eyewear Brands

Meta x Ray-Ban & Oakley

- Ray-Ban Meta Glasses (more than 2 million units sold until mid 2025)
- Oakley Meta HSTN: Designed for athletes and fans, features 3K Ultra HD camera, built-in camera, open-ear audio, and Meta AI assistant. Battery: 8 hours active use (48 hours with charging case)

Google x Warby Parker & others

- At Google I/O 2025, Google officially announced partnerships with fashion eyewear brands like Warby Parker to co-develop stylish smart glasses powered by Android XR and Gemini AI (Market launch expected in 2026)

Apple Glasses 🧐

- According to Bloomberg, Apple is working on new chips designed for smart glasses (Potential launch in 2026 or 2027)

source: https://www.macrumors.com/2025/05/21/apple-smart-glasses-everything-we-know-so-far/

source: https://blog.google/products/android/android-xr-gemini-glasses-headsets/

Ray-Ban Meta Display: glanceable AR meets neural input

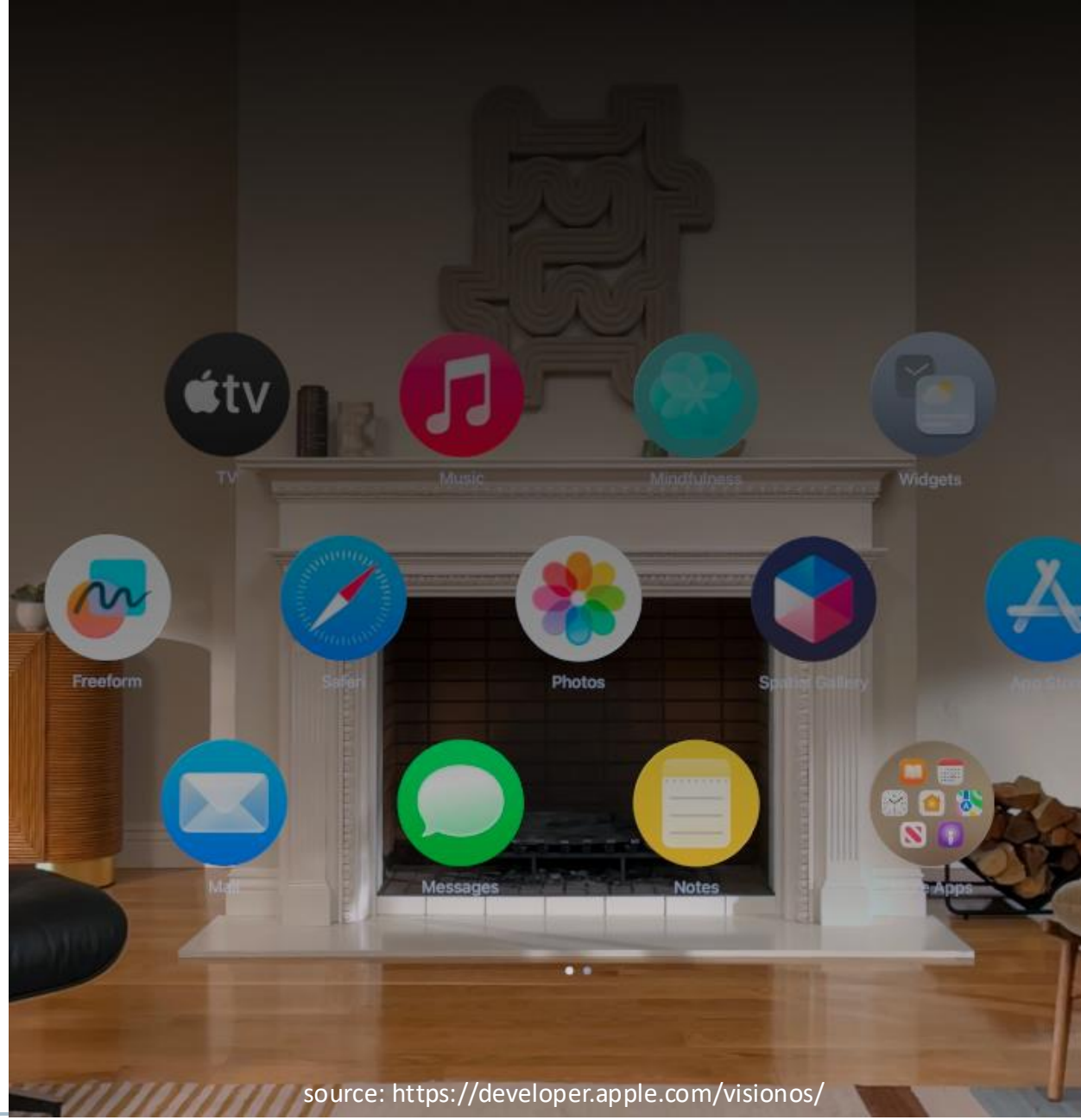
- Announced at Meta Connect 2025;
- First Ray-Ban with in-lens color HUD: a monocular waveguide display (right lens) for quick, private overlays (messages, nav, captions).
- Display off by default; designed for short, glanceable interactions.
- Ships with Meta Neural Band (EMG wristband) for subtle pinch/swipe/rotate gestures; voice and touch still available
- Launch & price: $799 bundle; US retail from Sept 30, 2025 (global expansion in 2026)

