Qualcomm

10th HbbTV Symposium

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Technologies for the Metaverse: XR, AI and 5G

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Qualcomm Technologies, Inc.

@QCOMResearch

Qualcomm

Today's agenda

- Metaverse – Introduction
- Technologies for the Metaverse
- Standards for the Metaverse
- Qualcomm's contributions to the Metaverse
- We have 12.5min before handing over to Louay

Presenter

Dr. Thomas Stockhammer
Director, Technical Standards
Qualcomm Europe, Inc.

Leading and driving among others

- DVB: 5G TF, DVB-I
- MPEG: MPEG-I, CMAF and DASH
- 3GPP: XR over 5G, 5G Video, 5GMS
- DASH-IF: Interop WG, Test
- ETSI & 5G-MAG: 5G Broadcast and 5GMS
- CTA WAVE: CMAF Device PB, Test
- Metaverse Standards Forum Lead

Introduction to the Metaverse

Metaverse

Metaverse **is a set of virtual spaces, where you can create and explore with other people in the same or different physical spaces**

Exercise / Games

Education

Shopping

Communication

Business

Courtesy: Joel Kim, Head of Cellular Standards and Ecosystems at Meta
Surfing Metaverse with 5G and Beyond, ICC 2022

Consumer

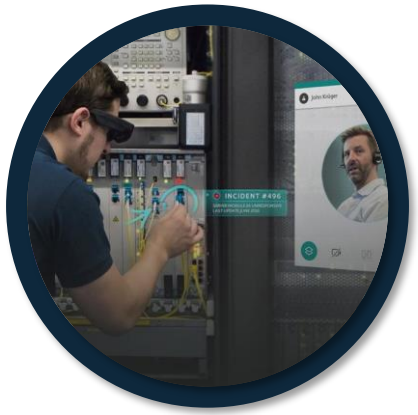
VR

- Fitness
- Gaming
- Social
- Sports / concerts

- Entertainment
- Navigation
- Shopping

AR

- Corporate training
- Education
- Medical



- Infinite desktop
- Instructions
- Remote assistance

Enterprise

Device Requirements

- **Ergonomics:**
  - **Wearable devices should be light enough, and not hamper movement of the users**
- **Power consumption:**
  - **Battery-friendly media and data processing to ensure high service quality and sufficient use time per charge**
- **Heat dissipation:**
  - **Heat from processors and displays worn around the face needs to be avoided or properly insulated**

Network Requirements

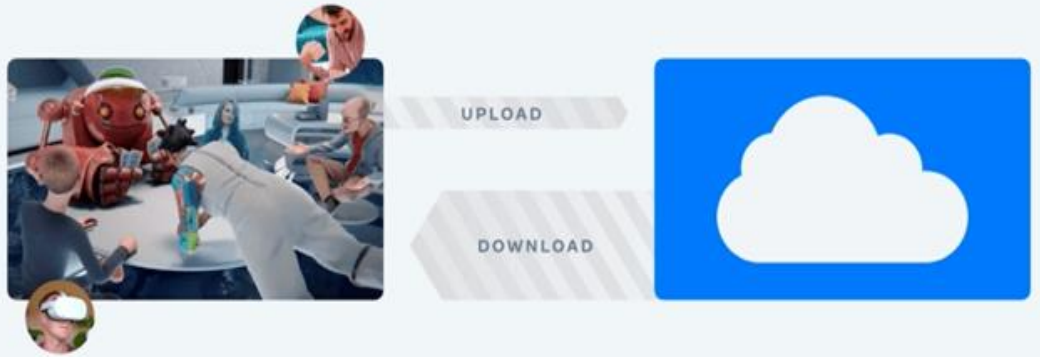
Consistent quality of experience

Ensure network availability can enable immersive experiences

Reduce latency

Reduce the time it takes for information to travel from point A to point B

Symmetric bandwidth



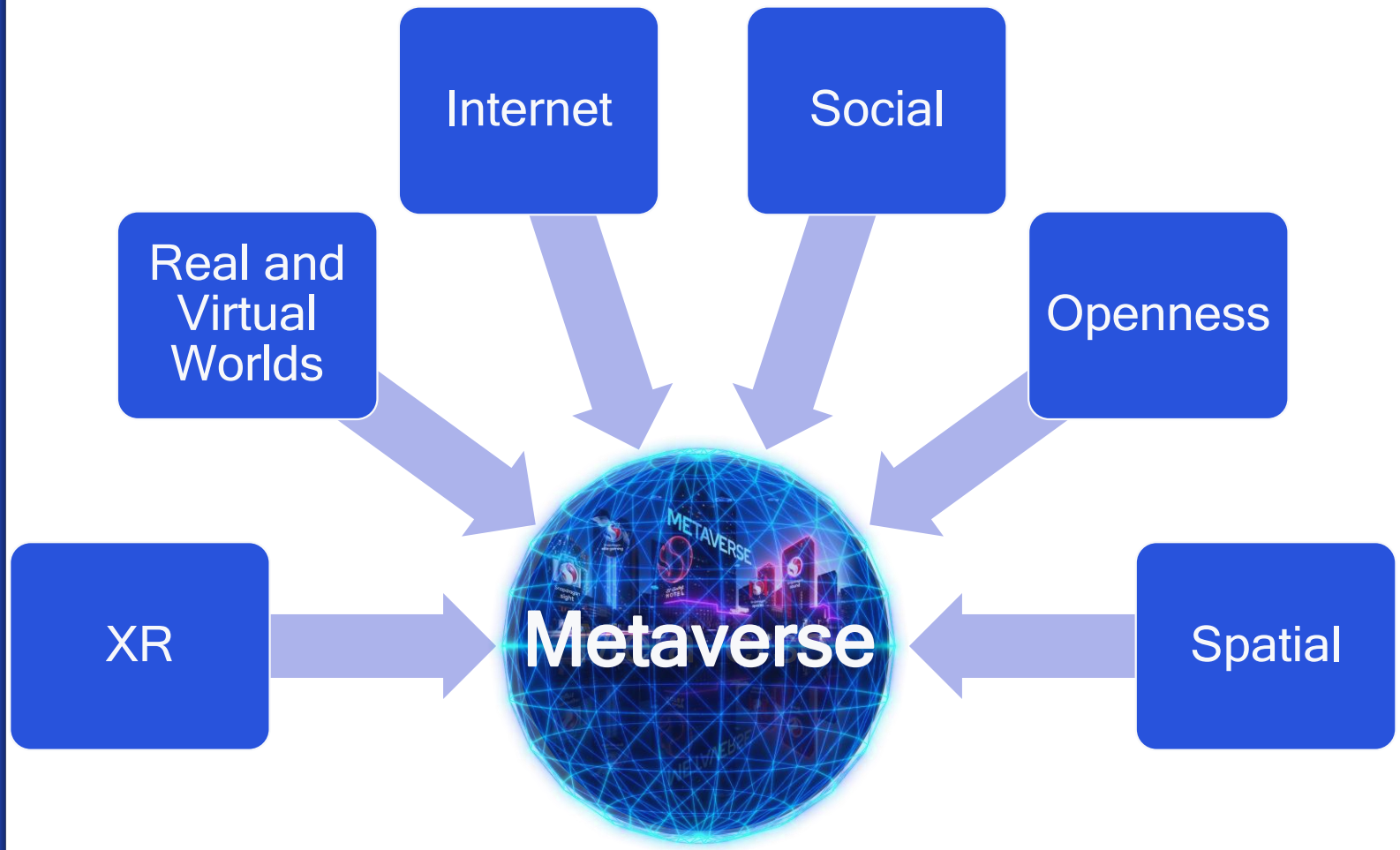
Ensure users can send as much information as they can receive

