Brief Overview of International Standards and Open Source Projects for AR Interoperability

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IEEE COMPUTER SOCIETY

IEEE Advancing Technology for Humanity

Overview

SDO	Working Group	Specifications
W3C	Immersive Web Working Group, Web of Things Working Group, Devices and Sensors WG	WebXR, Web of Things (WoT) Suite of specifications, Devices and Sensors APIs
OGC	GeoPose SWG, IMDF, IndoorGML SWG, O&M SWG, PoI SWG, CDB SWG	GeoPose, IndoorGML, PoI, O&M, Indoor Mapping Data Format, CDB Next
IEEE	ARLEM WG, VRAR WG, ARMD WG, Spatial Web WG	ARLEM, P2048.X (1-101), P2874 Hyperspace Transaction Protocol
Khronos Group	3D Formats (glTF), OpenXR WG	glTF, OpenXR, Sensor Processing
ETSI	Industry Specification Group AR Framework	Framework, Interoperability Requirements
BSI	IST/31/1	Safety, Human Factors Interfaces
ISO/IEC JTC1	SC24 WG8, 9 and 11 and SC29	Graphics and Multimedia, MPEG
UL	8400 STP	Safety
3GPP	5G	TR 26.998 on Glass-type devices

Industry Associations and Community Projects

Group	How relevant
Open AR Cloud	Open and Interoperable AR Cloud will reduce load on devices and increase computational diversity, services and spatial computing for many use cases
Industrial Ontology Foundry	Ontologies for use in industrial and enterprise AR use cases
OntoCommons Consortium	Ontologies for Standardization of data documentation across all domains related to materials and manufacturing
CWL Project	Common Workflow Language could be supported in AR Authoring systems for portable executions
UMI3D Consortium	Developing a web protocol that enables the creation of 3D media in which users of any AR/VR device can collaborate in real time
Digital Twin Consortium	consistency in vocabulary, architecture, security and interoperability of digital twin technology
Industry IoT Consortium	Accelerates the adoption of the Industrial IoT through best-practices frameworks and testbeds
AR for Enterprise Alliance	Development of requirements and review draft specifications

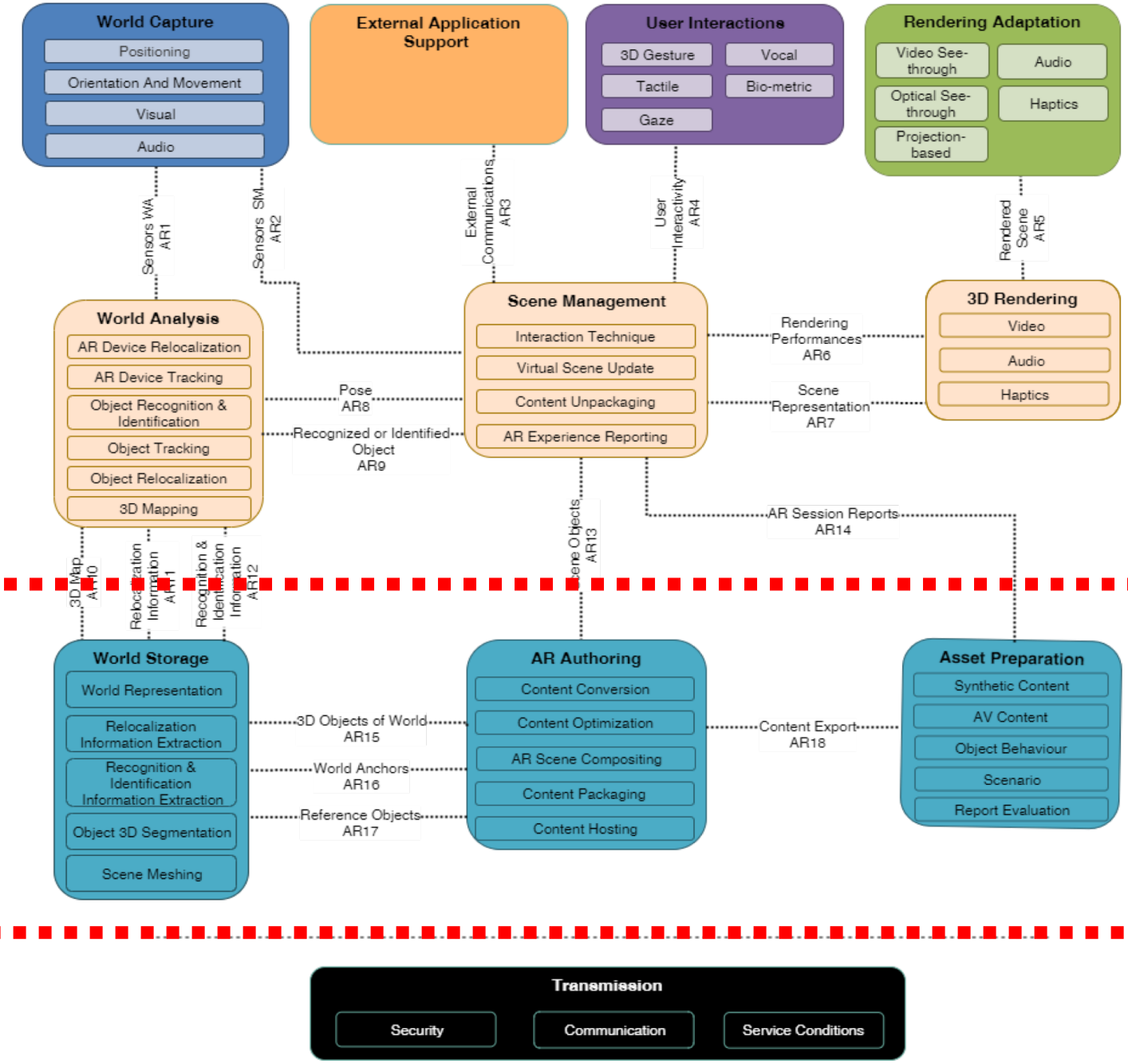
How Can All These Activities be Compared?

