

VQEG

An Overview on Standardization for Social XR

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POLITÉCNICA

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Generations of social XR experiences

And their standardization needs

The first generation

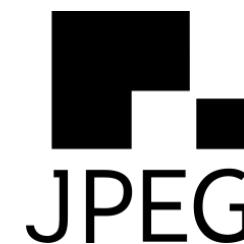


- Analog signal (interoperability)
- **Perceptual quality** (capacity planning)

Going digital



- Digital coding (voice, audio, video)
- Digital signal transport



Internet & the web: an open platform



- IP Protocol stack (HTTP, RTP, TCP, UDP...)
- Web standards (HTML, CSS, ...)
- Open and proprietary implementations

Social XR experiences

- A complex ecosystem of standards and platforms
- No unique way of doing things



Media coding and transport



ITU-T SG16: Multimedia

(Joint standards,
e.g. ITU-T H.26x)

Subcommittee 29:
*Coding of audio, picture, multimedia
and hypermedia information*



3GPP SA4
Multimedia Codecs,
Systems and Services

(Voice codecs)



ISO/IEC JTC 1/SC 29

- Standards in the field of: Coding of audio, picture, multimedia and hypermedia information.

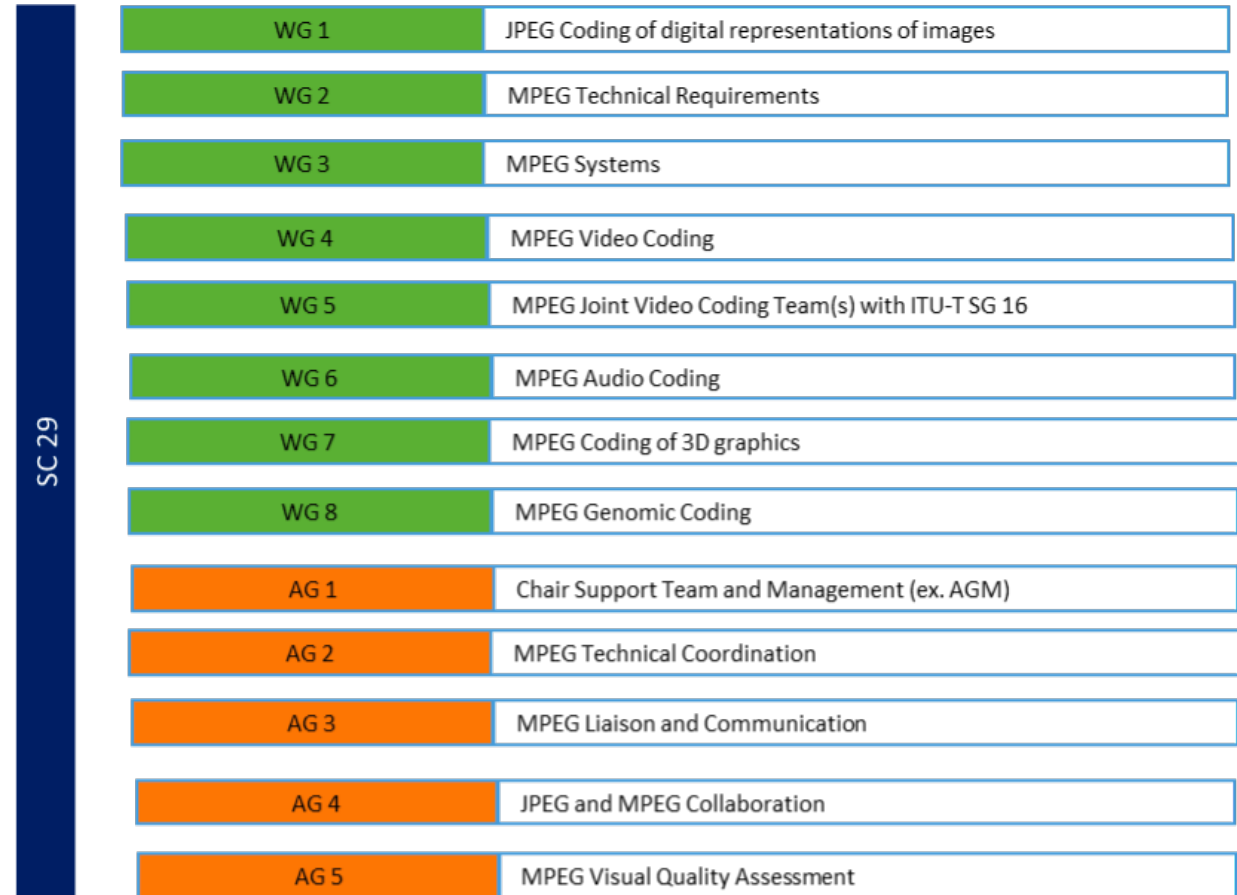
- Moving Picture Experts Group**



- <https://www.mpeg.org/>

- Joint Photographic Experts Group**

- <https://jpeg.org/>

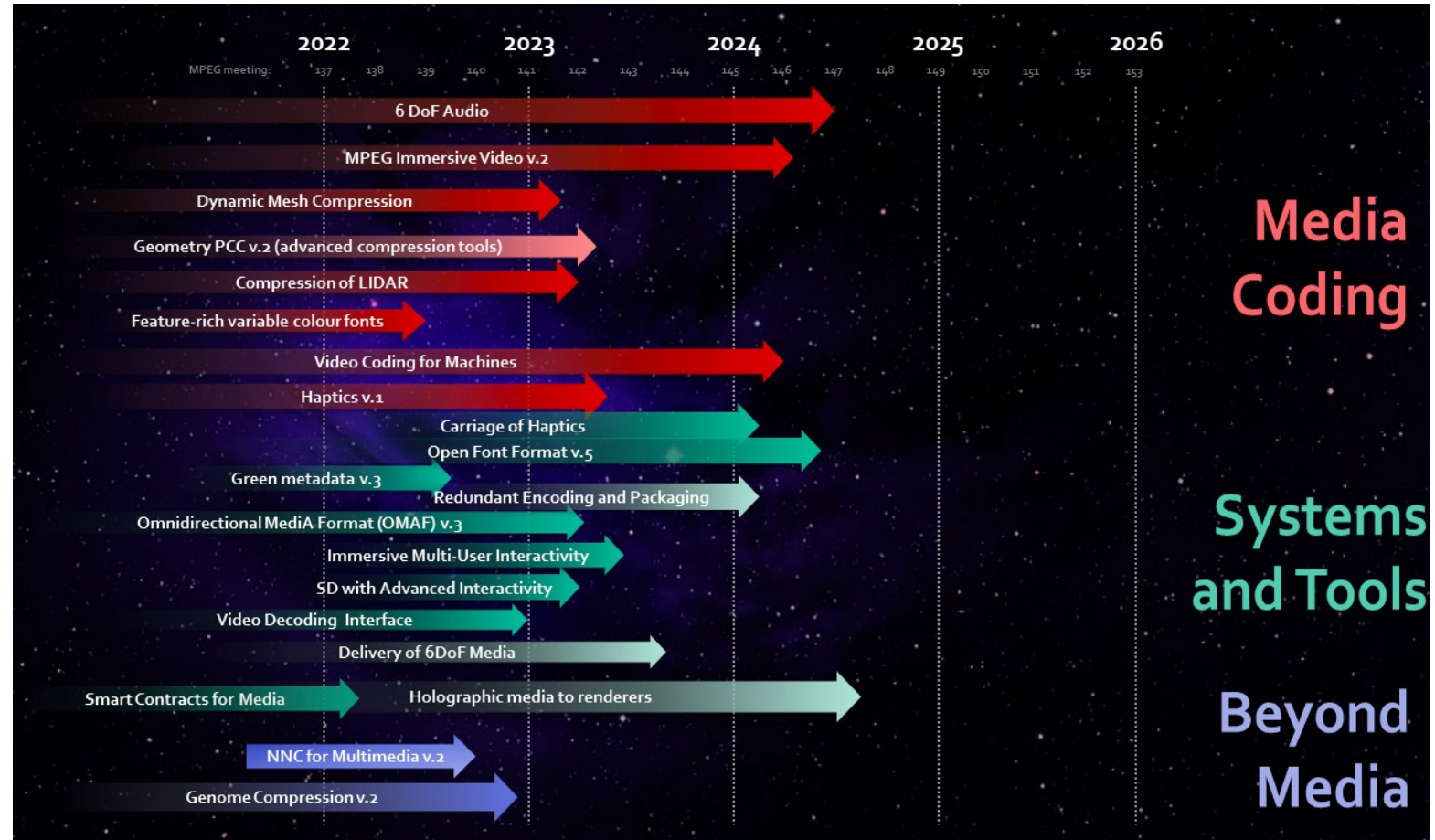


*ISO/IEC JTC1 SC29, "Terms of Reference of SC 29/WGs and AGs," Doc. SC29N19020, July 2020.



- Develops standards for coded representation of digital audio, video, 3D graphics and genomic data.

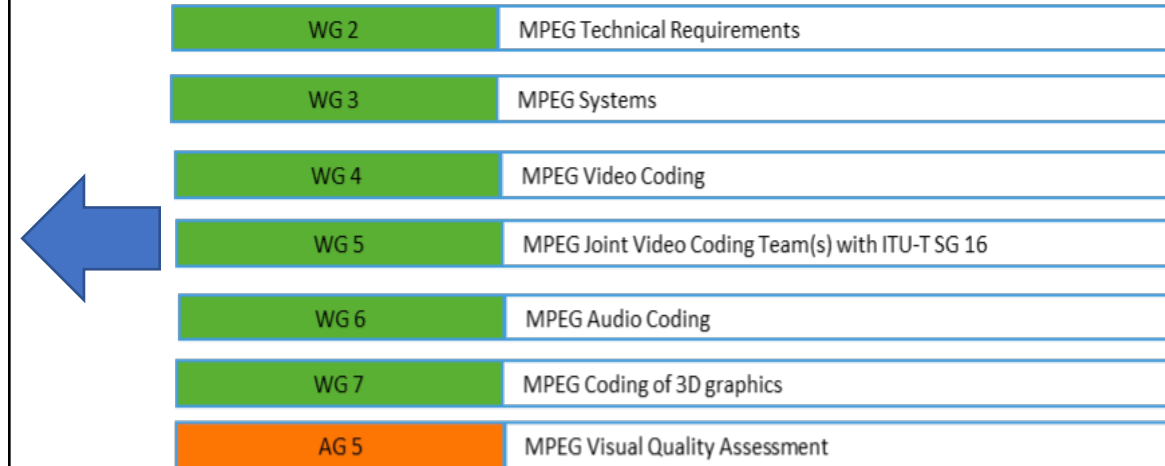
- Enable the industry to offer interoperable devices for an enhanced digital media experience.
- For example, AVC, HEVC, VVC, MP3, DASH.