3 - Virtual Worlds Enabler Technologies

- XR Platforms

XR Platforms: visionOS

- **Vendor**: Apple
- **Market Introduction**: 2023 (with Apple Vision Pro) / Last update: visionOS26 (WWDC25)
- **Platform Type**: Spatial computing OS for immersive apps and environments
- **Key Features**:
  - Spatial widgets and multitasking
  - Shared spatial experiences (multi-user)
  - Realistic avatars (Personas)
  - Spatial web browsing and 3D content
  - Deep integration with Apple ecosystem
- **Applications**: Productivity, media, design, collaboration, entertainment

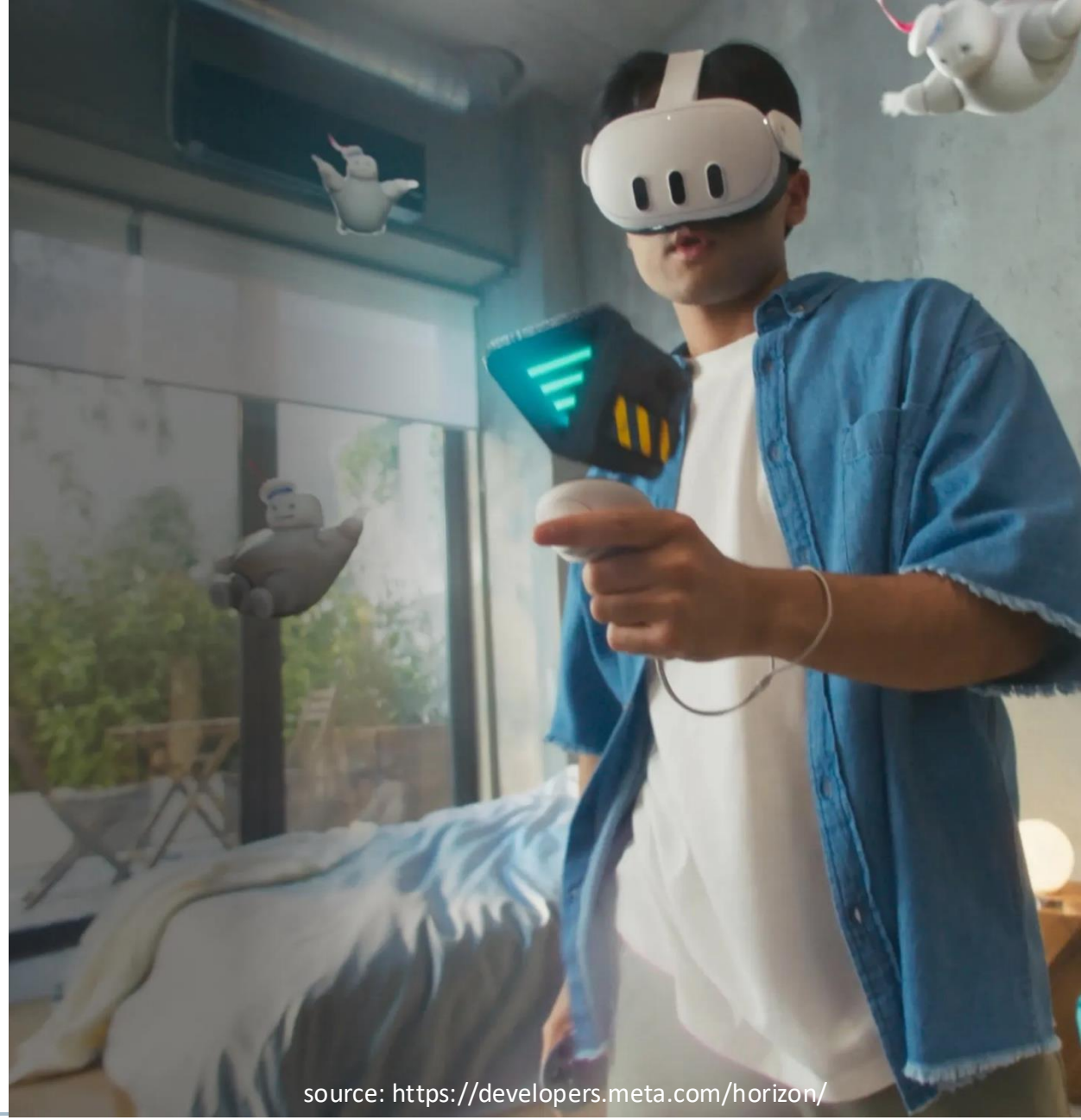