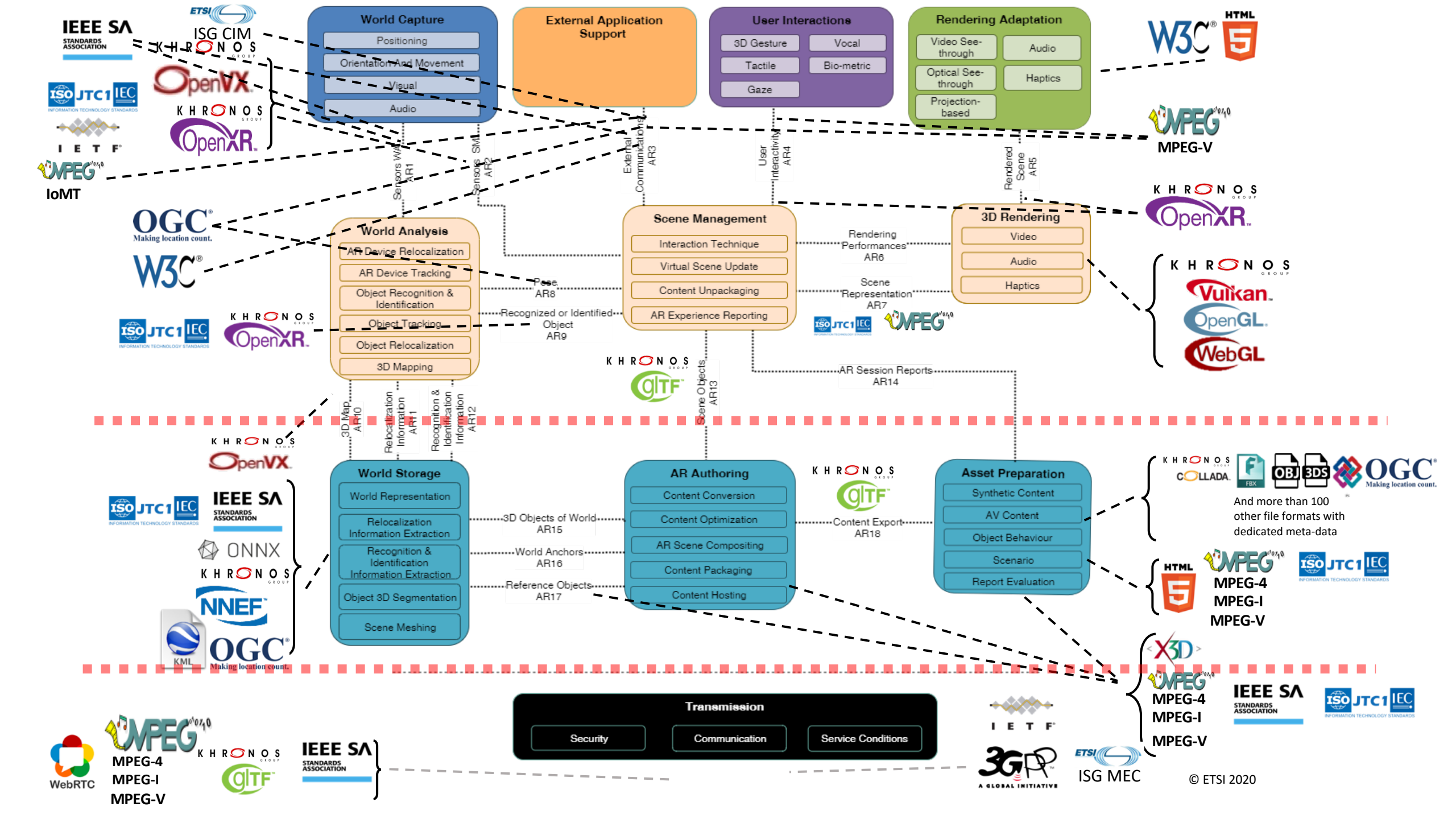
- Focus of a company's or an organization's value proposition and efforts
- Membership in various SDOs or industry organzations
- One or more of the AR Conceptual Frameworks or Reference Architectures
- In advance of AR experience delivery (e.g., authoring, publication, discovery) or during AR experience production (run time engine)

