ETSI GS ARF 004-6 V1.1.1 (2025-06)

Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services; Part 6: 3D Objects of World for AR Authoring and Scene Management functions

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Augmented Reality Framework (ARF).

The present document is part 6 of a multi-part deliverable covering Interoperability Requirements for AR components, systems and services, as identified below:

Part 1: "Overview";

Part 2: "World Storage and AR Authoring functions";

Part 3: "World Capture, World Analysis and Scene Management";

Part 4: "World Analysis, World Storage and Scene Management functions";

Part 5: "External Communications";

Part 6: "3D Objects of World for AR Authoring and Scene Management functions".

The ISG ARF shares the following understanding for Augmented Reality: Augmented Reality (AR) is the ability to mix in real-time spatially-registered digital content with the real world. The present document specifies interoperability requirements for References Points AR15 and AR19 of the reference architecture for AR solutions defined in ETSI GS ARF 003 [1].

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document specifies the high level Reference Point requirements between the AR Authoring functions, Scene Management and World Storage as they are identified in ETSI GS ARF 003 [1]. It further defines the requirements of Reference Points "3D objects of World ARA" (AR15) and "3D Objects of World SM" (AR19).

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found in the ETSI docbox.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI GS ARF 003 (V2.1.1): "Augmented Reality Framework (ARF); AR framework architecture".

[2] ETSI GS ARF 004-2 (V1.1.1): "Augmented Reality Framework (ARF); Interoperability Requirements for AR components, systems and services; Part 2: World Storage and AR Authoring functions".

[3] Kerbl B., Kopanas G., Leimkühler T., & Drettakis G. (2023): "3d gaussian splatting for real-time radiance field rendering". ACM Trans. Graph., 42(4), 139-1.

[4] Mildenhall B., Srinivasan P. P., Tancik M., Barron J. T., Ramamoorthi R., & Ng R. (2021): "Nerf: Representing scenes as neural radiance fields for view synthesis". Communications of the ACM, 65(1), pp. 99-106.

2.2 Informative references

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Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

object of world: any kind of static or dynamic part of the representation of the real world, defined by shape and appearance properties

NOTE: An object of world can be of different nature including, dense or sparse, parametric, mesh or point cloud.

world graph: hierarchy of Trackables and World Anchors representing the real world knowledge in the World Representation sub-function

NOTE: As defined in ETSI GS ARF 004-2 [2].

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3DT	3D Transform
AR	Augmented Reality
ARA	Augmented Reality Authoring
ARF	Augmented Reality Framework
CAD	Computer-Aided Design
GIS	Geographic Information System
LOD	Level Of Detail
SM	Scene Management
WS	World Storage
WA	World Analysis

4 Interoperability requirements for AR15 and AR19

4.1 AR15 and AR19 Reference Points scope

AR15 "3D objects of World ARA" and AR19 "3D Objects of World SM" as specified in ETSI GS ARF 003 [1], define a subset of the dialog structure between the AR Scene Management (SM), the AR Authoring (ARA), and the World Storage (WS) functions. The AR Authoring needs the representation of the real world to ease the positioning of AR assets. The SM function needs the representation of the real world to perform real time interactions between the real and the virtual worlds. This representation of the real world can be provided before the AR session by the ARA and at runtime thanks to the Scene Meshing and Object 3D Segmentation functions of the WS.

4.2 Object of World

4.2.1 Overview

An Object of World is a virtual representation of a real object that specifies its shape and/or appearance. It represents a static or dynamic part of the real world and is part of the World Storage. It can encompass several Representation Items corresponding to different Levels of Detail or different states of the associated Object of World.

It can be used as a visual aid for authoring the world graph and the scene graph relative to the real world.

On the Scene Management side, it can be used at runtime to alter the user's experience and create interaction between the physical and the virtual worlds. For instance, they allow the management of occlusions and physical interaction between AR assets and the real world. Objects of Worlds could also be used for diminished reality as masks to display hidden content.

At runtime an Object of World can be positioned and oriented in the real world to match its real counterpart.