source: https://developer.apple.com/visionos/

Virtual Worlds Enabler Technologies

XR Platforms: Meta Horizon OS

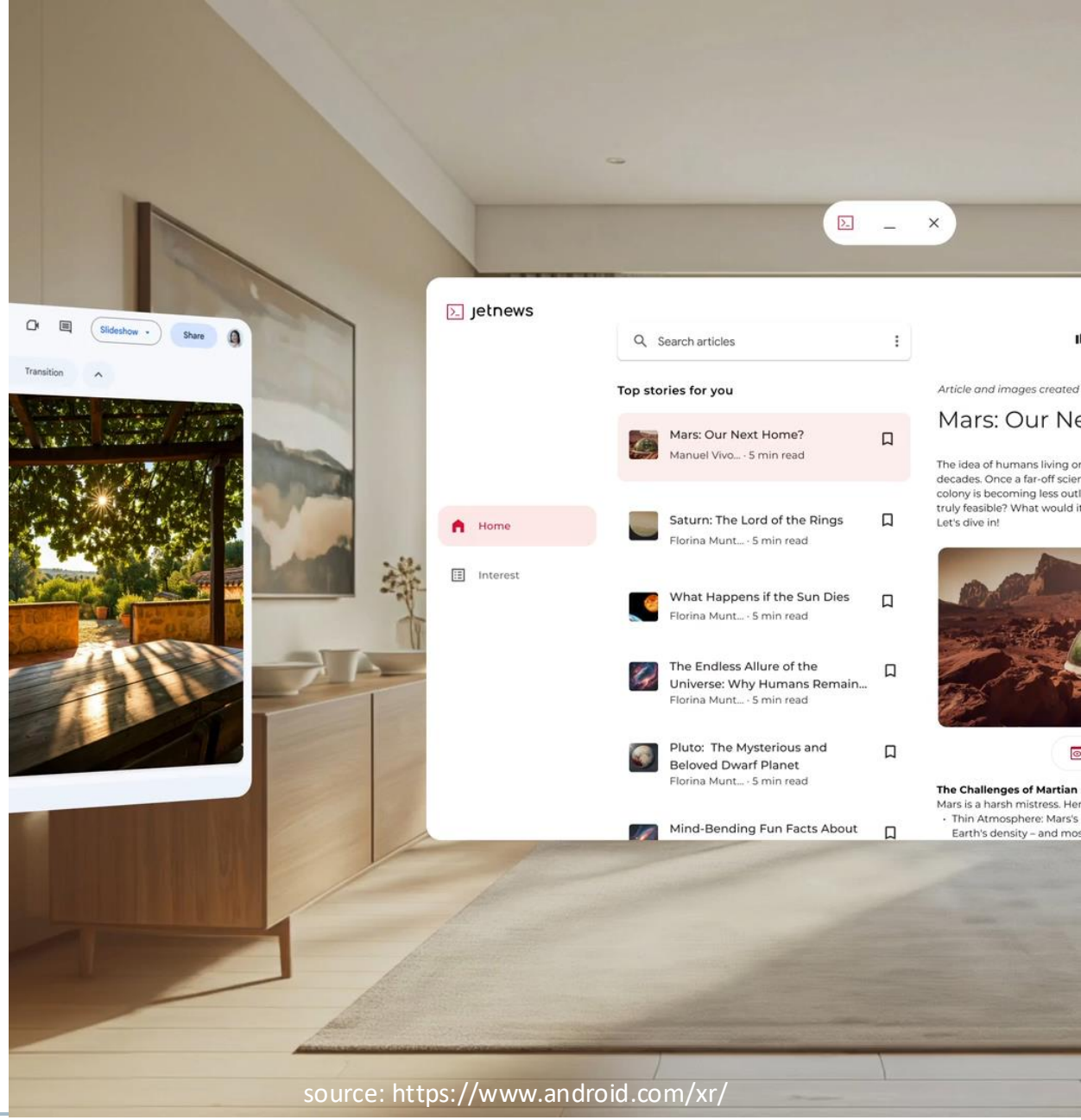
- **Vendor**: Meta Platforms
- **Market Introduction**: 2024 (open ecosystem announced)
- **Platform Type**: Mixed reality OS (based on Android) for Meta Quest and third-party devices
- **Key Features**:
  - Social presence and multiplayer experiences
  - Access to Meta Quest Store and Horizon Worlds
  - Inside-out tracking, high-res passthrough, scene understanding
  - Open to partners like ASUS, Lenovo, Xbox
- **Applications**: Gaming, social XR, fitness, collaboration