Primarily During AR Experience Delivery to User

Primarily in Advance

Both




World Capture
Positioning
Orientation And Movement
Visual
Audio
External Application Support
User Interactions
3D Gesture
Vocal
Tactile
Bio-metric
Gaze
Rendering Adaptation
Video See-through
Audio
Optical See-through
Haptics
Projection-based
Sensors World AR1
Sensors SML AR2
External Communications AR3
User Interactivity AR4
Rendered Scene AR5
World Analysis
AR Device Relocalization
AR Device Tracking
Object Recognition & Identification
Object Tracking
Object Relocalization
3D Mapping
Scene Management
Interaction Technique
Virtual Scene Update
Content Unpackaging
AR Experience Reporting
3D Rendering
Video
Audio
Haptics
Rendering Performances AR6
Scene Representation AR7
Pose AR8
Recognized or Identified Object AR9
AR Session Reports AR14
Scene Objects AR13
3D Map AR10
Relocalization Information AR11
Recognition & Identification Information AR12
World Storage
World Representation
Relocalization Information Extraction
Recognition & Identification Information Extraction
Object 3D Segmentation
Scene Meshing
3D Objects of World AR15
World Anchors AR16
Reference Objects AR17
AR Authoring
Content Conversion
Content Optimization
AR Scene Compositing
Content Packaging
Content Hosting
Content Export AR18
Asset Preparation
Synthetic Content
AV Content
Object Behaviour
Scenario
Report Evaluation
And more than 100 other file formats with dedicated meta-data
Transmission
Security
Communication
Service Conditions
IoMT
MPEG-V
MPEG-4
MPEG-I
MPEG-V
ISG MEC
WebRTC
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For More Detailed Information

- Go to the standards working group, committee or standards pages from
  - http://www.perey.com/ISMAR2021-Interop-and-Standards-Tutorial/standards/
- Watch/listen to 50-min public video on ISMAR 21 YouTube channel
  - https://youtu.be/TZllXuCXmRY

W3C Immersive Web WG's WebXR

- A group of standards to support rendering 3D scenes to hardware designed for VR and AR
- **WebXR Device API** implements the core of the WebXR feature set
  - Selection of output devices,
  - Render the 3D scene to the chosen device at the appropriate frame rate, and
  - Manage motion vectors created using input controllers.f
- Editor's Draft Specification (September 30, 2021)
- https://immersive-web.github.io/webxr/

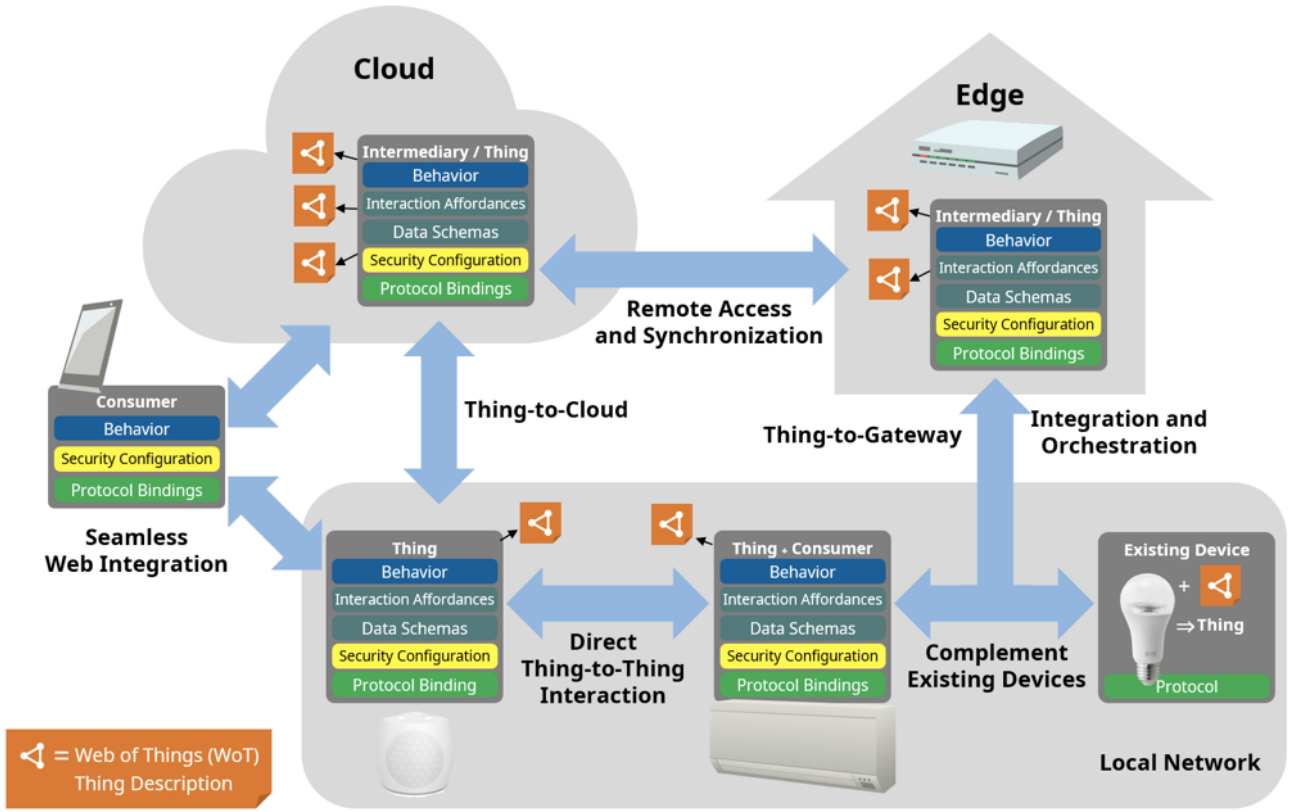
IWWG AR Module 1.0 Editors' Drafts

- Depth Sensing Editors' Draft Specification on GitHub (September 30, 2021)
- https://immersive-web.github.io/depth-sensing/
- Privacy and Security are major issues
- https://github.com/immersive-web/privacy-and-security/blob/master/EXPLAINER.md#accessing-real-world-data
- Lighting Estimation Editors' Draft Specification (September 9, 2021)
- https://www.w3.org/TR/2021/WD-webxr-lighting-estimation-1-20210909/

