

14<sup>TH</sup> ITU ACADEMIC CONFERENCE

**ITU** KALEIDOSCOPE  
ACCRA 2022

# A survey of Extended Reality standards

7-9 December 2022  
Accra, Ghana





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**Session:** Invited paper

*NOTE: The opinions expressed in this presentation are those of the authors and do not necessarily reflect the views of the ITU or its membership.*



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# What is XR?

*An environment containing real or virtual components or a combination thereof, where the variable 'X' serves as a placeholder for any form of new environment (e.g., augmented, assisted, mixed, virtual or diminished reality).*

Recommendation ITU-T P.1320



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MR HoloLens, Microsoft

Pokémon Go, Shutterstock / Wachiwit

# Transitioning from physical to virtual interaction

- **Pre-pandemic >>** XR videoconferencing; AR gaming (Pokémon Go); XR headsets (Oculus VR, HoloLens MR)
- **Pandemic >>** Professional/social activity moves online, increased use of meeting platforms with real, virtual, mixed elements
- **Facebook becomes Meta >>** *Rise of The Metaverse* “a hybrid of today’s online social experiences, sometimes expanded into three dimensions or projected into the physical world”



# Rationale for standards

## Post-pandemic status:

- Market growth
- Increased consumer demand
- Tech developments, Metaverse



## Challenges:

- Market fragmentation
- Cost of production, service delivery & usage
- Access for new market entrants



# Standardization themes

## **INTEROPERABILITY**

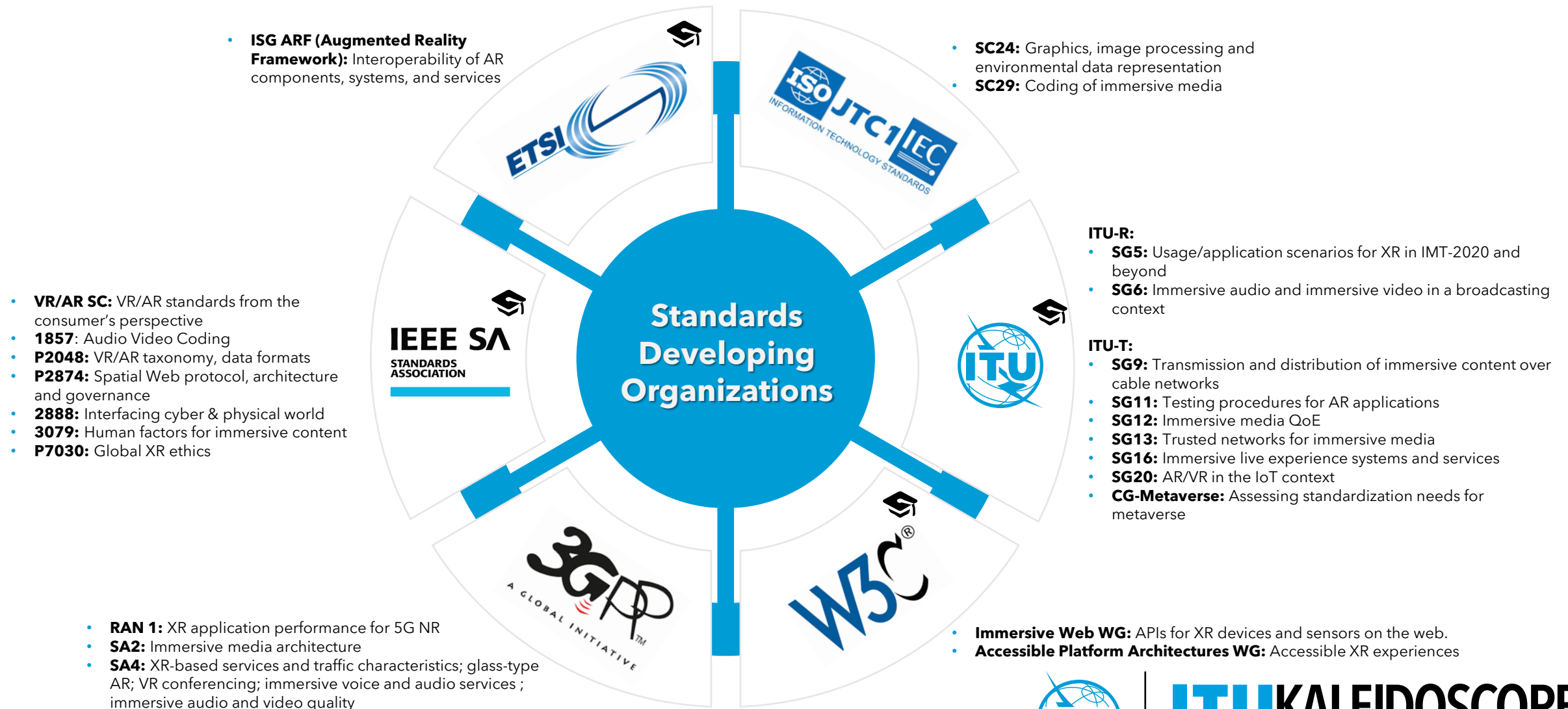
Building capabilities for interoperable XR experiences