Metaverse

Persistent spatial internet with personalized digital experiences

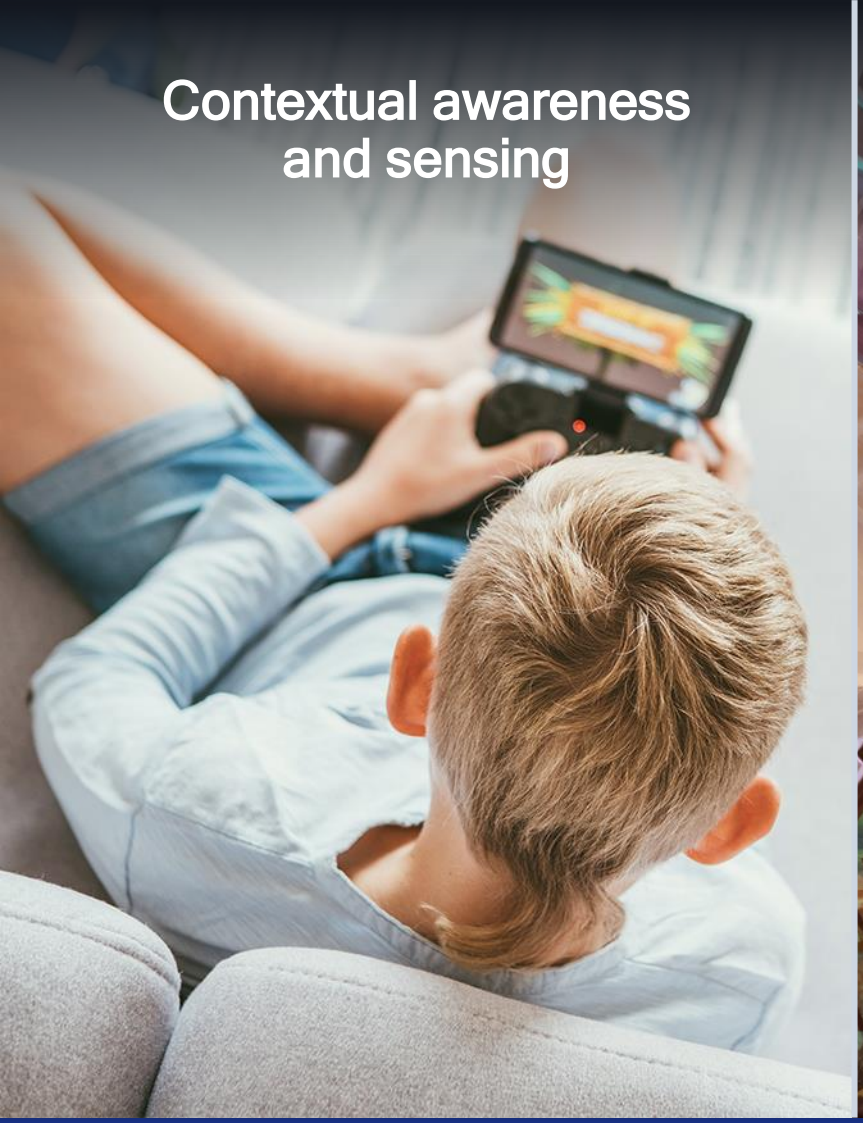
Spans both physical and virtual worlds

Shared virtual space in VR today, evolving to digitally enhanced physical space with AR & MR



Snapdragon

Your ticket to the metaverse



Technologies for the Metaverse: XR, AI, 5G

AR/VR/AI Work Flow

Simultaneous Complex Processing for Seamless AR/VR Experience

3 **Recognize and understand images** for symbolic information

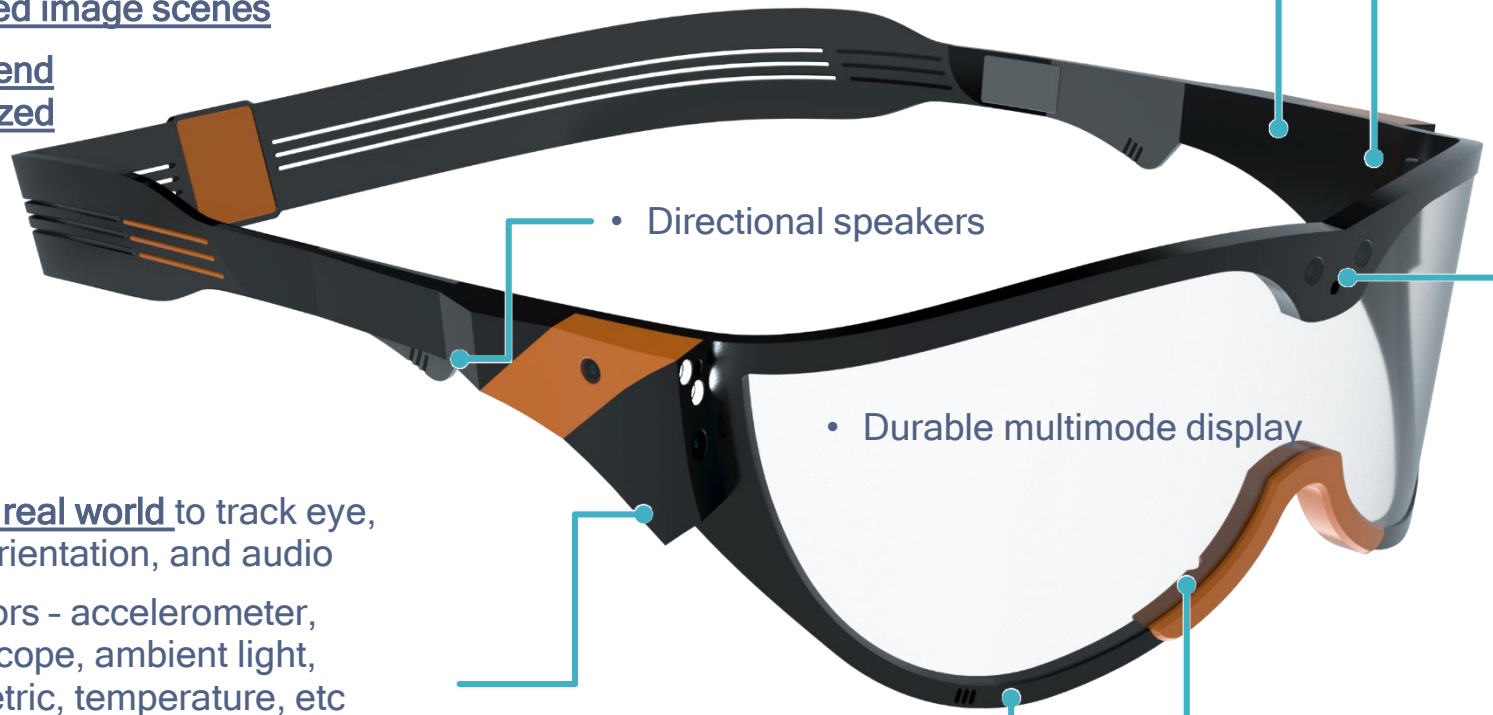
- Highly efficient and lower power CV processing