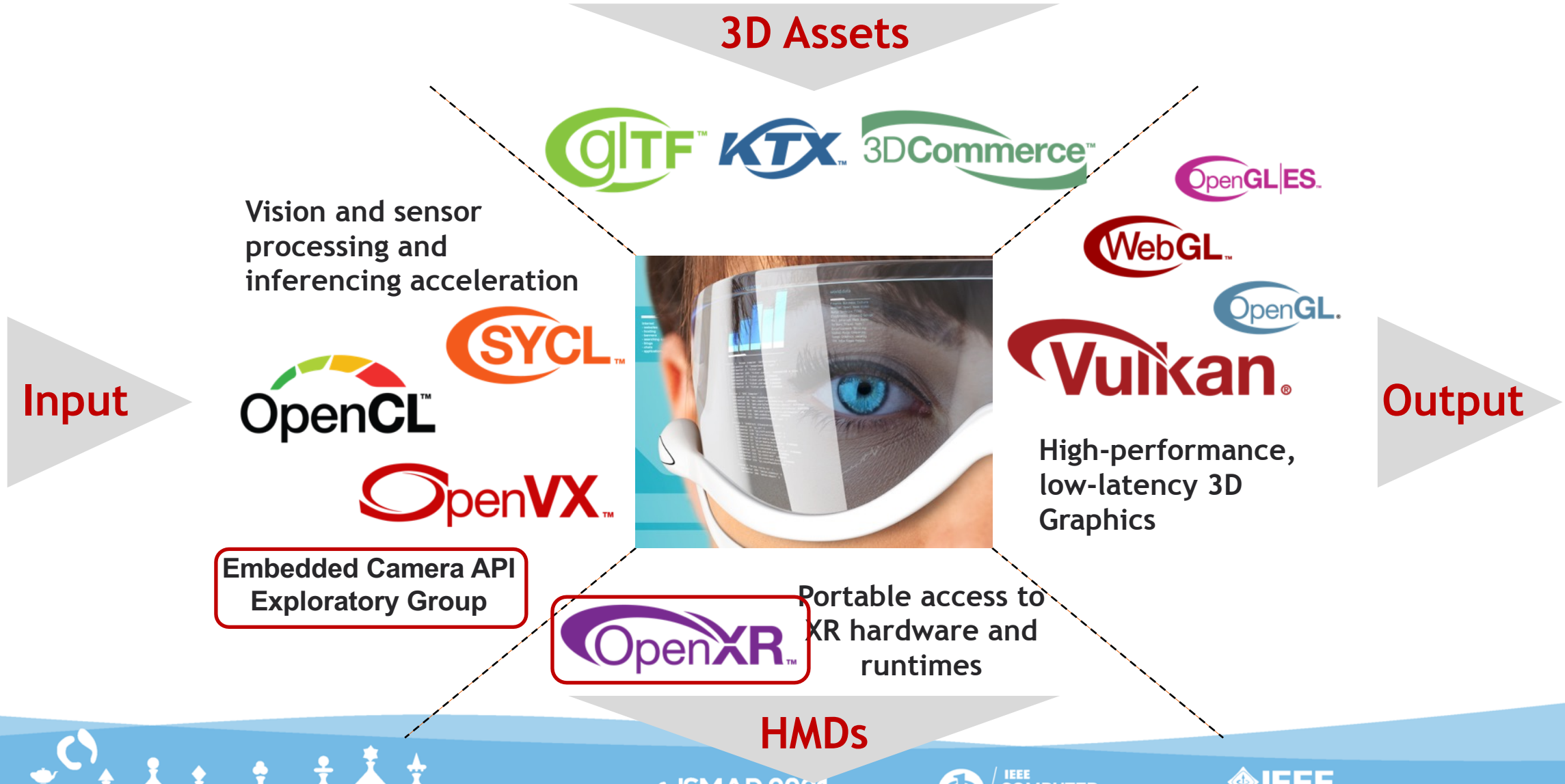
- Real World Geometry (RWG) Project Repository on GitHub
- https://github.com/immersive-web/real-world-geometry