source: https://developers.meta.com/horizon/

XR Platforms: Android XR

- **Vendor**: Google (in partnership with Samsung and Qualcomm)
- **Market Introduction**: 2025 (Samsung Project Moohan expected to be annouced today)
- **Platform Type**: Open XR OS (Android) for headsets and smart glasses
- **Key Features**:
  - Gemini AI integration (contextual assistant)
  - Support for Android apps, Unity, OpenXR, WebXR
  - Spatial UI with panels, 3D models, and multimodal input
  - Designed for both headsets and lightweight glasses
- **Applications**: AI assistant, productivity, gaming, immersive web, education, live translation,



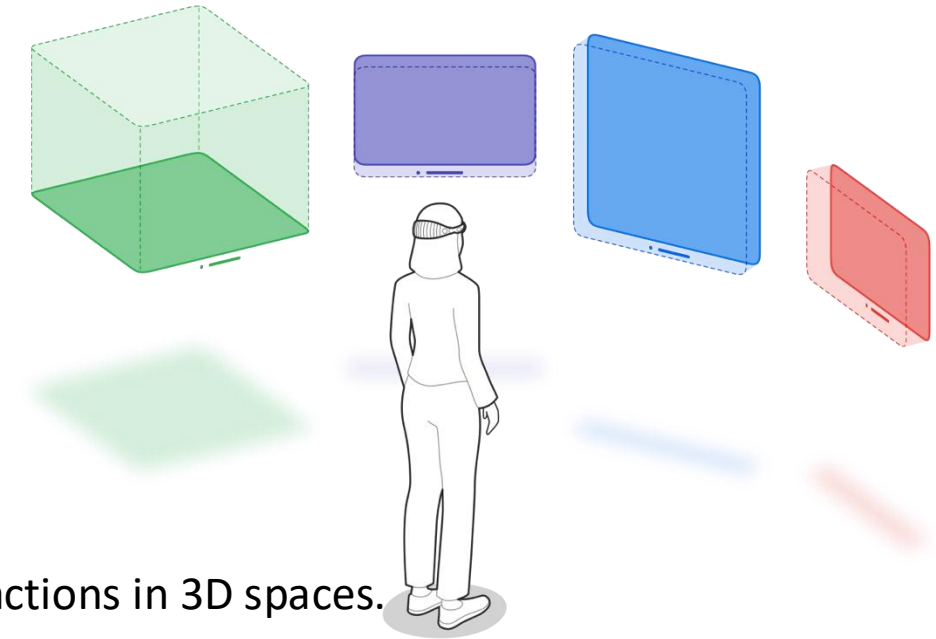
source: https://www.android.com/xr/

3 - Virtual Worlds Enabler Technologies

- Spatial Computing

Spatial Computing: 2D to 3D Paradigm Shift

- In traditional systems (e.g., desktops, smartphones), content is managed using 2D windows on flat displays.
- Spatial Computing introduces a new paradigm to blend digital content with the physical world
- The building blocks of spatial computing (inspired by visionOS):
  - **Windows**: contain traditional views and controls plus depth for 3D content. Can be rendered on curved surfaces.
  - **Volumes**: are scenes that can showcase 3D and Volumetric content, allowing users to navigate and manipulate them naturally and view them from any angle.
  - **Spaces**: Apps use Windows and Volumes to show content and can launch in a shared space and co-exist with other apps (like multiple windows on Desktop) or can open a dedicated full space where only the content of this app is visible (like Fullscreen apps on Desktop)
- In spatial computing, users can freely position and resize surfaces in their environments, enabling multi-window interactions in 3D spaces.