5 **Overlay virtual objects/data with real or virtually created image scenes**

6 **Recommend personalized actions**

4 **Collect virtual contents and data** from cloud network

- Multimode connectivity (4G, 5G, Wifi)
- GPS for location information
- Coding compression
- Video transport



- Directional speakers
- Durable multimode display

1 **Sense the real world** to track eye, position, orientation, and audio

- Sensors – accelerometer, gyroscope, ambient light, biometric, temperature, etc
- Multiple audio microphones
- Eye tracking cameras

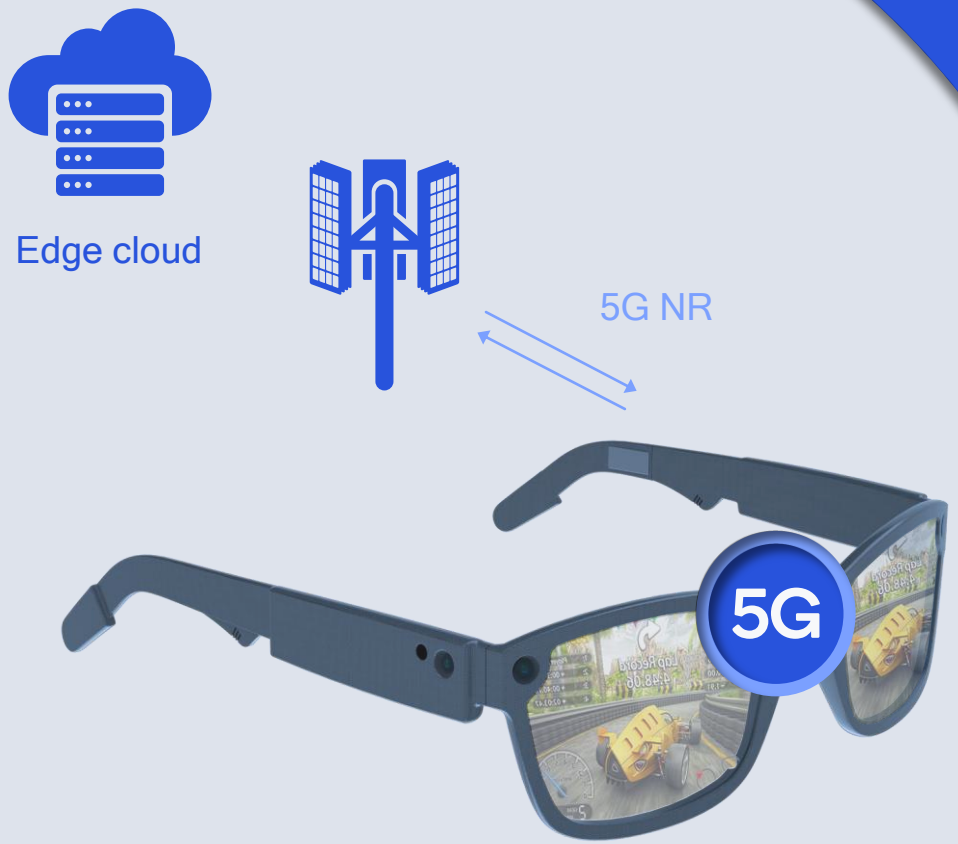
2 **See the world around** you by collecting and monitoring visual images for depth info, object detection, face detection

- Cameras with fisheye and telephoto lenses
- Depth sensing camera (TOF, Structured Light, etc)
- Optoelectronic night vision and thermal imaging sensors

A distributed compute architecture enables rich XR user experience

M2R2P = Edge processing + 5G round-trip time + Device processing

Boundless AR



Enabling 5G-powered AR glasses

Optimized edge processing

Migration from central cloud to local edge

Improved Infra schedulers[1]

Delay aware schedulers to meet latency QoS

Low-power, low-latency 5G

3GPP based features

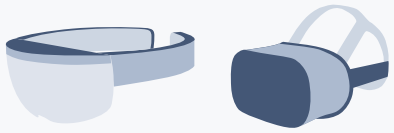
5G modem APIs

Enabling low latency on-device optimizations

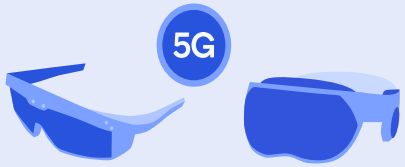
Enabling applications to adapt to RF/network conditions

XR evolution

Standalone
VR and AR



Standalone
VR and AR

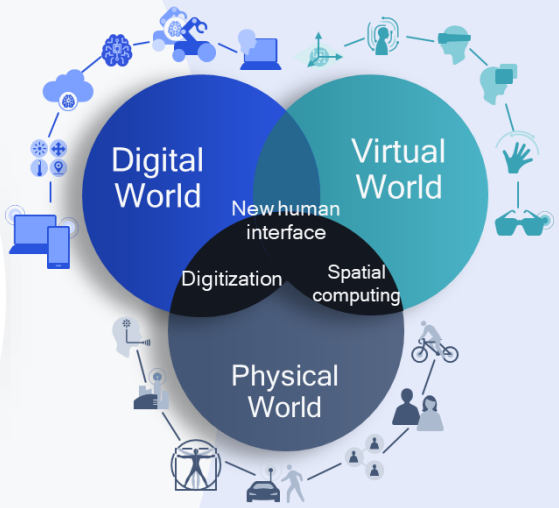


Today

Viewer VR & AR
cabled

1 - 4 years

Viewer VR & AR
wireless



Metaverse
6G research vector

Standards for the Metaverse

Open and Global Standards for the Metaverse

Metaverse STANDARDS FORUM™

3GPP A GLOBAL INITIATIVE

MPEG

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- XR Architectures
- XR Split Rendering
- Tethered AR Glass
- XR Conferencing
- IVAS Speech Codec
- XR Traffic QoS, Power Savings, Capacity Enhancement