W3C Web of Things (WoT) General

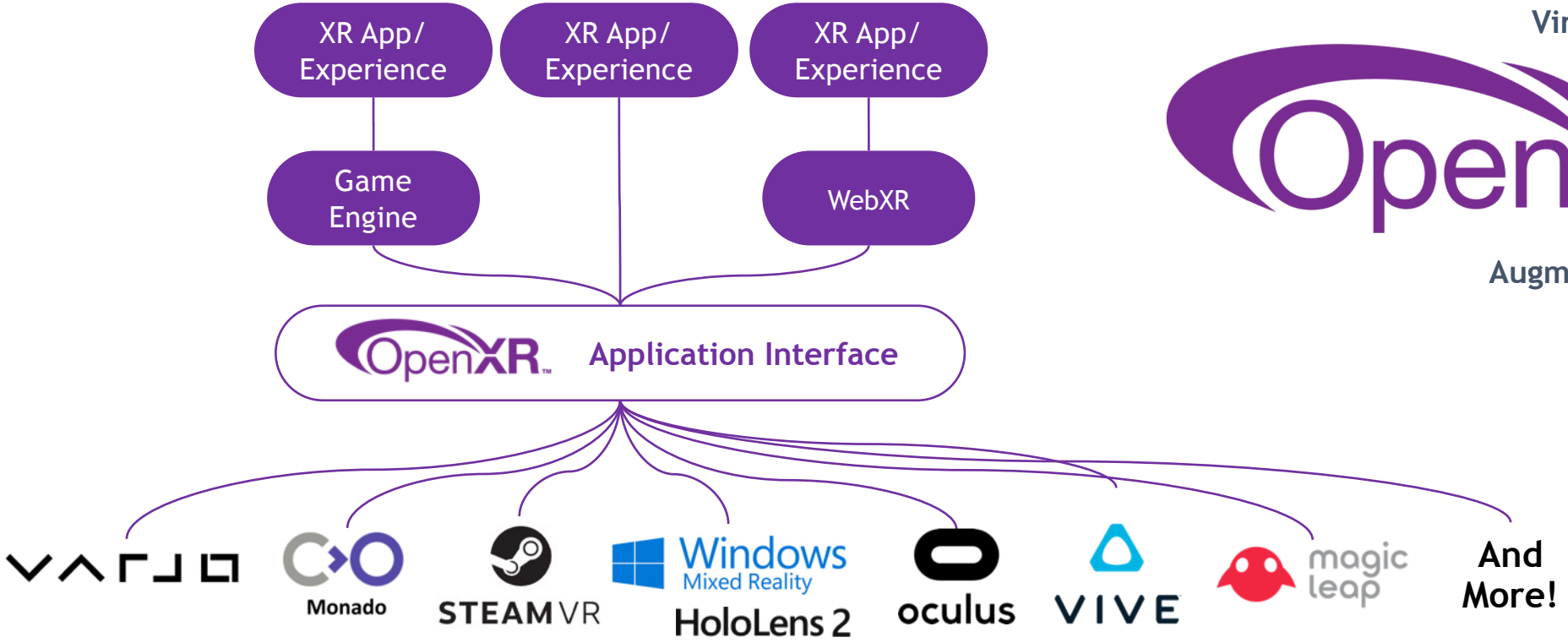
- The WoT Architecture describes the overall Web of Things conceptual framework (right)
- The WoT Thing Description is to the Internet of Things what index.html is to a website: it can be considered as the entry point of a physical or virtual Thing/device



Khronos Group Standards for XR



Access to Device Runtimes - Portability



Virtual Reality

OpenXR™

Augmented Reality

OpenXR provides cross-platform, high-performance access directly into XR device runtimes across multiple platforms

glTF- JPEG for 3D

Audio	Video	Images	3D
MP3	H.264	JPEG	glTF
napster	YouTube	facebook	New market opportunities for 3D content creation and deployment!

glTF

- Compact to Transmit ✓
- Simple and Fast to Load ✓
- Describes Full Scenes ✓
- Runtime Neutral ✓
- Open and Extensible ✓

Efficient, reliable transmission
Bring 3D assets into 100s of apps and engines

glTF

WebGL

glTF 1.0 - December 2015
Primarily for WebGL
Uses GLSL for materials

glTF

WebGL Vulkan DirectX 12

glTF 2.0 - June 2017
Native AND Web APIs
Physically Based Rendering
Metallic-Roughness and Specular-Glossiness

Open Geospatial Consortium (OGC)

Highly Relevant

- GeoPose
- Indoor Mapping Data Format (IMDF)
- Points of Interest
- Moving Features
- SensorThings API

Somewhat Relevant

- CDB (Simulation, Military)
- CityGML
- OGC APIs
- 3D Tiles
- Geospatial Data Cubes Best Practices

GeoPose Current Status and Next Steps

- Draft Standard was made public on GitHub repository in mid-February
  - https://github.com/opengeospatial/GeoPose
  - https://github.com/opengeospatial/GeoPose/blob/main/standard/pdf/geopose_standard.pdf
- A screen movie https://youtu.be/m09SuhtMwB8
- OGC Architecture Board has approved GeoPose draft to be released for public comment
- Development of implementations of eight standards targets
- Preparation of guides and a web site

Points of Interest (PoI) Current Status and Next Steps

- A “point of interest” (PoI) is a location for which information is available.
- It can be as **simple** as a set of coordinates, a name and a unique identifier, or **more complex** such as a three-dimensional model of a building with names in multiple languages information about opening and closing hours, and a civic address
- Work on PoI standard began in W3C in 2011, continued briefly in OGC
- OGC PoI Standard Working Group (SWG) was rechartered in March 2021
- Currently reviewing and revising requirements and UML model

ETSI ISG ARF Current Status

- Interoperability Requirements were developed for World Storage, World Analysis and interfaces with AR Authoring and Scene Management functions
- Published July 2021
- https://www.etsi.org/deliver/etsi_gs/ARF/001_099/00402/01.01.01_60/gs_ARF00402v010101p.pdf