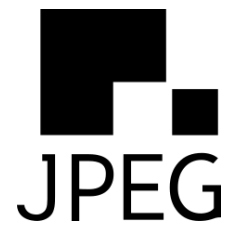




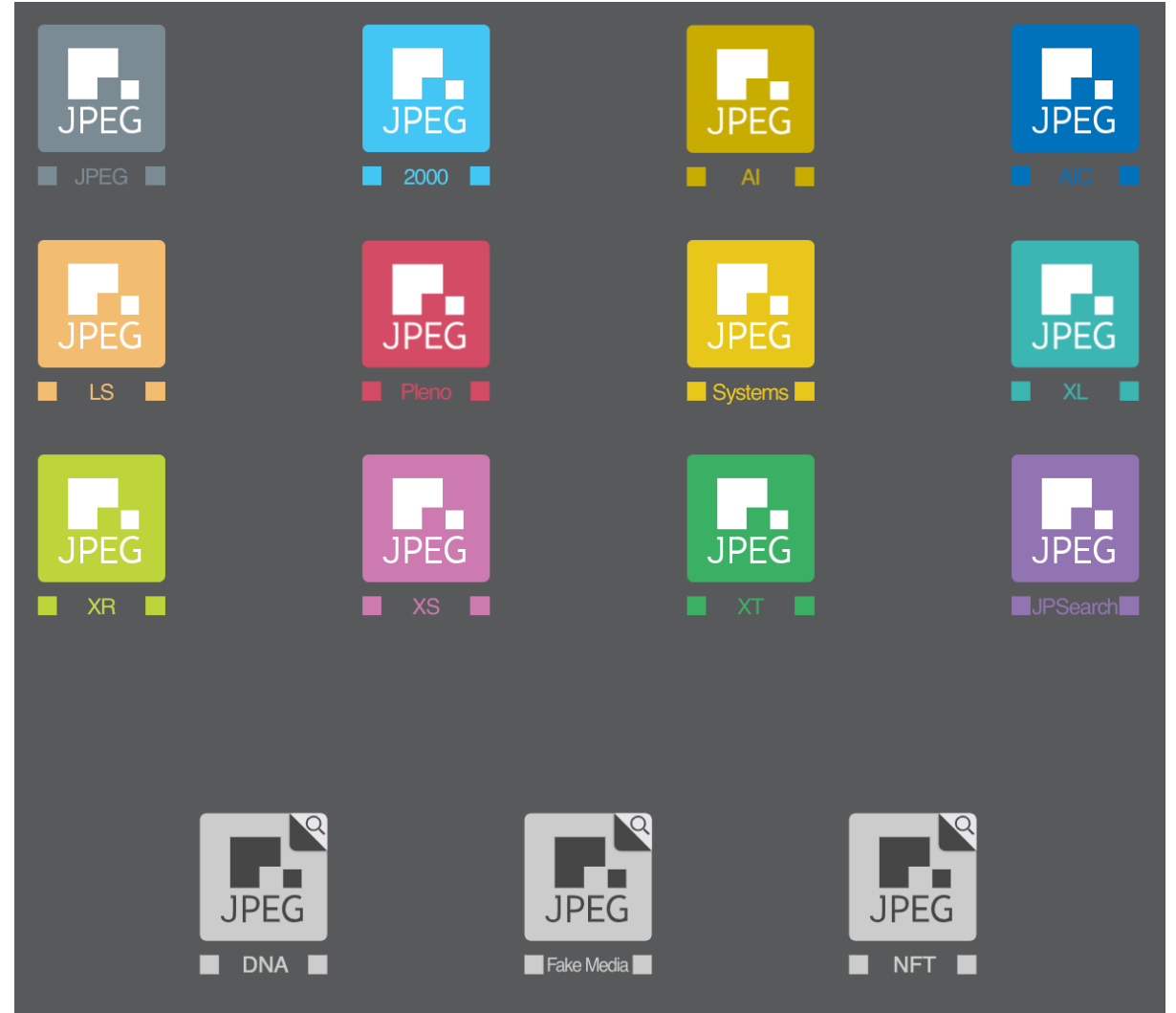
- Standards related to immersive media: **MPEG-I (ISO/IEC 23090)**
 - A collection of standards to digitally represent immersive media, such as:

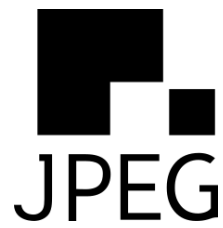
Part 1	Immersive Media
Part 2	Omnidirectional Media Format
Part 4	Immersive audio
Part 5	Visual Volumetric Video-based Coding (V3C) and V-PCC
Part 6	Immersive Media Metrics
Part 7	Immersive Media Metadata
Part 9	G-PCC
Part 10	Carriage of Visual Volumetric Video-based Coding Data
Part 12	Immersive Video
Part 13	Video Decoding Interface for Immersive Media
Part 14	Scene Description for MPEG Media
Part 29	Video-based dynamic mesh coding
Part 31	Haptics coding





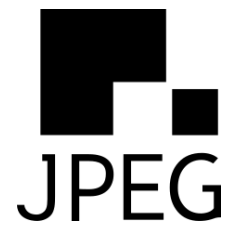
- Long tradition in the creation of still image coding standards.
- Creates the standards for coding of digital representations of images.
- JPEG activities are the result of an additional collaboration with the International Telecommunication Union (ITU).





- **JPEG Pleno**

- Aims to provide a standard framework for representing new imaging modalities, such as **texture-plus-depth**, **light field**, **point cloud**, and **holographic** imaging.
- It is not just a set of efficient coding tools addressing compression efficiency...
- It is a representation framework understood as a fully integrated system for providing advanced functionality support for **image manipulation**, **metadata**, **random access and interaction**, and **various file formats**.



- **JPEG Pleno**

Part 1: Framework

Specifies the JPEG Pleno framework and the interrelationships between the different components of the standard, i.e. representation of light-field, point-cloud and holographic modalities and system related aspects.

Part 2: Light Field Coding

Specifies the coding technology for light field modalities

Part 3: Conformance testing

Defines conformance testing for the standardized technologies covered by the JPEG Pleno framework.

Part 4: Reference software

Provides reference implementations for the standardized technologies within the JPEG Pleno framework for purpose of reference for prospective implementers of the standard and compliance testing.