source:
https://developer.apple.com/visionos/

Demo

Apple Vision Pro – visionOS26

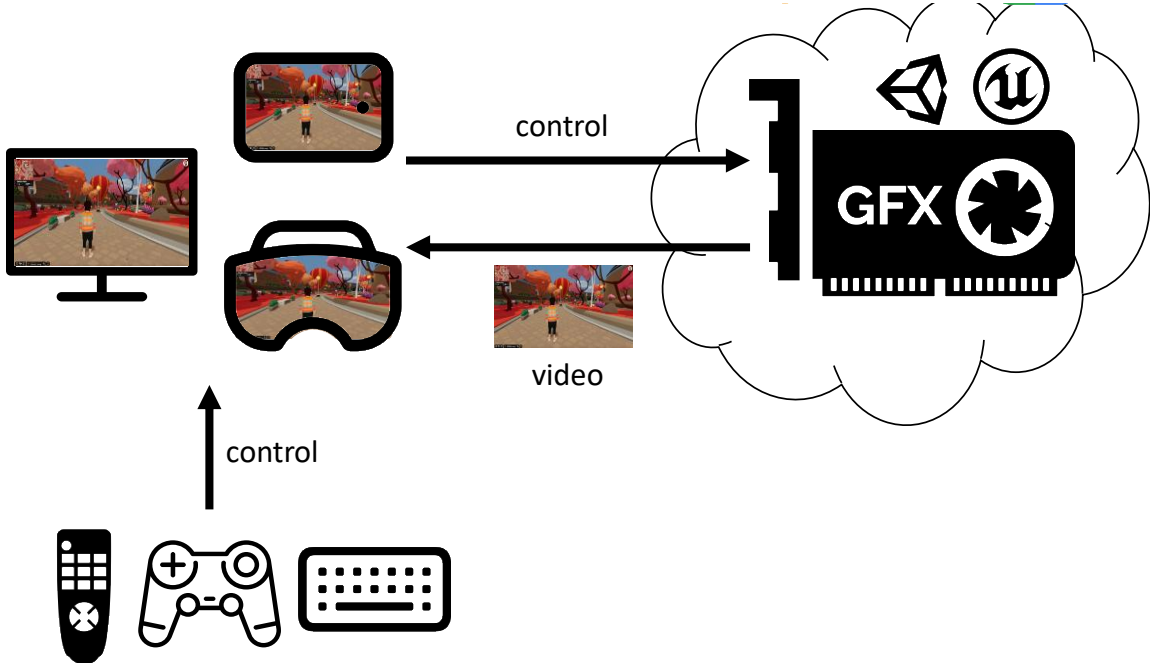
3 - Virtual Worlds Enabler Technologies

- Computation (Local vs Remote Rendering, Streaming)