## **USER EXPERIENCE**

Specifying user requirements for accessible and high quality XR experiences

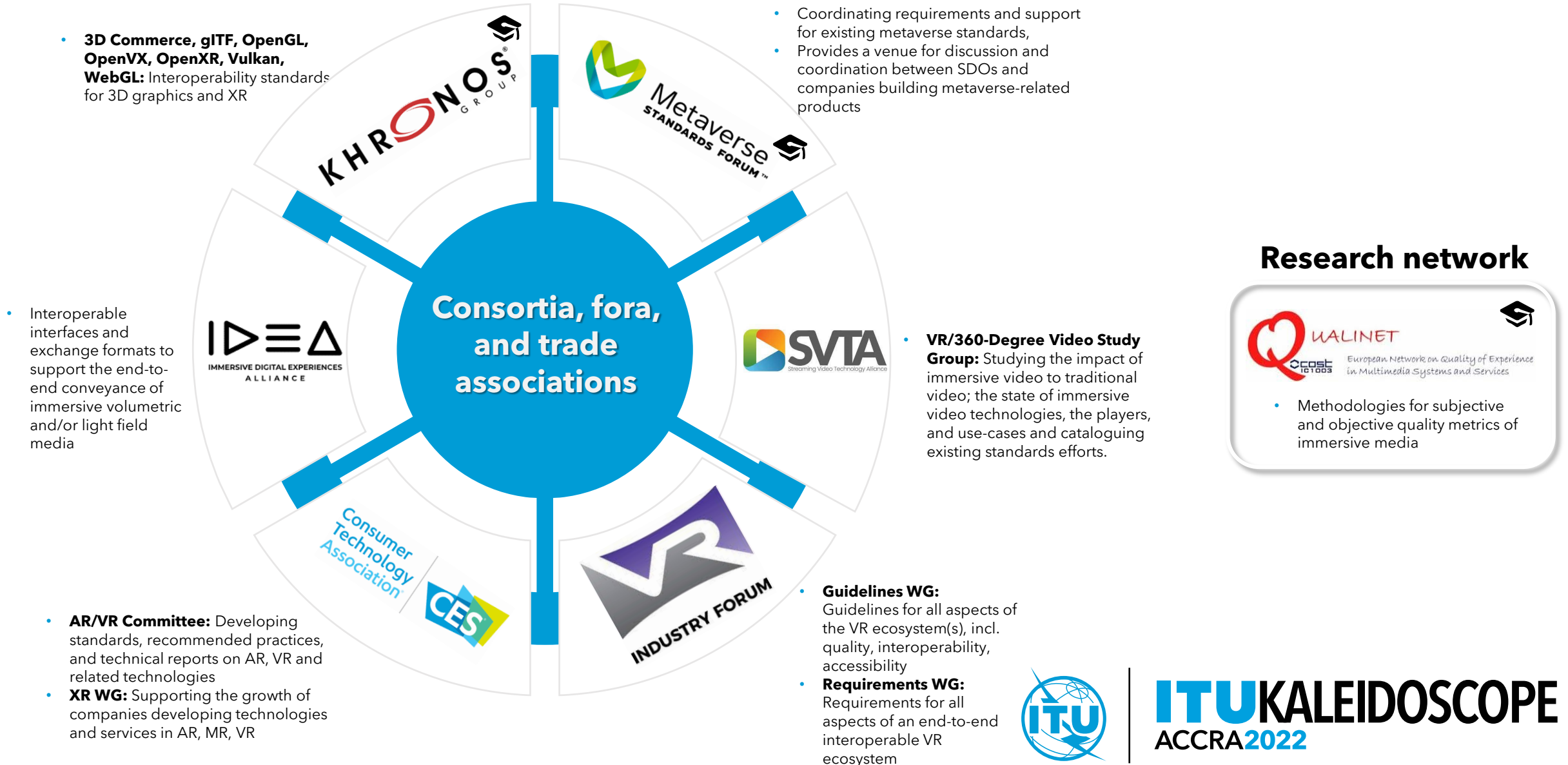


# SDOs active in XR standardization



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# Other groups active in XR standardization