An Object of World can come with different shape and appearance properties such as geometries, textures and materials.

Figure 1 shows how Objects of World are symbolized in the World Graph diagrams as detailed in ETSI GS ARF 004-2 [2].

Figure 1: Object of World Representation

RQ-AR1519-001	An Object of World is a part of the representation of the real world, defined by shape and appearance properties, that can be used by the AR Authoring, Scene Management and 3D Rendering functions.

NOTE 1: The SM function can leverage the representation of the real world to manage physical interactions between real and virtual objects (collisions for instance). This representation can also be used for rendering graphics such as managing occlusions and shadows, rendering audio such as managing reverberation or rendering haptics. The AR Authoring function can also use the representation of the real world as a visual aid for creating content.

RQ-AR1519-002	An Object of World can encompass different Representation Items.

NOTE 2: Different Representation Items of a unique Object of World can correspond to different levels of quality (referred to as Level Of Details or LOD) from a highly detailed geometry to a simple bounding box approximating the object. Using different representation items also allows to use different methods to define a given Object of World.

RQ-AR1519-003	An Object of World shall have a unique identifier.

RQ-AR1519-004	Each Representation Item shall have a unique identifier.

RQ-AR1519-005	Each Representation Item shall reference the Object of World it represents.

NOTE 3: The unique identifier of the Object of World can be used for referencing it.

RQ-AR1519-006	An Object of World or a Representation Item can be static or change over time (i.e. be dynamic). In case of a dynamic object, the framerate at which it is updated shall be specified.

NOTE 4: The representation of the real world can be provided before an AR session and be updated in real time based on the WA and WS functions.

RQ-AR1519-007	An Object of World or a Representation Item shall be defined in a specific transmission format and can be accessed from a static file or be continuously streamed through a dedicated channel.

NOTE 5: A static representation of the real world may already exist before an AR session and be defined in a given transmission format (gltf, ifc, fbx, etc.). The WS function can also be able to update in real time a representation of the real world with features such as meshing and plane detection. For updates, the full object or only modifications can be transmitted at each iteration in a given transmission format.

RQ-AR1519-008	Semantics information may be attached to Objects of World and Representation Items.

NOTE 6: Shapes and appearances information may be difficult to interpret at runtime to customize the experience. Semantics provide useful information for spatial and context understanding to adapt the scene graph. As an example, an AR Scene author could want to display the AR content only on some tables in the environment of the end user.

RQ-AR1519-009	Each Object of World and Representation Item shall have a timestamp corresponding to the moment it was acquired, created, or modified.

NOTE 7: As an Object of World can be provided between sessions or at runtime with a potential delay due to computation, providing a time stamp corresponding to the time of the capture or creation can be useful to manage latency or for being aware that the representation could slightly differ from the real world.

RQ-AR1519-010	Each Object of World and Representation Item shall be associated with a score of quality.

NOTE 8: Depending on the way the Object of World was captured or created or depending on its format, it can slightly differ from the exact geometry of the real world. With that quality score provided by the WS, the SM and the ARA functions could inform in real-time the end user who can act accordingly.

4.2.2 Examples of Objects of World and Representation Items

Objects of World can be represented through any kind of methods to define and display 3D geometries. It can include parametric representations to define primitives such as planes, cubes, spheres, or even more complex data such as CAD models and GIS data. It can also include meshes and point clouds. It can also be based on more recent methods such as Gaussian splatting [3] and neuronal representations (for example NERF [4]).

Figure 2: Examples of Types of Objects of World

A single Object of World can be represented with different Representations Items that can for example define different Level of Details.