- XR System: Scene Description
- Coding/Compression for CGC/3D content
- Haptics, Audio, Video
- Coding for Machines

Vulkan

OpenXR™

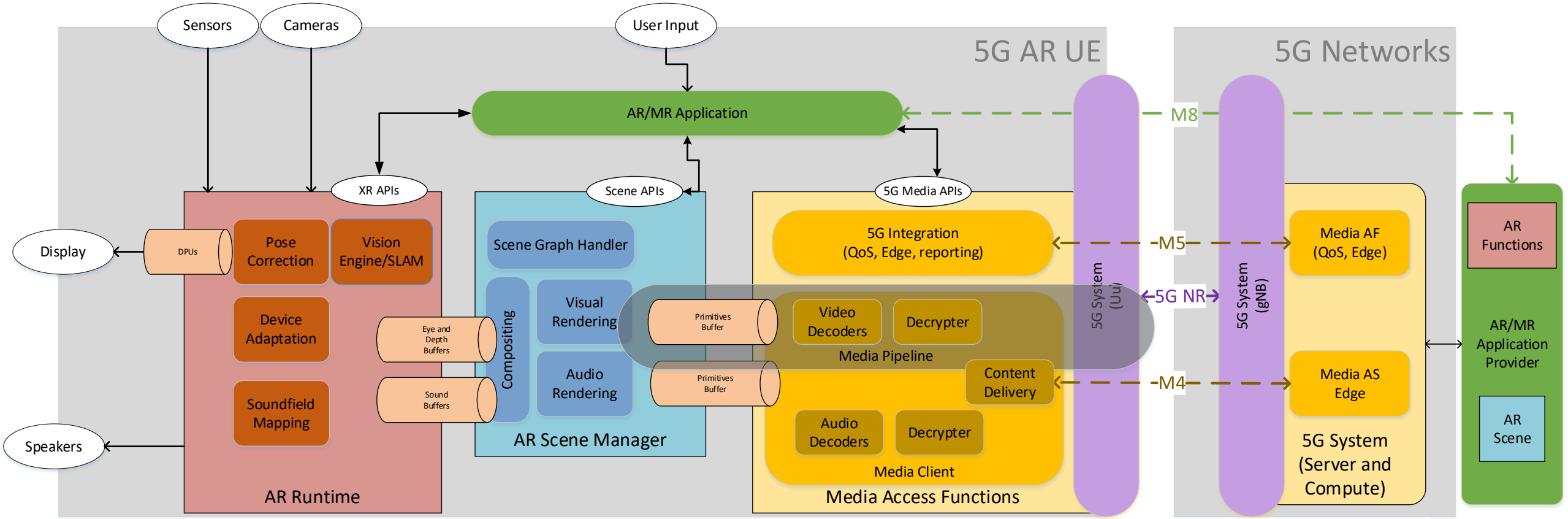
glTF™

QC driving or contributing

Additional selected organizations

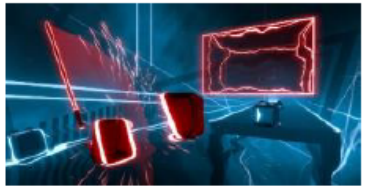
XR Standards – Optimizations, Systems and Workflows

Formalizing architectures, workflows and APIs for highest quality and lowest power consumption



OpenXR handles communication to and from an application and an XR platform

- Image(s) to display
- Audio
- Haptic responses



Application

OpenXR™

XR device

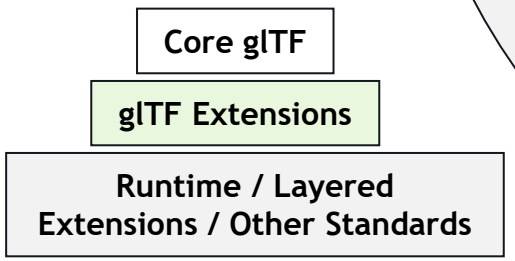
- Head & hand pose information
- Controller/input state
- Display configuration / form factor