## **INTEROPERABILITY**

Building capabilities for  
interoperable XR experiences

- Terminology
- Service scenarios, use cases
- Architecture, design guidelines, system requirements
- Interfaces and reference models
- Data formats and coding



## Terminology, service scenarios, use cases

### Terminology

- [CTA >> CTA-2069-A](#) "Definitions and Characteristics of A & VR"; **CTA-2085** "Definitions and Characteristics for VR Video and VR Images"

- [ITU-T Study Group 12 >> Rec. P.1320](#) "QoE assessment of XR meetings"

\*XR terminology features more in standards covering other XR topics than in stand-alone documents

### Service scenarios, use cases

- [3GPP SA4 >> TR 26.862](#) "IT4RT Use Cases, Requirements and Potential Solutions"; **TR 26.928** "XR in 5G"; **TR 26.918** "VR media services over 3GPP"; **TR 26.998** "Support of 5G glass-type AR/MR devices"

- [ETSI ISG ARF >> GR ARF 002](#) "Industrial use cases for AR applications and services"

- [ETSI ISG MEC >> GS MEC 002](#) "MEC; Phase 2: Use Cases and Requirements"; **GS MEC-IEG 004** "MEC; Service Scenarios"

- [ITU-T Study Group 9 >> Rec. J.301](#) "Requirements for AR smart TV systems"

- [ITU-T Study Group 12 >> GSTR-5GQoE](#) "QoE requirements for real-time multimedia services over 5G networks"

- [ITU-T Study Group 16 >> Rec. F.740.2](#) "Requirements and reference framework for digital representation of cultural relics and artworks using AR"; **Rec. H.430.3** "Service scenario of ILE"

- [SVTA >>](#) "eXtended reality brief"



## System requirements, architecture, design guidelines, APIs

### System requirements

- ETSI ISG ARF >> **GS ARF 004-x series** "Interoperability Requirements for AR components, systems and services"
- ITU-R Study Group 5 >> **Rec. BT.2123** "Video parameter values for advanced immersive audio-visual systems for production and international programme exchange in broadcasting"
- ITU-T Study Group 9 >> **Rec. J.302** "System specifications of AR smart TV service"
- ITU-T Study Group 16 >> **Rec. H.430.1** "Requirements for ILE services"; **Rec. H.430.4** "Service configuration, media transport protocols, signalling information of MPEG media transport for ILE systems" ; **Rec. H.430.5** "Reference models for ILE presentation environments"

### Architecture, design guidelines

- ETSI ISG ARF >> **GS ARF 003** "AR framework architecture"
- ITU-T Study Group 16 >> **Rec. H.430.2** "Architectural framework for ILE services"
- VRIF >> **VRIF 2.3** "VRIF Guidelines 2.3"



## Interfaces and reference models

### APIs

- [ISO/IEC JTC 1 SC29 >> ISO/IEC 23090-8](#) "Coded representation of immersive media – Part 8: Network based media processing"
- [Khronos Group >> gLTF 2.0.1](#) "gLTF 2.0 Specification"; **OpenXR 1.0** "The OpenXR Specification"

*Under development: W3C Immersive Web WG's WebXR series*

### Reference models

- [ISO/IEC JTC 1 SC24 >> ISO/IEC 18038](#) "Sensor representation in mixed and augmented reality (MAR)"; **ISO/IEC 18039** "MAR reference model"; **ISO/IEC 18040** "Live actor and entity representation in MAR"; **ISO/IEC 18520** "Benchmarking of vision-based spatial registration and tracking methods for MAR"; **ISO/IEC 19775 series** "X3D"; **ISO/IEC 19776 series** "X3D encodings"; **ISO/IEC 23488** "Object/environmental representation for image-based rendering in VR/MAR"