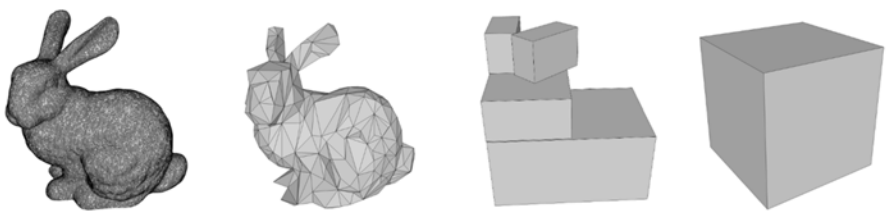

Figure 3: Examples of using representation items for handling LOD

4.3 Attaching Objects of World to specific real-world places or things

Objects of World are part of the World Graph and included in the WS. They are attached and arranged in relation to the real world by using Trackables and/or Anchors thanks to 3D Transforms.

Their attachment is specified before the session in the AR Authoring function for static objects or automatically by the World Storage function for the dynamic ones.

The representation of the real world is possible through a combination of Objects of World.

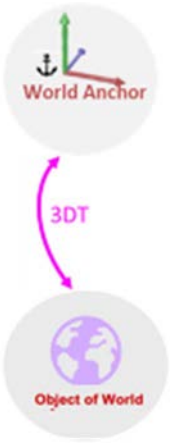

Figure 4: World Graph with an Object of World

RQ-AR1519-011	An Object of World is part of the World Graph and may be attached to one or more World Anchors or Trackables.

RQ-AR1519-012	A 3D Transform shall define the relative position and orientation between Objects of World and Trackables and Anchors.

RQ-AR1519-013	An Object of World and its Representation Items share the same reference coordinate system.

4.4 Accessing Objects of World

The Objects of World are stored in the WS and can be accessed from ARA through AR15 and from SM through AR19.

RQ-AR1519-014	The ARA and SM shall have the ability to request the Objects of World of the World Graph.

NOTE 1: On the ARA side for designers that create an AR Scene, or at runtime for the end-user, only the representation of the real world of the area in proximity of the interactions may be required. For that the World Storage could give the possibility to request the Objects of World associated with given Trackables and/or World Anchors.

RQ-AR1519-015	The ARA and SM shall have the ability to request only Objects of World or Representations Items with several filters including type, LOD, timestamp, semantics, transmission format, etc.

NOTE 2: Depending on the use-case of the end-user and based on the capabilities of the SM or the ARA, only a subset of Objects of World may be needed, of interest or supported. Following the previously mentioned example, if a designer wants to only position content on tables, it is possible to only request Objects of World (and associated Representation Items) with this associated Semantics. In the same way, if the device has low computing capabilities, the SM can request only the lowest LOD of each Object of World. For transmission formats, the WS can manage conversion between formats or notify that it is not supported.

RQ-AR1519-016	The SM shall have the ability to provide a channel on which the dynamically updated data of an Object of World will be streamed.

RQ-AR1519-017	The WS shall be able to notify the SM and the ARA when an Object of World is created, deleted or updated.

RQ-AR1519-018	When access control is required by the WS function, the ARA or SM function shall provide the WS function with identification information to manage access rights.

NOTE 3: The Objects of World may have restricted access for confidentiality purposes. In these cases, it is essential to pass some user identification information to the WS function to let it decide if it could provide back the requested representation of the real world.

4.5 Provisioning and updating Objects of World

RQ-AR1519-019	The AR Authoring function as well as the Scene Meshing and Object segmentations functions of the WS shall be able to add, modify and delete Objects of World in the World Storage.

RQ-AR1519-020	The AR Authoring function shall maintain the relative poses between the Objects of World and the World Anchors and Trackables.

Annex A (informative): Example use cases

A.1 Example use case 1: managing occlusions

In this outdoor example, a pre-existing CAD model of a building of the real world is used to manage occlusions in the AR experience. The CAD model is loaded, spatially registered in the user space and displayed as a mask to occlude the AR assets.

STEP 1

As shown in Figure A.1, at authoring time, the AR experience designer creates a World Graph composed of one GeoTrackable and one Object of World corresponding to the CAD model of a building. AR Assets are then attached to this GeoTrackable.