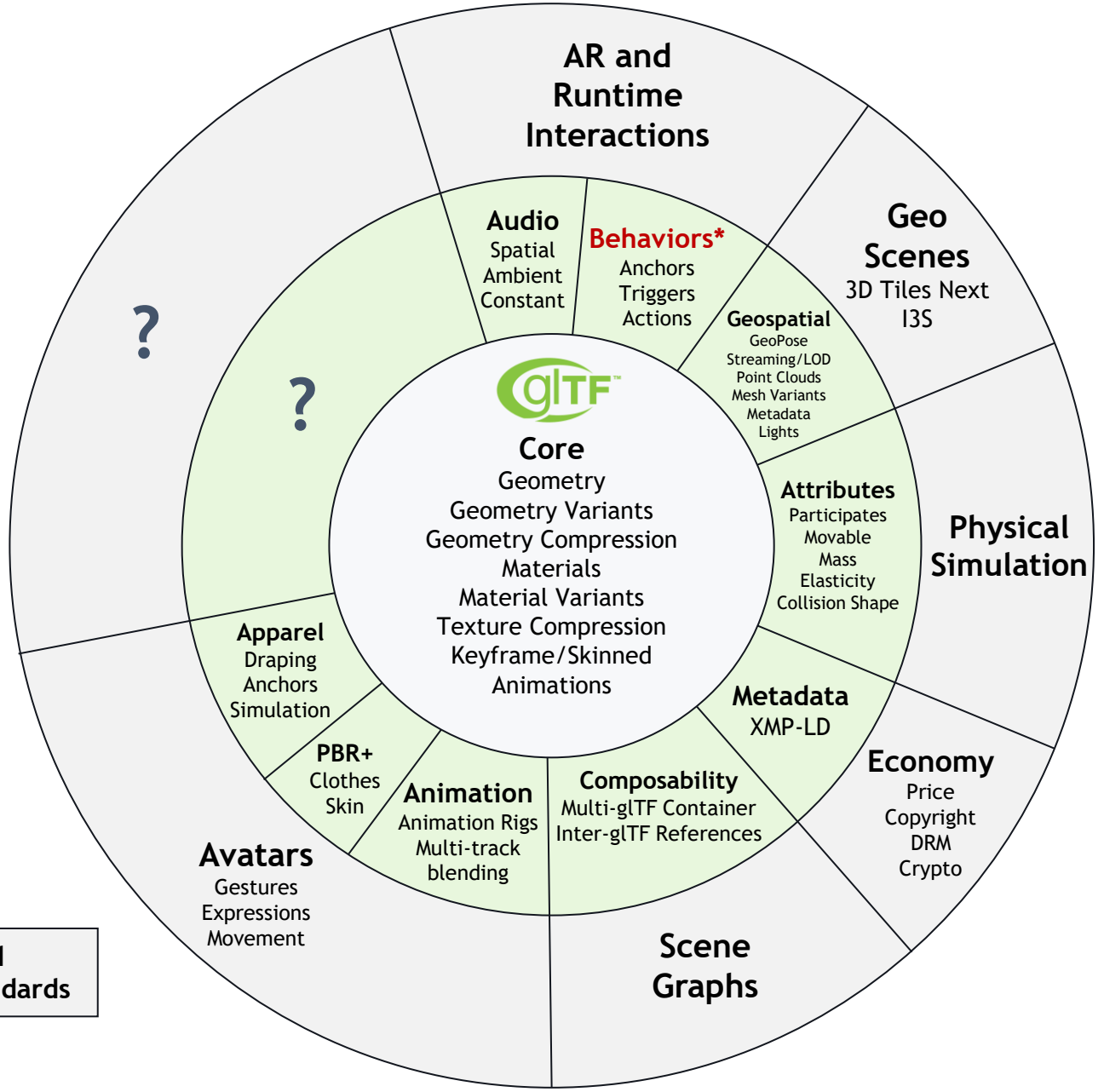
KHRONOS GROUP

glTF Roadmap

The metaverse is driving many key glTF use cases and requirements

KHRONOS GROUP



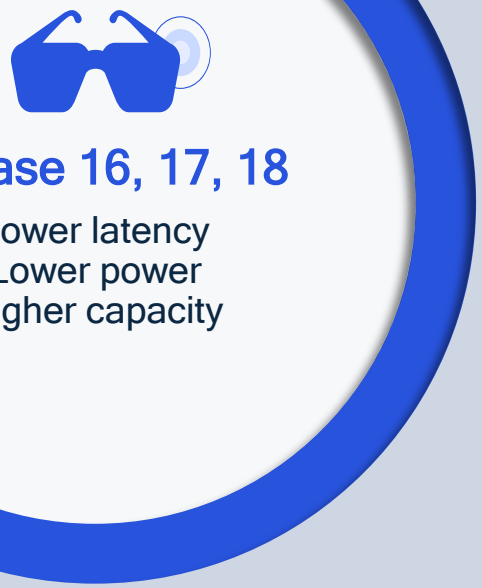


Improving XR experience with 5G and 5G Advanced

Rel-16: Low power modes

Rel-16: Uplink enhancements

Rel-17: XR burst handling



Release 16, 17, 18

Lower latency
Lower power
Higher capacity

Align transmission to multimedia cadence

Enhanced CDRX and configured grant

Sleep after low latency uplink transmission

Retransmission-less configured grant

QoS based on multimedia payload

Define QoS based on PDU sets

Staggering UE traffic arrivals at gNodeB

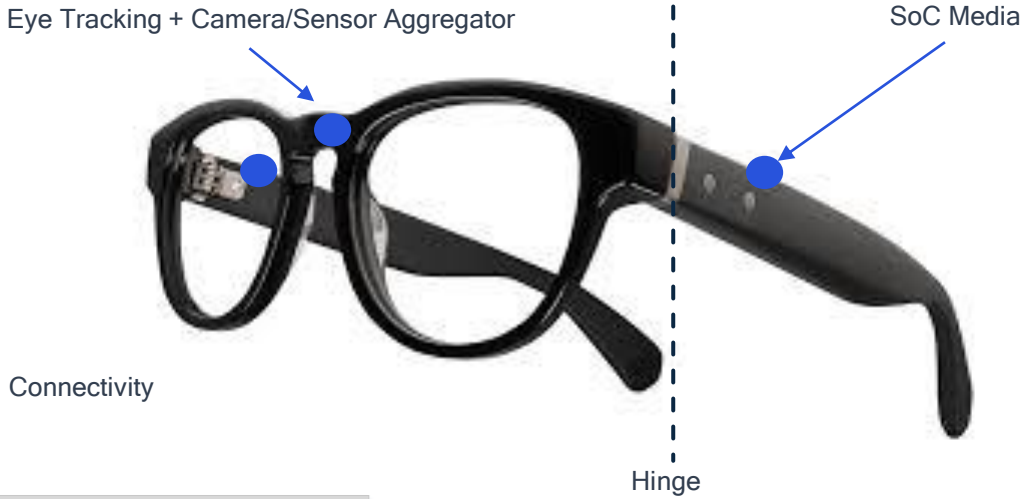
Improved scheduler

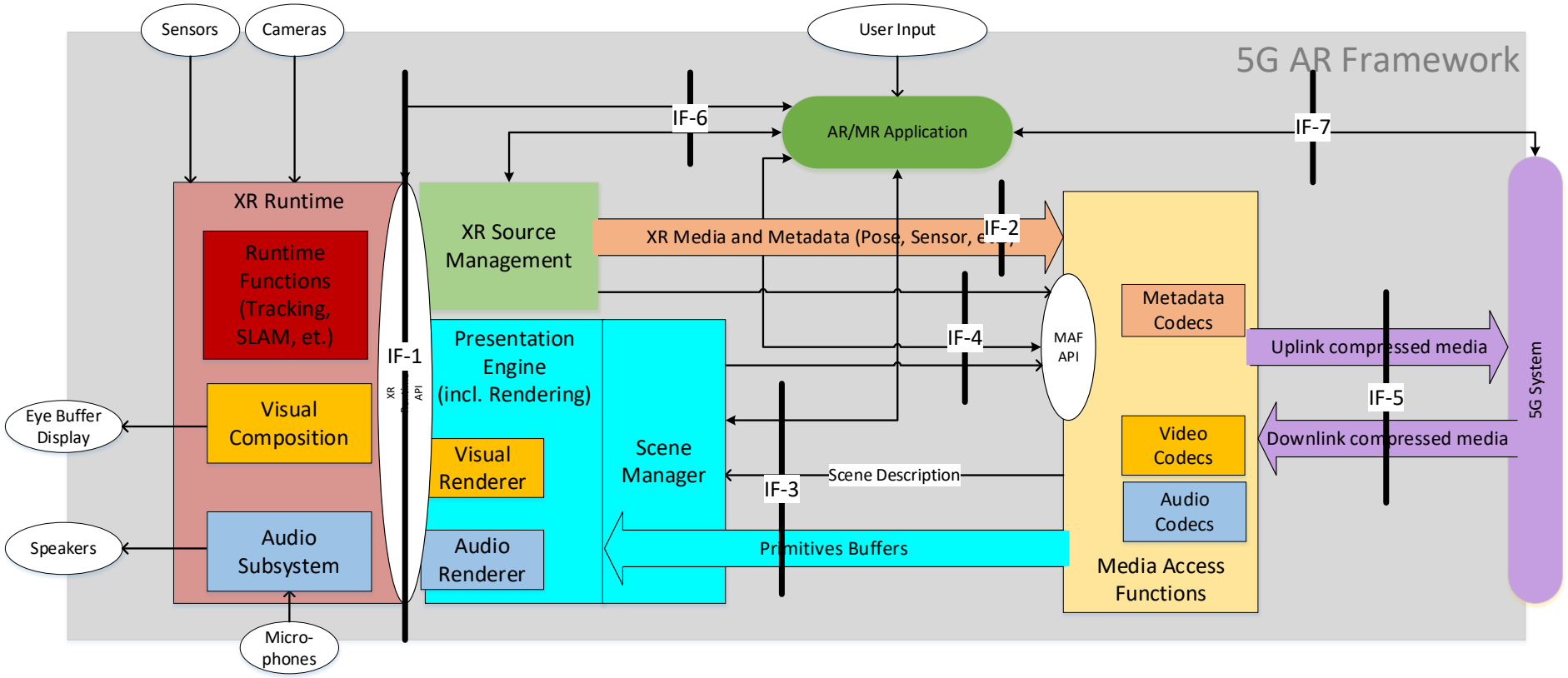
Low latency mobility

Using L1/L2 signaling for handoffs

Rel-18 Media Capabilities for AR

Defining baseline requirements for an AR lightweight device



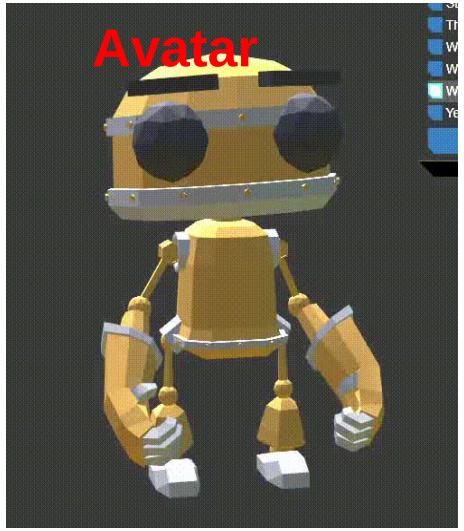


Requirements include

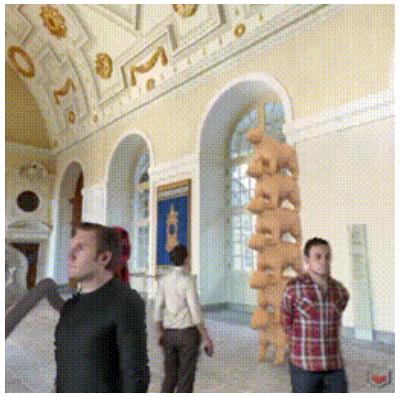
- OpenXR Core APIs
- rendering capabilities
- capturing capabilities
- audio and video codecs
- scene descriptions
- Profiles for split rendering and stand-alone rendering

MPEG-I Standards to power the Metaverse

- Scene Description
  - Entry point to the 3D experience
  - From shared experiences to 6DoF content and XR
  - Extensions to glTF for networked and real-time media



- Immersive Audio and Haptics
- Video Decoding Interface
  - Leverage and optimize 2D decoders for 3D and immersive media
- V-PCC and V-Mesh
  - Compress 3D formats such as point clouds and dynamic meshes
- MPEG Immersive Video
  - Support multi-view and light field displays



The Vision

A Venue for
Cooperation between
Standards Organizations and Companies to
Foster the Development of
Interoperability Standards for an
Open and Inclusive Metaverse

Metaverse
STANDARDS FORUM™

June 2022 - 37 Founding Organizations

November 1, 2022 - 1990 Members and Counting!

Wide diversity of organizations, including…

SDOs
Khronos, W3C, Open Geospatial Consortium, IEEE, OMI, ASWF, Spatial Web Foundation, VRM Consortium, XRSI, OMG, Open AR Cloud …