Use case: XR in 5G



Technical Specification Groups (TSGs)

The Working Groups, within the TSGs, meet regularly and come together for their quarterly TSG Plenary meeting, where their work is presented for information, discussion and approval.

**TSG CT Core
Network & Terminals**

**TSG RAN
Radio Access Network**

**TSG SA
Service & System Aspects**

SA WG2

System Architecture and Services

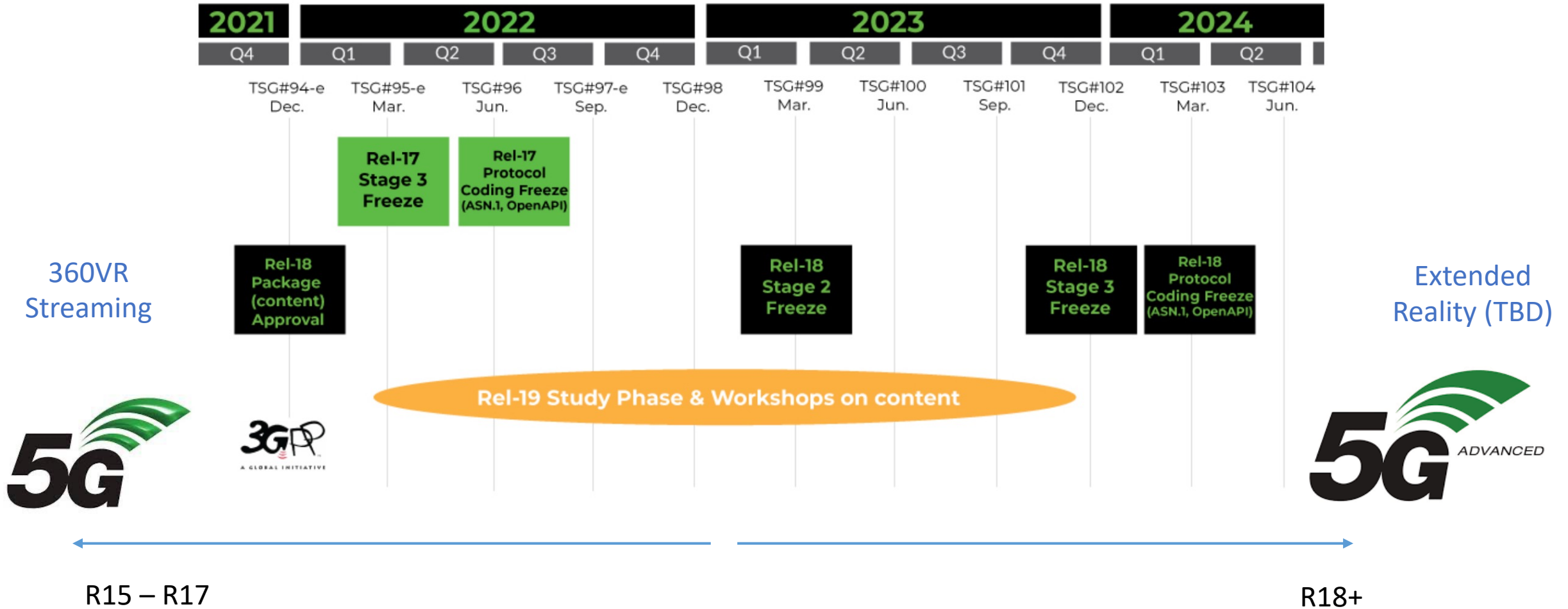
SA WG4

Multimedia Codecs, Systems and Services

- TR (Technical Report) -> Informative
- TS (Technical Specification) -> Normative



3GPP Release system



3GPP TR 26.928 V17.0.0 (2022-04)

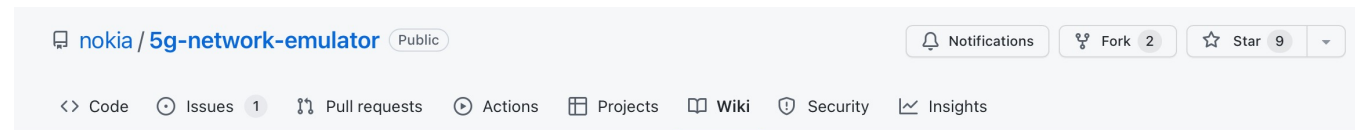
Extended Reality (XR) in 5G

Core Use Cases and Scenarios
Offline Sharing of 3D Objects
Real-time XR Sharing
XR Multimedia Streaming
Online XR Gaming
XR Mission Critical
XR Conference
Spatial Audio Multiparty Call

Architecture
Viewport independent streaming
Viewport dependent streaming
Viewport Rendering in Network
Raster-based Split Rendering with Pose Correction
Generalized Split Rendering
XR Distributed Computing
XR Conversational
XR Conferencing

5G Emulator for application developers

- <https://github.com/nokia/5g-network-emulator>

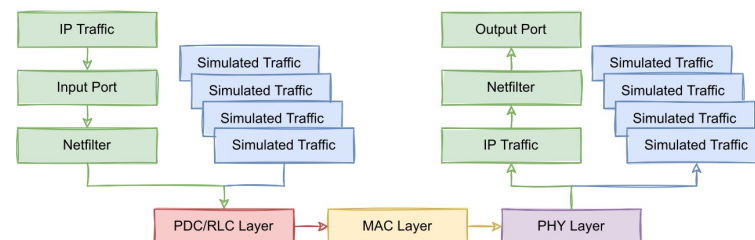


Architecture and Implementation

diegomorin8 edited this page on May 11, 2022 · 3 revisions

Our goal was to develop an emulator which fully follows the 3GPP specifications and models for both the Physical and MAC layer simulations, allowing the possible users to add their own algorithms, models or modifications. We haven't added any proprietary algorithms or models, our contribution is a tool which is easy to use and modify, and gathers the main models and procedures described on 3GPP specifications.