## Data formats and coding

### Data formats and coding

- [IDEA >> ITMF](#) "*Immersive Technologies Media Format specification suite*"
- [IEEE 1857 >> IEEE 1857.9](#) "*Standard for Immersive Visual Content Coding*"
- [ISO/IEC JTC 1 SC29 >> ISO/IEC 21794](#) "*Plenoptic image coding system (JPEG Pleno)*"; [ISO/IEC 23000-13](#) "*Multimedia application format (MPEG-A) – Part 13: AR application format*"; [ISO/IEC 23005 series](#) "*Media context and control*"; [ISO/IEC 23090 series](#) "*Coded representation of immersive media*"
- [ITU-R Study Group 6 >> ITU-R BT.2133-0](#) "*Transport of advanced immersive audio visual content in IP-based broadcasting systems*"



## **USER EXPERIENCE**

Specifying user requirements  
for accessible and high quality  
XR experiences

- XR accessibility guidelines
- QoE influencing factors
- Quality metrics and KPIs
- Test specifications
- Quality assessment methods
- Quality of Service (QoS) and network performance aspects



## XR accessibility

### XR accessibility user requirements and design principles

- [ETSI Human Factors >> ETSI EG 202 848](#) "Optimizing the accessibility and the use of upcoming user-interaction technologies"
- [W3C Accessible Platform Architectures >> WG Note](#) "XR Accessibility requirements"

### Accessibility requirements for users with reduced mobility

- [AR/VR Committee >> CTA-2095](#) "Best practices for limited mobility in XR"



## QoE factors, quality metrics & KPIs, test specifications

### QoE

- [IEEE 3079 WG](#) >> **IEEE 3079** "Head-Mounted Display (HMD)-Based VR Sickness Reduction Technology"
- [ITU-T Study Group 12](#) >> **Rec. G.1035** "Influencing factors on QoE for VR services"; **Rec. G.1036** "QoE influencing factors for AR services"

### Quality parameters, metrics and KPIs

- [ISO/IEC JTC 1 SC29](#) >> **ISO/IEC 23090-6** "Coded representation of immersive media – Part 6: Immersive media metrics"
- [3GPP SA4](#)>> **TR 26.929** "QoE parameters and metrics relevant to the VR user experience" | **TR 26.998** "Support of 5G glass-type AR/MR devices"
- [ITU-T Study Group 12](#) >> **GSTR-5GQoE** "QoE requirements for real-time multimedia services over 5G networks"

### Test specifications

- [ITU-T Study Group 11](#) >> **Rec. Q. 4066** "Testing procedures of AR applications"





## Quality assessment methods, QoS and performance aspects

### Quality assessment methods

- 3GPP SA4 >> **TS 26.259** "Subjective test methodologies for the evaluation of immersive audio systems"; **TS 26.260** "Objective test methodologies for the evaluation of immersive audio systems"
- ITU-T Study Group 12 >> **Rec. P.919** "Subjective test methodologies for 360° video on HMDs"; **Rec. P.1320** "QoE assessment of XR meetings"
- IEEE P3333.1 >> **IEEE 3333.1.1** "QoE and Visual-Comfort Assessments of 3D Contents Based on Psychophysical Studies"; **IEEE 3333.1.2** "Perceptual Quality Assessment of 3D and UHD Contents"; **IEEE 3333.1.3** "Deep Learning-Based Assessment of Visual Experience Based on Human Factors"

### QoS and performance aspects

- 3GPP RAN1 >> **TR 38.838** "Study on XR evaluations for NR"
- ITU-T Study Group 9 >> **Rec. J.1631** "Functional requirements of E2E network platforms to enhance the delivery of cloud-VR services over integrated broadband cable networks"
- ITU-T Study Group 13 >> **Rec. Y.3109** "QoS assurance-related requirements and framework for VR delivery using MEC supported by IMT-2020 "



# Summary

- **Standards are critical** in achieving interoperability and facilitating greater adoption of XR.
- Current standardization activities are centered around 2 themes:
  1. **Building capabilities for XR interoperability** - by establishing common understanding, identifying key system/user requirements, developing compatible interfaces and data formats
  2. **Defining XR user experience requirements** - addressing accessibility and quality aspects

## **Explore avenues for participation and contribute to the growing XR standards landscape**

- Opportunities for engagement:
  - Towards **completion of standards under development** e.g., IEEE P2048.x, W3C WebXR, MPEG-I series, ITU-T P.IntVR (subjective test methods for interactive VR) and F.ARMSOR (object recognition for digital artwork using AR)
  - **In future standards work** with a potentially extended scope covering e.g., security, privacy, ethics



**Thank you!**