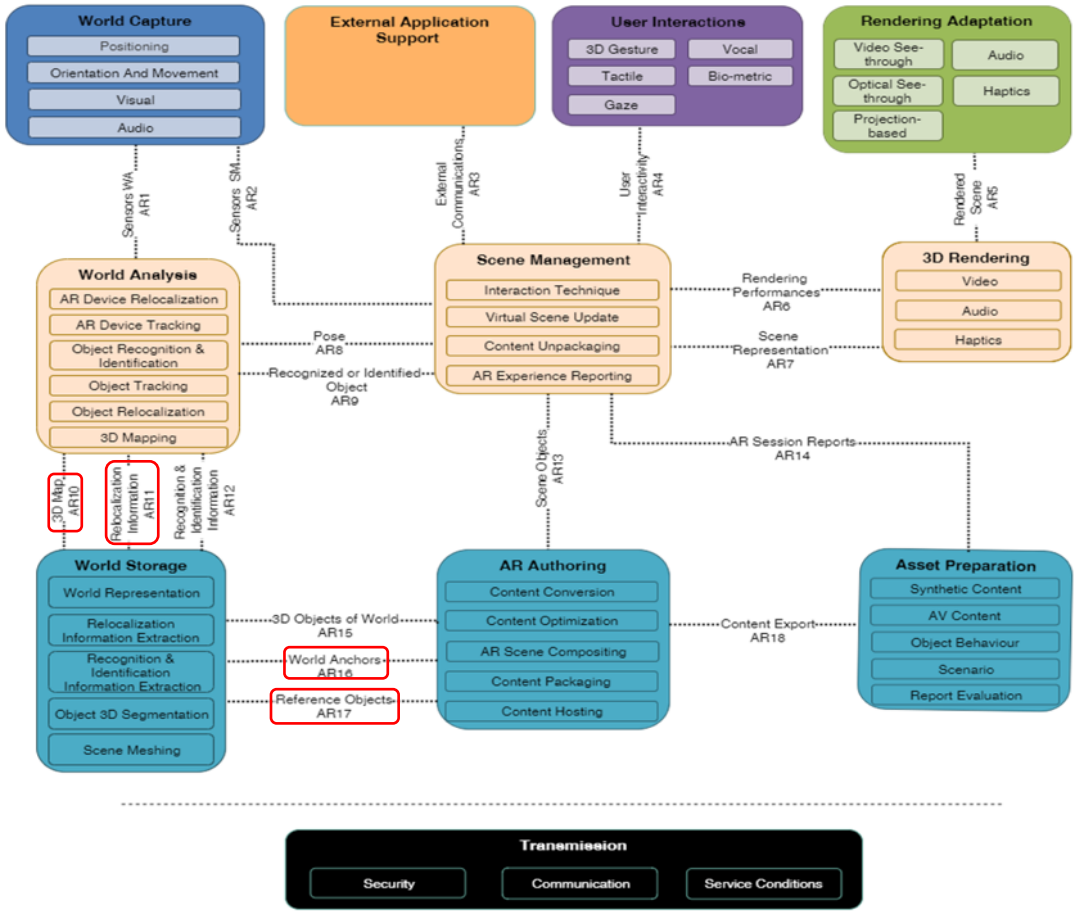


Figure 2: Diagram of the functional reference architecture

ETSI ISG ARF Status Update (2)

- GS 004-03 World Capture, World Analysis and Scene Management requirements drafted
- Draft specification received ISG approval Sept 2021
- Release for comment in October 2021