The general architecture is designed as follows:



While the specifics and details of each implemented module and functionality is described later, we give a brief overview of the overall data flow and logic. The time granularity of the emulator is the duration of a subframe (1 ms). In each time step (1 ms) the next overall flow is followed:

1. A. For simulated traffic:

Pages 16
Find a page...
Home
Architecture and Implementation
Compilation and Usage
Configuration File
Data Logging
MAC Layer
Metric Estimation
Mobility Models
Netfilter Module
Overall Flow

Industry coordination initiatives



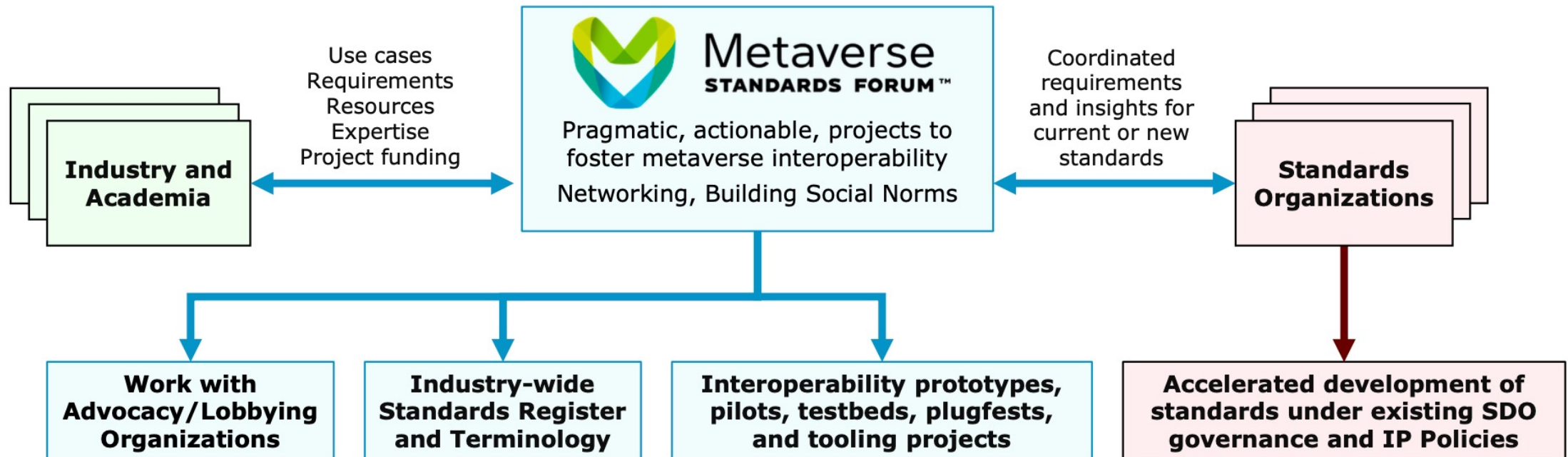
Epic MetaHumans



Roblox, Minecraft, Manticore

Better Metaverse Standards – Sooner!

- Coordination and cooperation between Standards Developing Organizations (SDOs) and wider industry
- Open to all, no participation fee, no NDA, no patent licensing
- NOT another SDO! All standardization 'heavy-lifting' continues at existing SDOs
- The Forum exists to accelerate the mission of its members – including SDOs and advocacy organizations



Quality of Experience



ITU-T SG12:
Performance, Quality
of Service and Quality
of Experience



3GPP SA4
Multimedia Codecs,
Systems and Services

Video Quality
Experts Group



ITU-T SG12



- Expert group responsible for the development of international standards (ITU-T Recommendations) on **performance, quality of service (QoS) and quality of experience (QoE)**.
- This work spans the full spectrum of terminals, networks and services, ranging from **speech** over fixed circuit-switched networks to **multimedia** applications over mobile and packet-based network.
- Highlights:
 - E-model' for voice quality prediction (ITU-T G.107).
 - Algorithmic models to monitor the quality of streamed audiovisual media (ITU-T P.1200 series).
 - Methods for the subjective assessment of video quality, audio quality and audiovisual quality of Internet video and distribution quality television in any environment (ITU-T P.913).
 - Subjective test methodologies for **360-degree video** on head-mounted displays (ITU-T P.919)



- VQEG brings international experts on video quality assessment together to work on common goals:
 - From industry, academia, government organizations, International Telecommunication Union (ITU), other Standard-Developing Organizations (SDOs), etc.
 - Provides a forum via email lists, online meetings and face-to-face meetings (2 per year).
- General motivation: “to advance the field of video quality assessment by investigating new and advanced subjective and objective methods for assessing quality”.
- VQEG activities are documented in reports and submitted to relevant ITU Study Groups (e.g., ITU-T SG9, ITU-T SG12, ITU-R WP6C), and other SDOs as appropriate.
 - Several VQEG studies have resulted in ITU Recommendations: <https://www.its.bldrdoc.gov/vqeg/vqeg-home.aspx>
- VQEG is open to all interested parties: no fees, no membership applications, no invitations...
 - Subscription to the main VQEG email list (ituvidq@its.bldrdoc.gov) → Membership in VQEG.