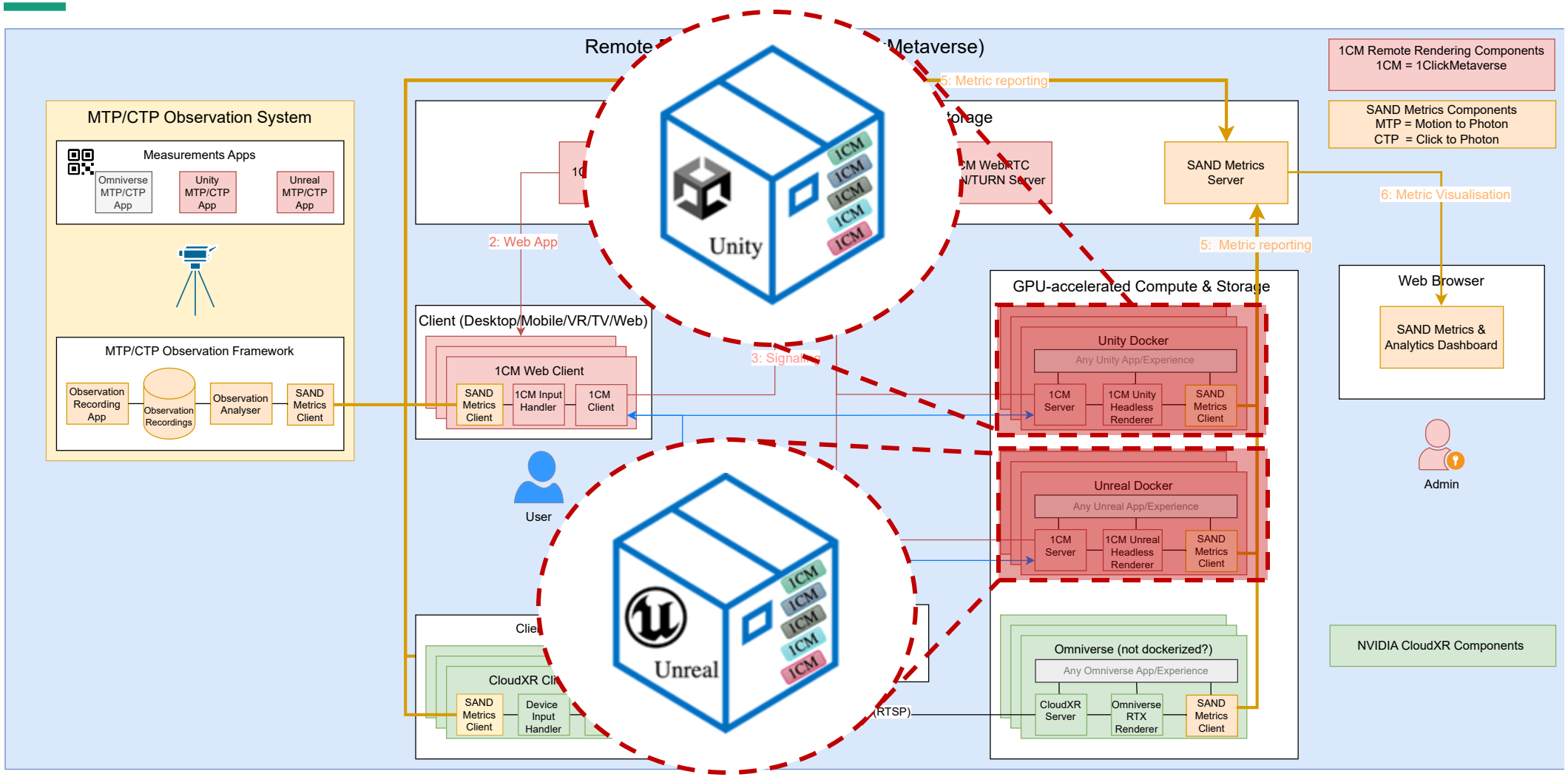
Computation – Local rendering vs remote rendering

Local Rendering

Remote Rendering



1ClickMetaverse Remote Rendering Architecture



Virtual Worlds Enabler Technologies

1ClickMetaverse – Unreal Engine Remote Rendering and Streaming via MoQ

https://www.fokus.fraunhofer.de/go/metaverse

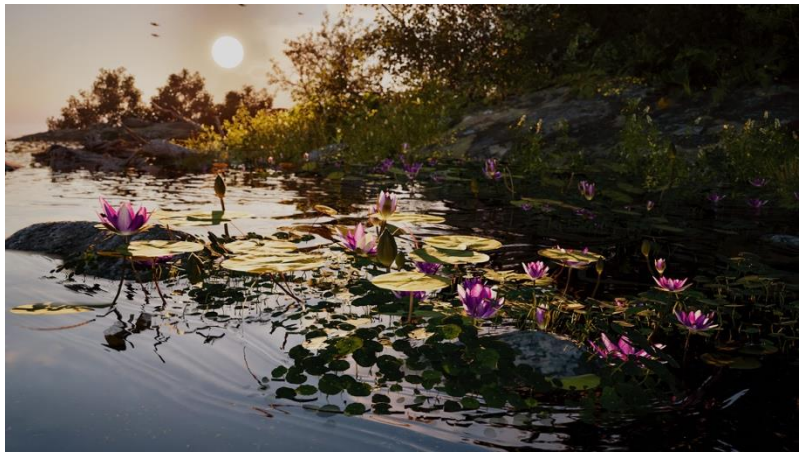
3 - Virtual Worlds Enabler Technologies

- Photorealistic Assets & Capturing

Photorealistic 3D Assets

Photorealistic 3D Assets are of high relevance for Metaverse applications contributing to a more immersive and engaging virtual experience:

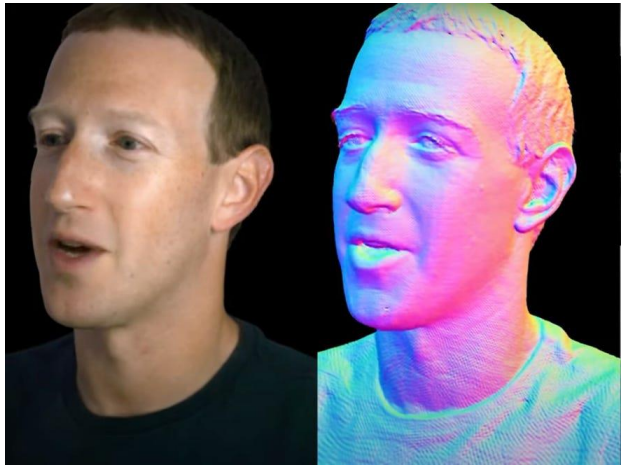
- Realism and Presence
- User Engagement
- Emotional Connection
- Enhanced Storytelling
- Increased User Adoption
- Create Synthetic Data for AI training



source: Unreal Engine 5

source: sordi.ai

source: MetaHuman

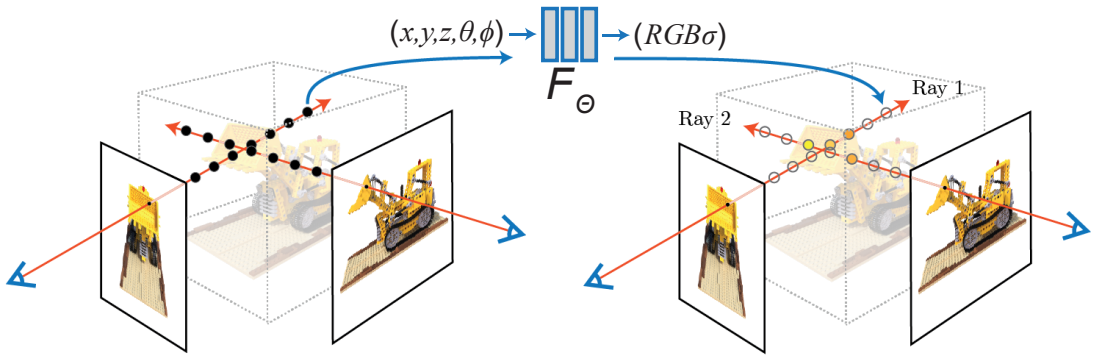


source: Meta Codec Avatar

Capturing - Neural Radiance Fields (NeRF) & 3D Gaussian Splatting (3DGS)

Neural Radiance Fields (NeRF) and 3D Gaussian Splatting (3DGS) are two techniques for synthesizing novel views of complex 3D scenes by learning a volumetric scene representation directly from images.

- **NeRF**: A neural network is trained to approximate the volumetric scene representation. This network takes 3D coordinates as input and outputs radiance values, effectively learning to model the complex lighting and geometry of the scene.



Single Input Video

Volumetric NeRF Representation

Photorealistic Avatars: Meta Pixel Codec Avatars

High-fidelity communication replicates real-world interactions in terms of sensory richness and detail.

Features:

- Photorealistic Avatars
- Spatial Audio
- Real-time Interaction
- Immersive Virtual Spaces
- Real-world Integration
- Haptic Feedback

source: https://www.youtube.com/watch?v=MVYrJJNdrEg

Photorealistic Avatars: Apple Personas

Apple Personas are realistic digital avatars generated from a user's facial scan using Apple Vision Pro. They enable natural, expressive communication in immersive environments like FaceTime, SharePlay, and collaborative apps

Features:

- **TrueDepth Camera System**: Captures detailed facial geometry and expressions.
- **Neural Engine**: Processes real-time facial motion and eye tracking for dynamic rendering.
- **Eye & Hand Tracking**: Enables natural interaction and gaze-based communication.
- **Secure On-Device Processing**: Persona data is encrypted and processed locally using Optic ID and the Secure Enclave.
- **visionOS Integration**: Seamlessly embedded into FaceTime, Messages, and third-party spatial apps.