Platforms
Meta, Microsoft, Sony, Google, Baidu, Huawei, General Motors, RedHat, Siemens, Tencent, Mozilla, Paramount …

Tools and Engines
Epic, ESRI, Unity, Adobe, Autodesk, Otoy, Maxon, Cesium, Blackshark.ai, Croquet, Lamina1, Niantic, Ready Player Me, DGG, Manticore …

XR
HTC, Magic Leap, Nreal, Panasonic, Tobii, zSpace …

Hardware
NVIDIA, Intel, AMD, HP, Acer, Dell, Qualcomm, Samsung, MediaTek, Oppo, Lenovo, ZTE, LG …

Wireless and Networking
China Telecom, Deutsche Telekom, T-Mobile, Verizon, Telefónica, Juniper, Comcast …

3D Commerce
Alibaba, Alvanon, Avataar, CLO, Browzwear, IKEA, VNTANA, Metaverse Fashion Council, Target, Wayfair …

Universities and Institutes
Stanford, John Hopkins, Yale (XRP), Queens University Belfast, University Salford, New York Institute Technology, APMG …

Advocacy
XRSI, AREA, XR Association, VRAR Association, XR Guild, Web3 Marketing Association, International Virtual Reality Healthcare, Swiss Institute for Disruptive Innovation, IOT Consortium, RIAA …

Organizing for Effective Forum Action

1. Gather interoperability Topics from all members

Online input from all members on actionable topics that need improvement today!

2. Organize Topics into Domains

Consensus on where is member interest AND the Forum has member expertise to add industry value

3. Create Domain Working Groups

Focused discussions for smaller groups, Dedicated Portal group, chairs elected from membership

4. Working Group Projects

Focus on project execution, chairs elected from membership

5. Publish Project Work Products

Recommendations and guidelines, open-source tooling, interoperability pilot projects

Over 200 topics suggested and counting, for example..

Database of metaverse standards
Taking 3D assets between worlds
Asset LODs
glTF / USD interoperability
Avatar customization / animation
3D Apparel and Fashion
Cloth Simulation
Metaverse traversal
Geospatial ontologies
Geospatial streaming
Decentralized User ID
Ethical framework
User privacy
Child safety
Payment frameworks
Metaverse Pharmacy
Etc. etc..