Immersive Media Group



- **Mission:** Quality assessment of immersive media
 - 360-degree content, virtual/augmented/mixed reality, light field/plenoptic content, 3D content (stereo, multiview, FVV, etc.), HDR...
- **Goals:** Baseline quality assessment of today's systems
 - Datasets of immersive media content
 - QoE guidelines, subjective test methods, objective metrics, etc.
- **Activities**
 - IMG test plan on quality assessment of short 360-degree (finalized):
 - Paper in IEEE TMM (Open Access): [Subjective evaluation of visual quality and simulator sickness of short 360 videos: ITU-T Rec. P.919](#)
 - ITU-T P.919: [Subjective test methodologies for 360° video on head-mounted displays.](#)
 - Test plan: Evaluation of immersive/interactive communication systems
- **Email reflector:** img@vqeg.org

ITU-T Rec. P.919

- Global target of the test plan: <https://www.its.bldrdoc.gov/vqeg/projects/immersive-media-group.aspx>
 - Design and execute a **cross-lab test** where we can assess and validate **subjective evaluation methodologies** for 360-VR video.
 - Generate a **dataset** of subjectively assessed content for future research.
- Phase 1
 - Assessment of **short sequences** (≤ 30 s), in the spirit of ITU-R BT.500, ITU-T P.910, etc.
 - Assessment of **video quality** and **simulator sickness**.
- Phase 2:
 - Assessment of long sequences (several minutes).
 - Assessment of socio-emotional aspects (e.g., spatial and social presence).
 - To be included in the recommendation.

ITU-T Rec. P.919



- Labs and test conditions:

ID	Test condition	Lab	HMD1	HMD2	Comment	Observers (female/ male)
A	ACR: 10s vs 20s	Wuhan	Vive			30 (15/15)
B	ACR: 20s vs 30s	AGH	O. Rift			39 (13/26)
C	DCR: 10s vs 20s	Roma3	Vive			30 (8/22)
D	DCR: 20s vs 30s	CWI	O. Rift			28 (14/14)
E	HMD vs HMD (ACR 20s)	Nokia	GearVR	Vive Pro	Mobile vs desktop	60 (25/35)
F	HMD vs HMD (ACR 20s)	UPM	Vive	Vive Pro	Low res vs. High res	40 per HMD
G	HMD vs HMD (ACR 20s)	Ghent	Vive Pro	Vive Pro	Tethered vs Untethered	30 (4/26)
H	With vs without audio (ACR 20s)	RISE	Vive			28 (16/12)
I	Scoring interface vs voice (ACR 20s)	TUI	Vive Pro			29 (14/15)
J	ACR: 10s vs 30s	Surrey	Vive			31 (10/21)

ITU-T Rec. P.919

- **Outcomes:**

- ACR and DCR methodologies for visual quality assessment.
- SSQ, VRSQ and Vertigo scale for simulator sickness.
- Number of observers for subjective assessments (more than 28).
- Annotated dataset of 360-degree videos.
- Application to collect ratings:
 - MIRO360: A Tool for Subjective Assessment of 360 Degree Video for ITU-T P.360-VR (QoMEX'19)



ITU-T P.1320

- QoE assessment of extended reality (XR) meetings
 - Factors influencing QoE of XR telemeetings
 - Constituents of QoE in XR telemeetings
 - Test methods targeting XR telemeeting QoE
- Best practices for QoE assessment of telemeetings with extended reality elements
- Not to the detail of proposing evaluation tasks or methodologies



ITU-T P.1320

Factors influencing QoE of XR telemeetings

- Human influence factors (HIFs)
 - Perceptual process, cognitive state, relation between participants...
- Context influence factors (CIFs)
 - Communication environment, use case, ...
- System influence factors (SIFs)
 - DoF, representation of users, locomotion, positioning...
 - Rendering
 - Network and compression



ITU-T P.1320

Constituents of QoE in XR telemeetings

- Simulator sickness
- Immersion
- Presence, co-presence and social presence
- Plausibility
- Ethics of XR use
- Carving out mental space
- Fatigue and cognitive load
- Ability to reach goals



Test methods targeting XR telemeeting QoE

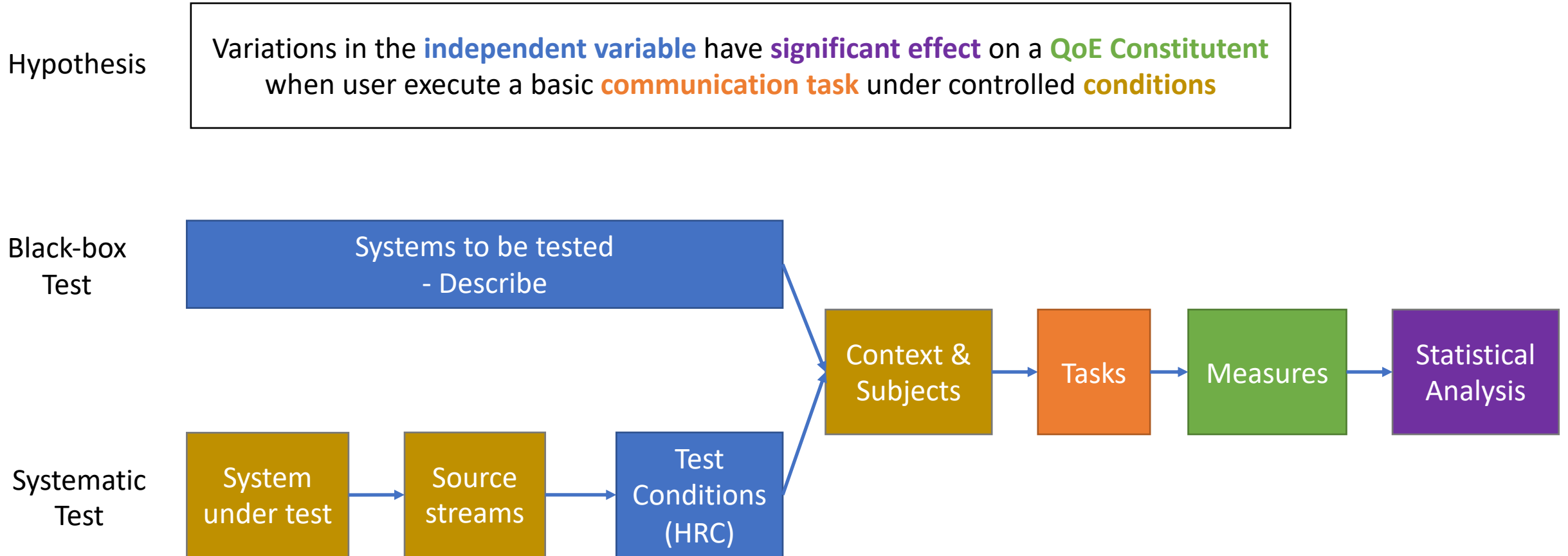
- Test design
 - System IF: independent variable
 - Human IF / Context IF: controlled and balanced
 - QoE constituents: dependent variable
- Define a suitable task: SIF variation → QoE variation
 - ITU-T P.1301: summary of tasks for QoE assessment in telemeetings
 - These tasks have not yet been validated for XR.
- Two main objectives
 - Systematically control an independent variable and observe the effects on QoE
 - Test complete black box systems without exploring individual variables
- Test paradigms
 - Conversation/behavior analysis
 - Post-experience questionnaires
 - Physiological measures