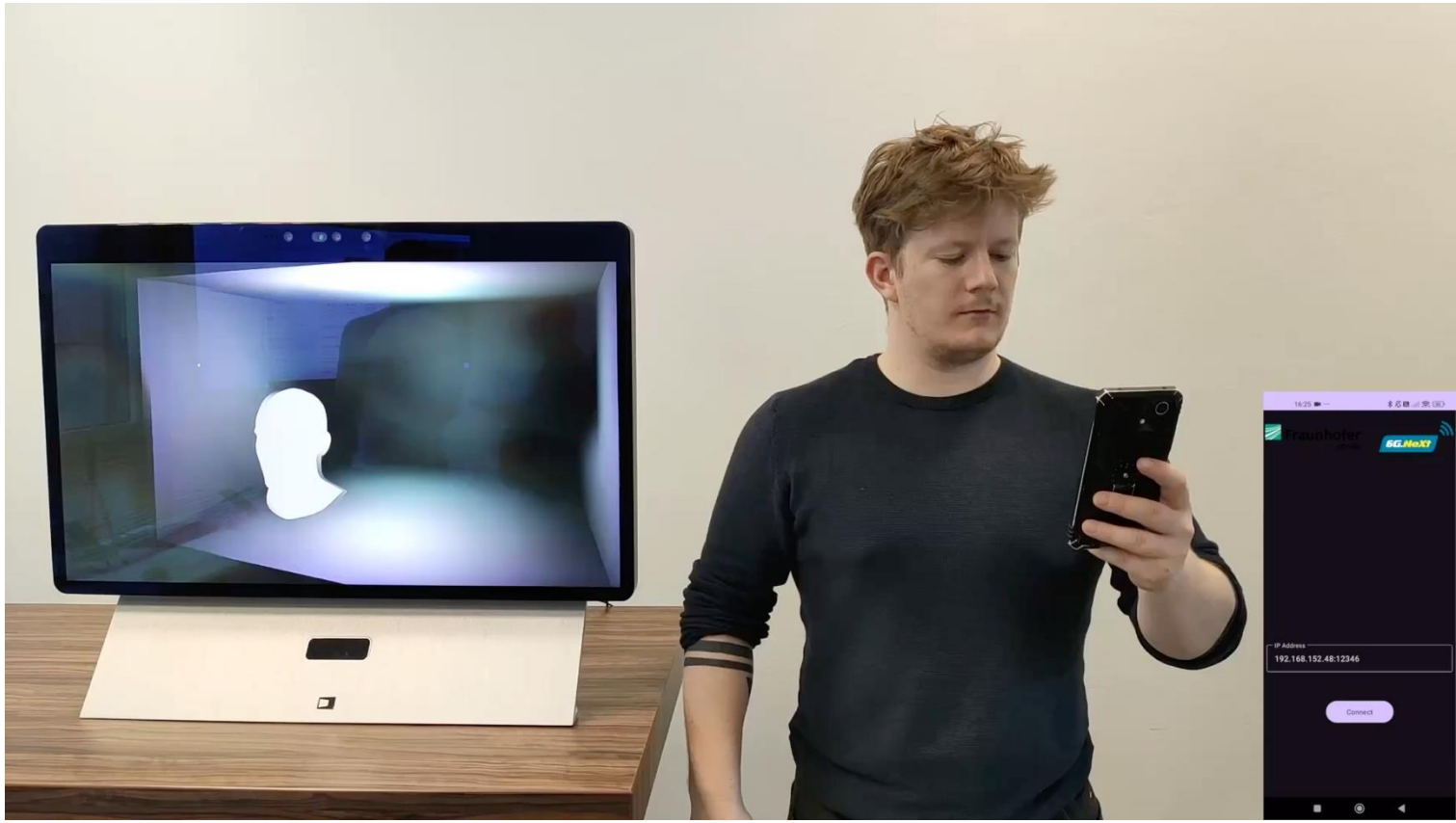
source:

Photorealistic Avatars: FAMIUM Head Avatars (WIP)

FAMIUM Head Avatars are reconstructed from 2D images using inexpensive commodity hardware, such as smartphones or laptops.

Features:

- **Real Time**: FAMIUM Head Avatars are created instantly, with no preprocessing necessary
- **Mesh-based**: Based on 3D meshes, they can easily be integrated into any 3D environment
- **Split Computing**: Capturing, ML inference, rendering, and display are distinct components and can be distributed across compute resources, enabling deployments that fit the desired purpose
- **Cross-Platform**: FAMIUM Head Avatars support cross-platform gaming Engine Unity



Contact

Dr.-Ing. Louay Bassbouss
+49 (30) 3463 - 7275
louay.bassbouss@fokus.fraunhofer.de
www.linkedin.com/in/lbassbouss/

Fraunhofer FOKUS
Institute for Open Communication Systems
Kaiserin-Augusta-Allee 31
10589 Berlin, Germany
www.fokus.fraunhofer.de