Topics naturally falling into Domains

Topic	# Upvotes
Metaverse Standards Registry	69
3D Assets	186
Avatars and Apparel	75
Real/Virtual World Integration	98
Geospatial	36
User Identity	72
Privacy, Safety, Security, Inclusion	182
Payments and Economy	39
Governance and Advocacy	24
Teaching, Education, Exams, Certification	65
XR and UI	50
Metaverse Definition	40
Runtimes and Object Model	29
Networking	23
Tooling and Creators	12
Health and Medical	7
Business Analytics	4
Performance and Scalability	9
Gaming	9
Miscellaneous	11
Forum Outreach	1

Domain Working Group Pipeline

Approved Working Groups
Executing agreed Working Group Charters
Metaverse Standards Register

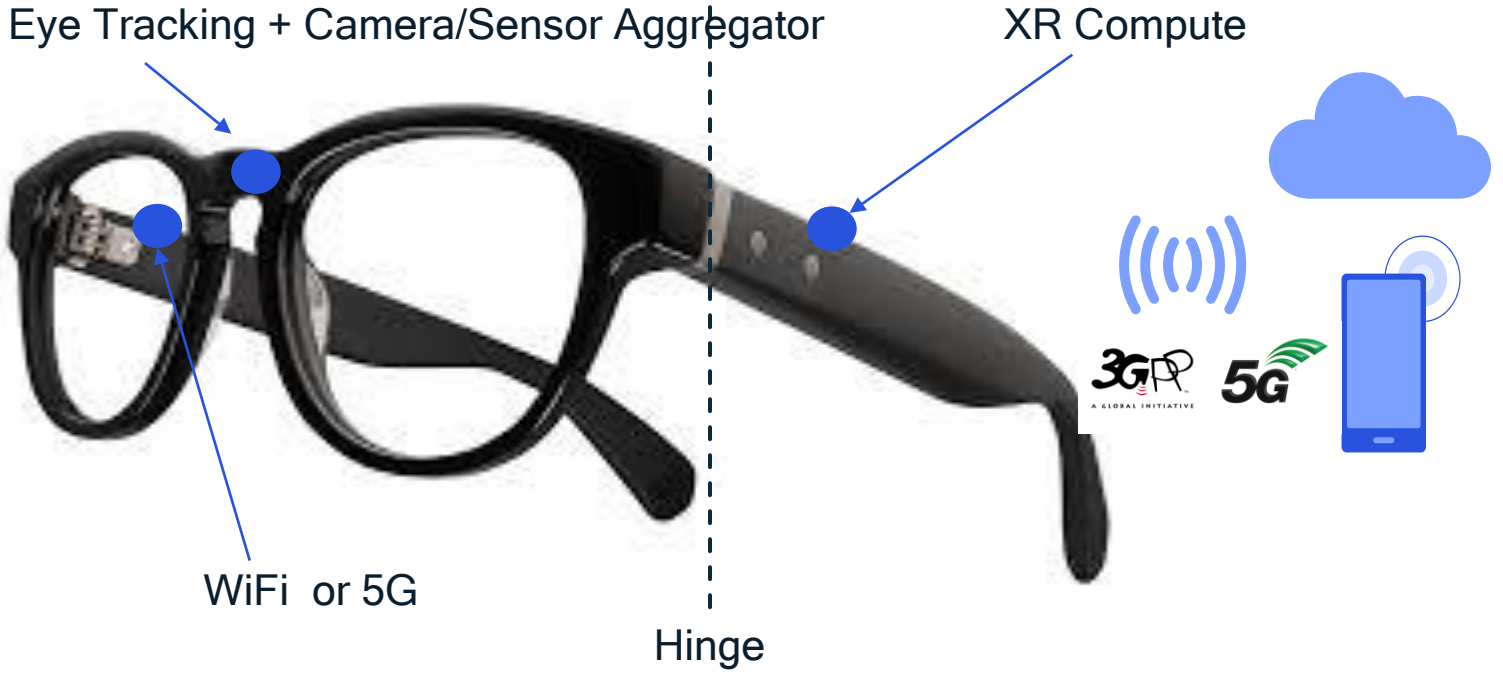
Approved Exploratory Groups
Building consensus on Working Group Charter Proposals
glTF/USD 3D Asset Interoperability (visuals, behaviors)
Digital Asset Management (web3, protection, digital rights)
Real/Virtual World Integration (Digital twins, IOT)
Avatars and Digital Fashion/Wearables
Privacy, Cybersecurity & Identity

More to come…
Any member can make Working Group proposals

Qualcomm`s view of the Metaverse Standards Forum

- "As a metaverse enabler and provider of key technology to the ecosystem, Qualcomm Technologies believes in taking an open platform approach and interoperable metaverse," said **Hugo Swart, vice president and general manager of XR, Qualcomm Technologies, Inc.** "We are thrilled to join the Metaverse Standards Forum to help define standards for the metaverse to flourish with a healthy ecosystem, and help creators pioneer innovative experiences that will lead the next generation of immersive technology."

- We strongly believe that the Metaverse needs to be mobile
  - Connected to real world - AR
  - Wireless
  - Minimize power
  - Split workloads
    - to remote devices / cloud
    - to balance power loading
  - Satisfy immersive user experience
  - Attractive for mass consumers



Qualcomm Technologies is enabling the Metaverse

Platforms

Snapdragon
XR2+ platform
Gen 1

Snapdragon
XR2 platform
Gen 1

Snapdragon
XR1 platform
Gen 1

Software & algorithms

6DoF/SLAM

Object Rec
& Tracking

Eye
Tracking

Pass Through
(video see through)