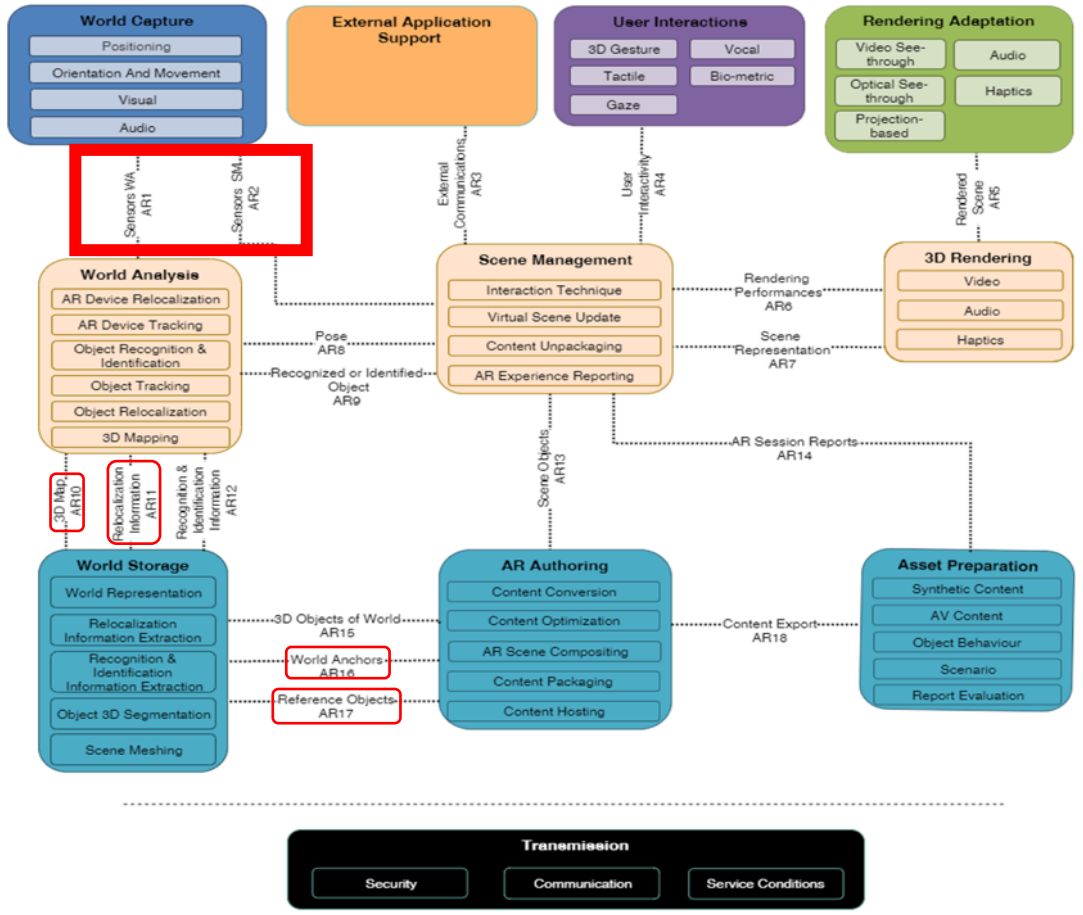


Figure 2: Diagram of the functional reference architecture

ISO/IEC JTC1 SC24 WG9

- Augmented Reality Continuum Concepts and Reference Model

Based on comments from reviewers, currently editing three documents

ISO/IEC CD 23488	Object/Environmental Representation for Image-based Rendering in Virtual/Mixed and Augmented Reality
ISO/IEC AWI 3721-1	Information model for Mixed and Augmented Reality Contents — Part 1: Core Objects and Attributes
ISO/IEC TR 2358	Material Property and Parameter Representation for Model based Haptic Simulation of Objects in Virtual, Mixed and Augmented Reality (VR, MAR)

CD= Committee Draft, AWI= Approved Work Item, TR= Technical Report

3GPP Began Working on 5G and XR in 2018

- In SA4

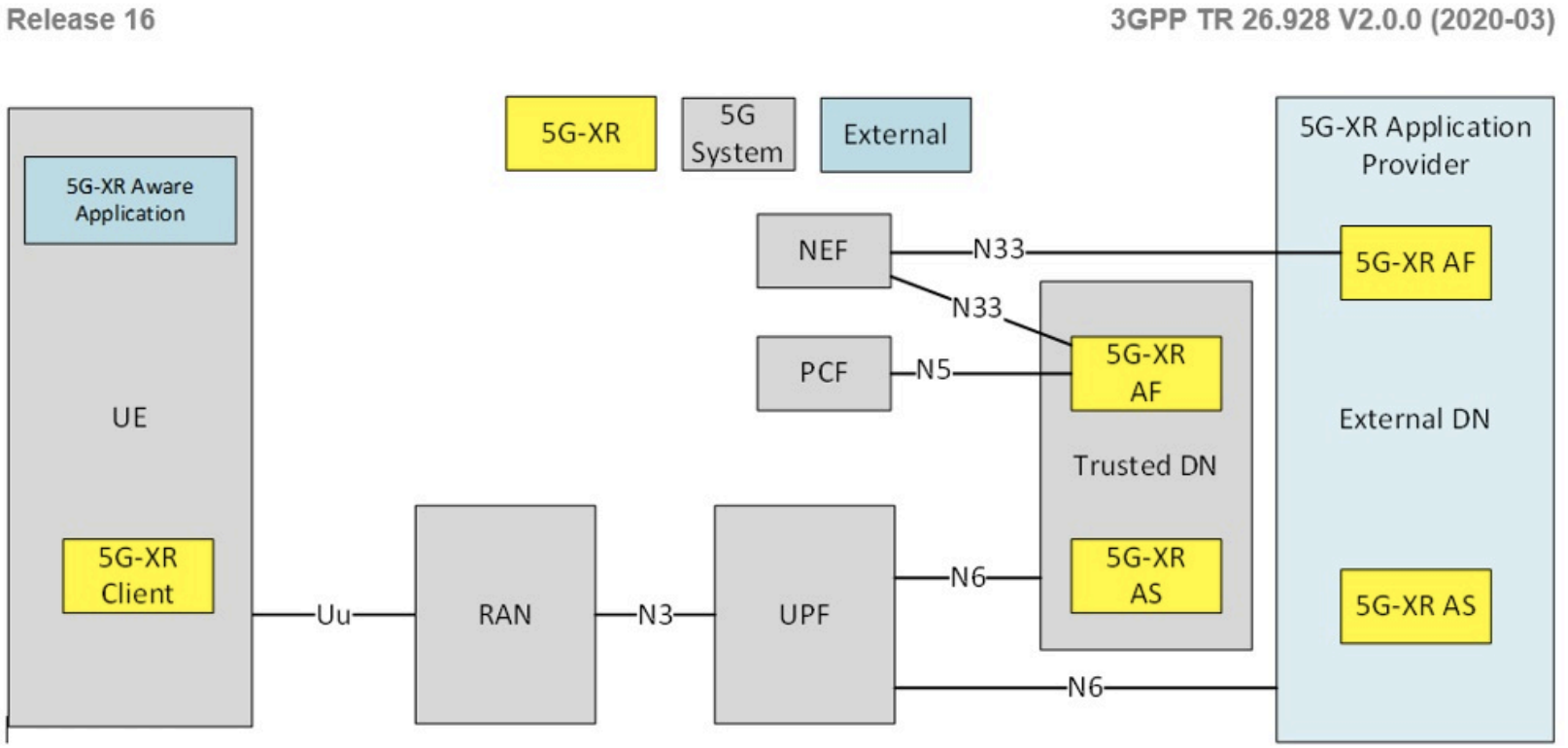


Figure 4.3.2-1: 5G-XR functions integrated in 5G System

IEEE P2874 Spatial Web Working Group

Spatial Web Protocol, Architecture and Governance

- This standard will describe a Hyperspace Transaction Protocol (HSTP) that enables **interoperable, semantically compatible connections** between connected hardware (e.g. autonomous drones, sensors, smart devices, robots) and software (e.g. services, platforms, applications, artificial intelligence systems) and includes specifications for:

  1) a **spatial range query** format and response language for requesting data about objects within a dimensional range (spatial, temperature, pressure, motion) and their content.