ITU-T P.IXC "Interactive test methods for subjective assessment of extended reality communications"

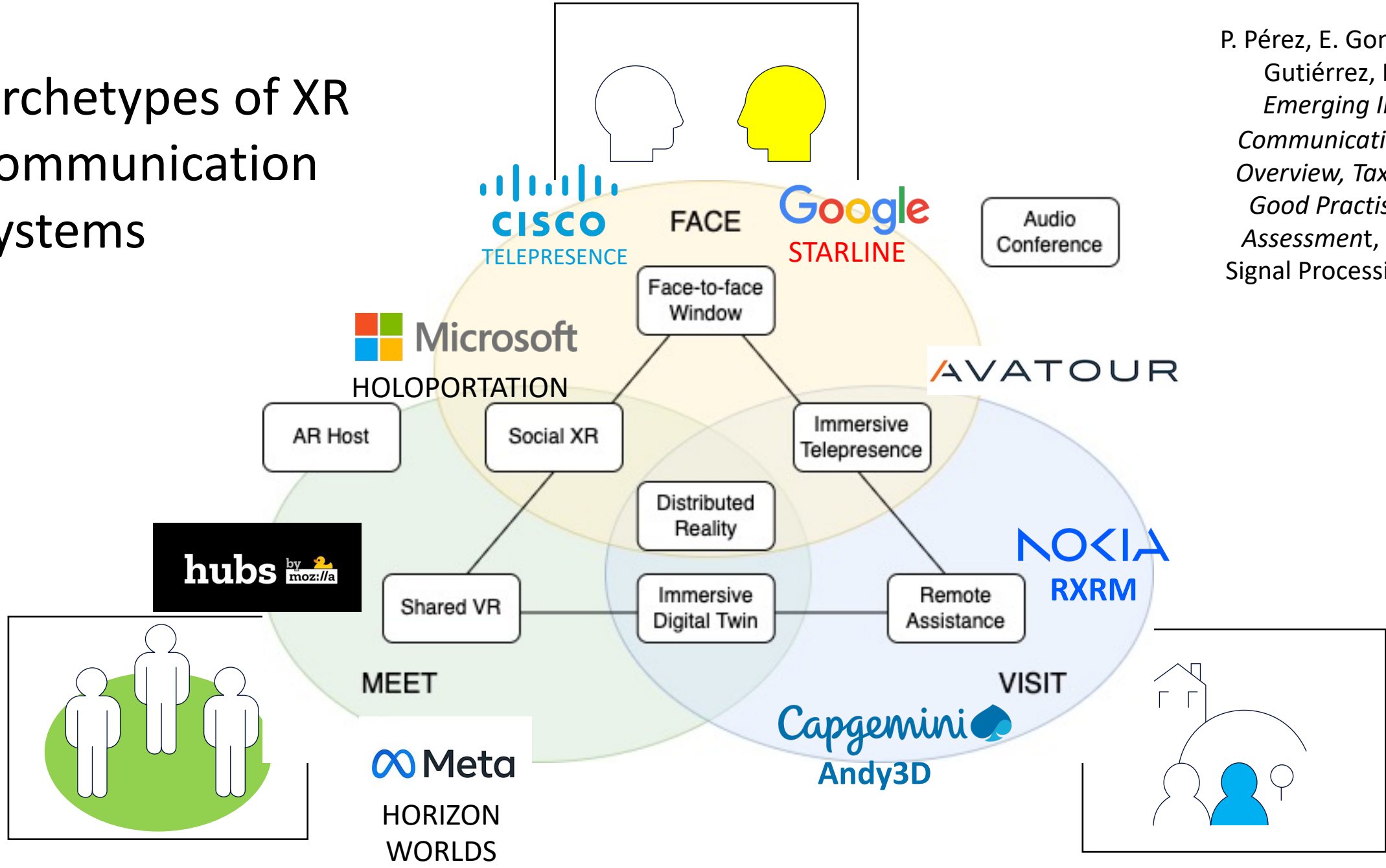
- How to test a bi-directional immersive communication system
 - Evaluate effect of technical factors in QoE (e.g. variations of latency / bitrate / etc.)
 - Compare with other systems / experiments
- Identify **3 simple tasks**: deliberation, exploration, manipulation
 - Feasible in many systems as possible and maximize coverage with only 3 tasks
 - Potential to react to SIFs and influence in QoE constituents
 - Background:
 - ITU-T P.920 - Interactive test methods for audiovisual communications
 - ITU-T P.1301 - Subjective quality evaluation of audio and audiovisual multiparty telemeetings
- Define a **basic (but specific) test methodology** around these tasks
 - How to consider/control HIF/CIFs
 - How to structure test session
- Validate / explore the test methodology with a cross-lab test

Test plan: immersive communication systems

Test methodology



Archetypes of XR communication systems



P. Pérez, E. González-Sosa, J. Gutiérrez, N. García, *Emerging Immersive Communication Systems: Overview, Taxonomy, and Good Practises for QoE Assessment*, Frontiers in Signal Processing, Jul. 2022

Test plan: immersive communication systems

Communication tasks

- **Deliberation:** Conversations between peers, normally oriented to achieve a common goal.
- **Exploration:** Exploration of the environment and identification of objects following indications.
- **Manipulation:** Interaction with system elements and manipulation of physical objects (e.g., lego blocks).