Hand
Tracking

3D
Reconstruction

Reference designs

Ecosystem

Snapdragon
spaces

Qualcomm Technologies is enabling the XR industry

Snapdragon powers key XR platforms

Snapdragon
XR2+ platform
Gen 1

Snapdragon
XR2 platform
Gen 1

Snapdragon
XR1 platform
Gen 1


Google Glass Enterprise Edition 2


ThirdEye X2


Vuzix M400


Microsoft Hololens 2


Nreal light


Lenovo ThinkReality A6


Lenovo Mirage Solo


Realmax Qian


Shadow Creator Action One


Shadow Creator Shadow VR


Shadow Creator Jimo


iQiyi 3


Shadow Creator HONGHU


Ximmerse Rhino X


Oculus Go


Oculus Quest


Meta Quest Pro


Pico G2 4K


Realwear HMT-1


iQiyi QiYu 2S


Lenovo Think Reality A3


Rokid Glass


Pic Neo


HTC VIVE Focus 3


Oculus Quest 2


HTC Vive Focus Plus


3Glasses X1


XRSpace Mova


HTC Vive Cosmos

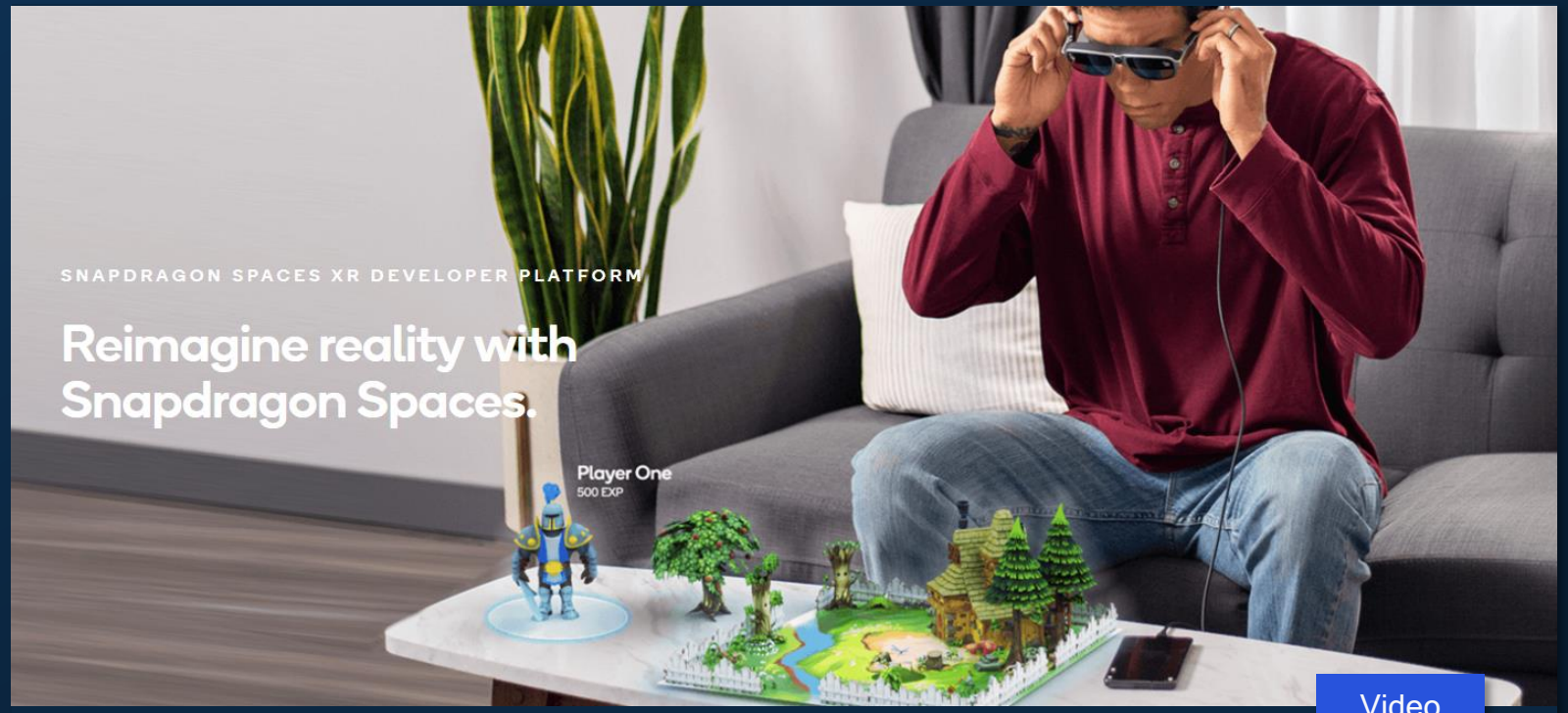

DPVR P1 Pro


Xiaomi Mi VR

60+
Devices launched

Snapdragon Spaces™ XR Developer Platform

Empowering developers to create immersive experience for AR Glasses



Video

- Open platform and open ecosystem
- Paves the way to a new Frontier of Spatial Computing

Qualcomm launches

up to $100M

Snapdragon™ Metaverse Fund

Qualcomm

enables boundless XR by

- XR Hardware technologies
- XR reference designs
- XR platforms and SDKs
- 5G/6G/WiFi Connectivity
- Open Standards

Questions?

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Snapdragon

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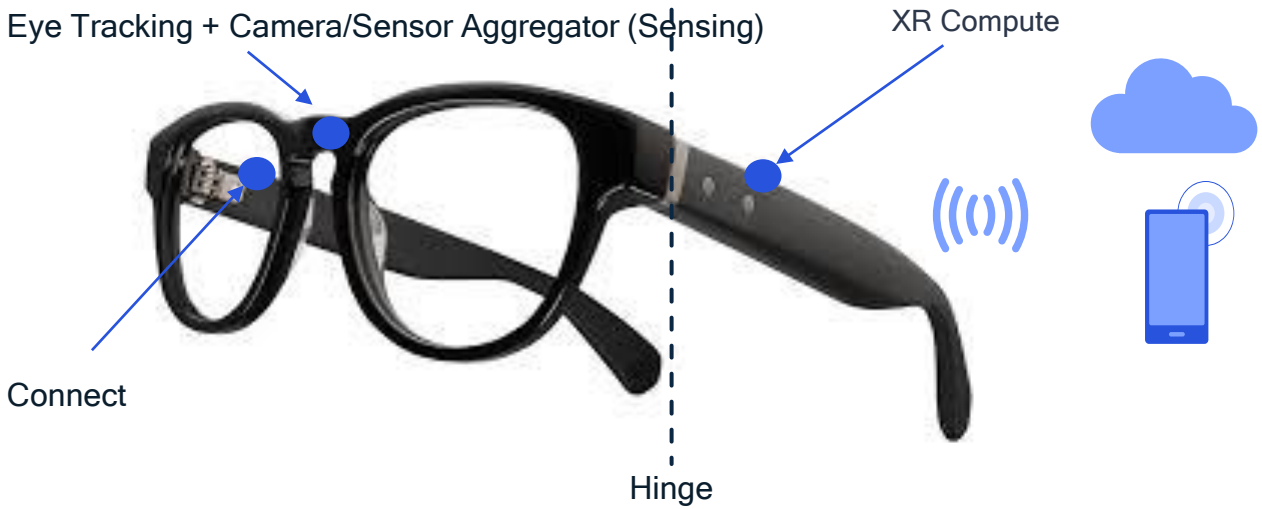
AR System Architecture / Partitioning



Key Goals/Constraints for Chipset

- Minimize power per thermal island – divide workloads to multiple chips in headset
- Minimize overall power for battery life
- Minimize wire across hinges
- Partition workloads to remote devices / cloud to balance power loading
- Satisfy end-to-end latency requirements
- Conform to physical size constraints