  2) a semantic **data ontology schema** for describing objects, relations, and actions in a standardized way

  3) a verifiable **credentialing and certification method** for permissioning create, retrieve, update, and delete (CRUD) access to devices, locations, users, and data; and

  4) a human and machine-readable **contracting language** that enables the expression and automated execution of legal, financial and physical activities.

IEEE AR on Mobile Devices Working Group

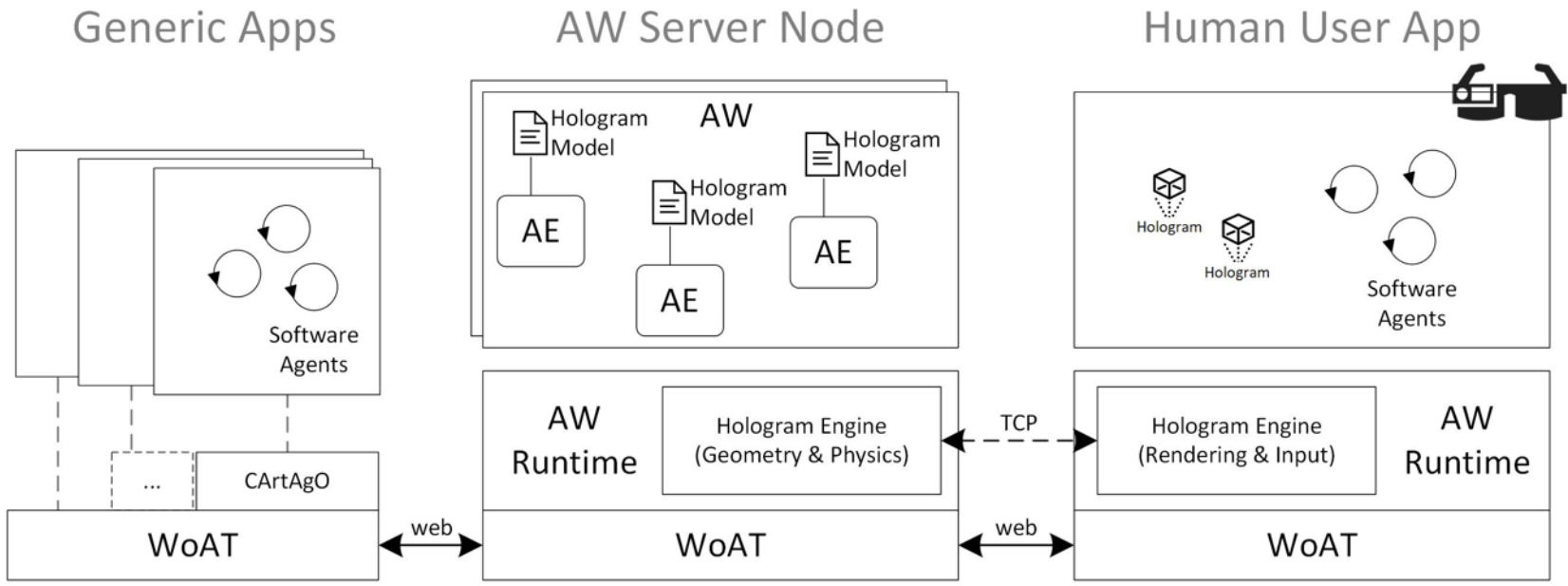
- Established in 2020, abbreviated ARMDWG
- First specification will be P2048.101
  - This standard specifies the general technical framework, components, integration, and main business processes of augmented reality systems applied to mobile devices, and defines its technical requirements, including functional requirements, performance requirements, safety requirements and corresponding test methods. This standard is applicable to the design, development, and management of augmented reality enabled applications or features of applications on mobile devices.
- https://standards.ieee.org/project/2048_101.html

UL 8400 STP

- Participants are AR/VR/MR equipment and component manufacturers
- Dedicated to the safety of spatial computing and extended reality equipment
- Based on the existing technical requirements of UL 62368-1 developed to mitigate risks of electrical and fire hazards in audio/video, information and communication technology equipment

Mixed Reality Augmented Environments (MiRAgE)

- Web of Augmented Things (WoAT), an extension of the Web of Thing (WoT) idea inspired by IEEE 1589 “AR Learning Experience Model”
- GitHub repository: https://github.com/pslabunibo/mirage



SoLAR

- Purpose: construction of customized computer vision pipelines targeting Augmented Reality applications (e.g. camera pose estimation or 3D mapping)
- Contains
  - Interfaces promoting interoperability
  - Computer vision components
  - Plugins for third-party applications
- https://github.com/SolarFramework

STAC - SpatioTemporal Asset Catalog specification

- Provides a common language to describe a range of geospatial information
- Standardized way to expose collections of spatial temporal data
- http://stacspec.org/

For More Information

- Visit this tutorial's web site http://www.perey.com/ISMAR2021-Interop-and-Standards-Tutorial/standards/
- Watch video recorded for this tutorial https://youtu.be/TZllXuCXmRY