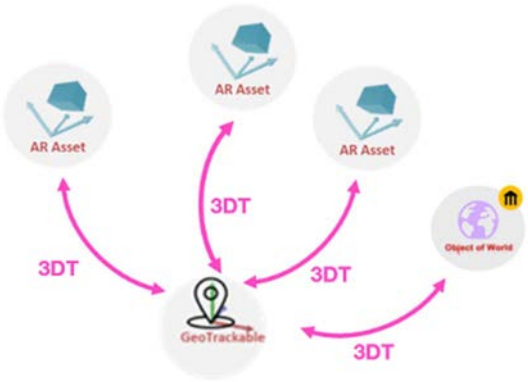

Figure A.1: World Graph with AR Assets and an Object of World

STEP 2

At runtime, the AR assets and the Object of World corresponding to the building are loaded. The WS and the WA functions allow the spatial registration of these elements in the user space. The AR assets are rendered in a classic way and the CAD model of the building is displayed as an occlusion mask. As shown in Figure A.2, some assets appear in front of the building while others appear partly occluded.

NOTE: From the left to the right: the real building, the AR assets (telecom towers), the CAD model of the building, the CAD model only displayed as a mask.

Figure A.2: Occlusions between AR Assets and an Object of World

A.2 Example use case 2: physics interactions

In this example, a mesh of the real world reconstructed in real time is used to manage collisions and physical interaction between AR assets and real objects. Here, when the AR assets fall with the simulated gravity, they are automatically blocked by the real table.

STEP 1

As shown in Figure A.3, thanks to depth sensing and the WA and WS functions, an Object of World is captured in real time as a mesh that is continuously streamed to the SM. Semantics information can be included, here the colour of the mesh corresponds to the type of object (table in green, floor in blue, chair in red).

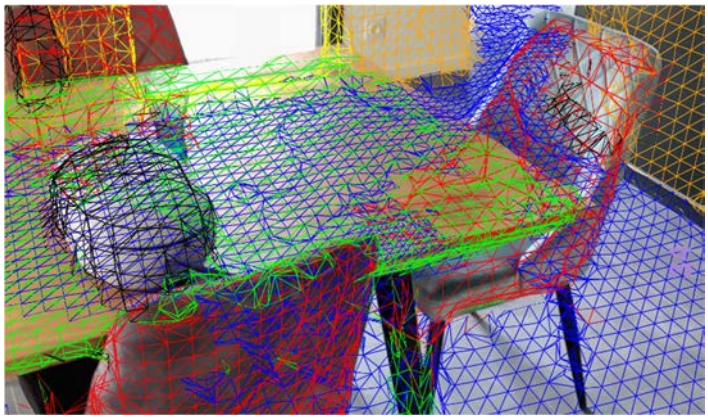

Figure A.3: Real-time captured 3D mesh of the real world

STEP 2

The SM function manages the physical interaction between the Object of World and the AR Assets. As shown in Figure A.4, the cubes fall on the real table.

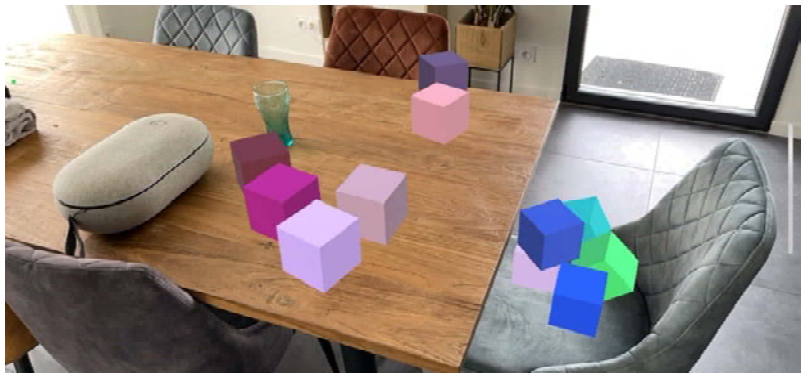

Figure A.4: Physical interactions between AR assets and the real world

History

Document history		
V1.1.1	June 2025	Publication