Test plan: immersive communication systems

Call for systems / participants

System	Archetype	Lab
The Owl (Baseline?)	Remote Assistance	Nokia XR Lab
VR2Gather	Social XR	CWI
FFV Live	F2F Window	UPM
Virtual Museum	Social VR	UniPd - UniRM3
Real-size MS Teams Session (Baseline)	F2F Window	TNO?
Jitsi (Baseline)	F2F Window	TU Ilmenau
Mozilla Hubs (Baseline)	Social VR	Surrey, ...
More?		

Other labs
TXState/ UnB
AGH
UGhent
Ericsson
RISE
Wuhan
U. Nantes
UCL
TUS
INSA Renes
Mid Sweden University

Test plan: immersive communication systems

Tentative plan

- **Step 1** (dec'22 – jun'23): planning
 - Start regular audio calls (✓) – Tuesdays at 14h (CET), Biweekly.
 - Create ITU-T Work Item (✓) – P.IXC
 - Call for systems / participants (**Ongoing**):
 - Decide on common elements (**tasks**, methodology, result report)
 - VQEG F2F (26-30/06): Each lab presents their experiment proposal. Close list of participants.
- **Step 2** (jun'23 – dec'23): execution
 - Each lab executes the test
 - (Common) Results are shared in agreed format
 - VQEG F2F: Present and discuss individual results.
- **Step 3** (dec'23 – may'24): evaluation
 - Evaluation of the test methodology based on results → common paper, ITU contribution
 - Evaluation of each individual experiment → each lab will exploit their results

To stay tuned...

- ACM SIGMM Records

<https://records.sigmm.org/>

- 4 issues per year
- Columns on standardization efforts (among other interesting topics)
 - MPEG
 - JPEG
 - VQEG

Report from ACM Multimedia 2022 by Nitish Nagesh



Nitish Nagesh (@nitish_nagesh) is a Ph.D. student in the Computer Science department, the University of California, Irvine, USA. He has been awarded as Best Social Media Reporter of ACM Multimedia 2022 conference. To celebrate this award, Nitish Nagesh reported on his wonderful experience at ACM Multimedia 2022 as follows. I was excited ... [Read more →](#)

Overview of Open Dataset Sessions and Benchmarking Competitions in 2022 – Part 1 (QoMEX 2022, ODS at MMSys '22)

In this Dataset Column, we present a review of some of the notable events related to open datasets and benchmarking competitions in the field of multimedia. This year's selection highlights the wide range of topics and datasets currently of interest to the community. Some of the events covered in this ... [Read more →](#)

Overview of Open Dataset Sessions and Benchmarking Competitions in 2022 – Part 2 (MDRE at MMM 2022, ACM MM 2022)

In this Dataset Column, we present a review of some of the notable events related to open datasets and benchmarking competitions in the field of multimedia. This year's selection highlights the wide range of topics and datasets currently of interest to the community. Some of the events covered in this ... [Read more →](#)

MPEG Column: 140th MPEG Meeting in Mainz, Germany

After several years of online meetings, the 140th MPEG meeting was held as a face-to-face meeting in Mainz, Germany, and the official press release can be found here and comprises the following items: MPEG evaluates the Call for Proposals on Video Coding for Machines MPEG evaluates Call for Evidence on ... [Read more →](#)

Students Report from ACM Multimedia 2022



ACM Multimedia 2022 was held in a hybrid format in Lisbon, Portugal from October 10-14, 2022. This was the first local participation in three years for many participants, as the strict travel restrictions associated with Covid-19 in 2020 and 2021 made it difficult to participate locally by travelling out of ... [Read more →](#)

Green Video Streaming: Challenges and Opportunities

Introduction Regarding the Intergovernmental Panel on Climate Change (IPCC) report in 2021 and Sustainable Development Goal (SDG) 13 "climate action", urgent action is needed against climate change and global greenhouse gas (GHG) emissions in the next few years [1]. This urgency also applies to the energy consumption of digital technologies. ... [Read more →](#)

Overview of Open Dataset Sessions and Benchmarking Competitions in 2022 – Part 3 (ImageCLEF 2022, MediaEval 2022)

In this Dataset Column, we present a review of some of the notable events related to open datasets and benchmarking competitions in the field of multimedia. This year's selection highlights the wide range of topics and datasets currently of interest to the community. Some of the events covered in this ... [Read more →](#)

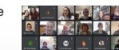
JPEG Column: 97th JPEG Meeting



JPEG initiates specification on fake media based on responses to its call for proposals The 97th JPEG meeting was held online from 24 to 28 October 2022.

JPEG received responses to the Call for Proposals (CfP) on JPEG Fake Media, the first multimedia international standard designed to facilitate the secure ... [Read more →](#)

VQEG Column: VQEG Meeting December 2022



Introduction This column provides an overview of the last Video Quality Experts Group (VQEG) plenary meeting, which took place from 12 to 16 December 2022. Around 100

VQEG

An Overview on Standardization for Social XR

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