# ETSI GS ARF 005 V2.1.1 (2024-12)


# Augmented Reality Framework (ARF); Open APIs for the Creation, Management and Querying of the World Representation



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# Foreword

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

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 the interoperability requirements for Reference Points AR 16 and AR 17 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).

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# 1 Scope

The present document provides an overview and an introduction to the interface specification for the reference points "AR 16 - World Anchors" and "AR 17 - Reference Objects" of the AR framework architecture [1] developed by the ETSI Industry Specification Group (ISG) for an Augmented Reality Framework (ARF). The actual interface specification is provided as OpenAPI™ specification [3] and forms the baseline for the present document.

# 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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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

[1] ETSI GS ARF 003 (V1.1.1): "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] "ARF005 - World Storage API" revision 2.0.0.

## 2.2 Informative 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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] IETF RFC 4122: "A Universally Unique IDentifier (UUID) URN Namespace".

[i.2] IETF RFC 2616: "Hypertext Transfer Protocol HTTP/1.1".

[i.3] OpenAPI™ Specification v3.0.0.

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

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

**Augmented Reality (AR):** ability to mix in real-time spatially-registered digital content with the real world

**AR experience:** real time perception of the mixture of the real world and spatially-registered digital content by user senses

**AR system:** combination of hardware and software that delivers an AR experience

**feature:** characteristics of a real world element that can be searched, recognized or tracked

NOTE: Features can be of different nature without being limited to visual patterns, UWB, Wi-Fi®, Infra Red or sounds.

**pose:** combination of position and orientation

**reference point:** point located at the interface of two non-overlapping functions of the AR framework architecture and representing interrelated interactions between those functions

**trackable:** element of the real world of which features are available and/or could be extracted

NOTE: Features can be made available from an analysis of the element itself (fiducial markers, natural images, 3D point cloud) or processed from a representation of the element (3D CAD model).

**world anchor:** coordinate system related to an element of the real world on which virtual content stays spatially-registered



## 3.2 Symbols

Void.



## 3.3 Abbreviations

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

| | |
|---|---|
| API | Application Programming Interface |
| AR | Augmented Reality |
| ARF | Augmented Reality Framework |
| CRUD | Create Read Update Delete |
| GUI | Graphical User Interface |
| ISG | Industry Specification Group |
| JSON | JavaScript Object Notation |
| REST | Representational State Transfer |
| UI | User Interface |
| UUID | Universally Unique IDentifier |
| UWB | Ultra Wide Band |
| YAML | YAML Ain't Markup Language |

# 4 Basic structure of the World Storage API for World Anchors, Reference Objects and Relocalization Information

## 4.1 Overview

The World Storage API for World Anchors (AR 16) and Reference Objects (AR 17) allow an AR Authoring function to store information about World Anchors and Reference Objects (named in the following document and API as Trackables) in the World Storage at authoring time. This also comprises relative position and orientation information between Trackables and World Anchors. Afterwards, an AR system processes that data at runtime, e.g. through the World Analysis function, to provide an AR experience. For this, it retrieves relocalization information from the World Storage (AR11). This information allows the World Analysis to determine the pose of objects relative to the AR system or vice versa. This pose can be continuously sent to the Scene Management so that the content of a 3D Rendering module can be updated in real-time (AR8).

Figure 1 shows the typical use cases for the World Storage within an AR system. The various authoring processes on the left side of the figure involve real persons (authors) as well as computing services (centre of the figure). While defining a scenario, authors can use the system in different locations, at different times. The API has to ensure an easy and elementary access to the World Storage data for creating, managing and deleting World Anchors, Trackables and their connections (World Links). In addition, the World Storage allows for the retrieval of relocalization information by the World Analysis. This is shown on the right side of Figure 1. This comprises, e.g. the retrieval of information about Trackables that can contribute to estimating the pose of a specific World Anchor, which can be determined following the World Links.



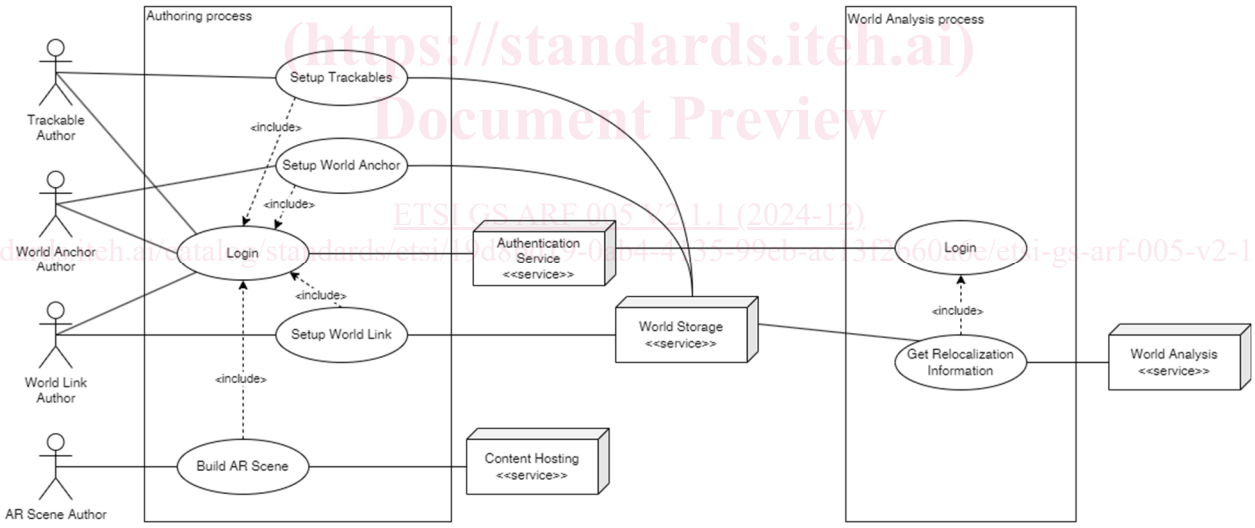


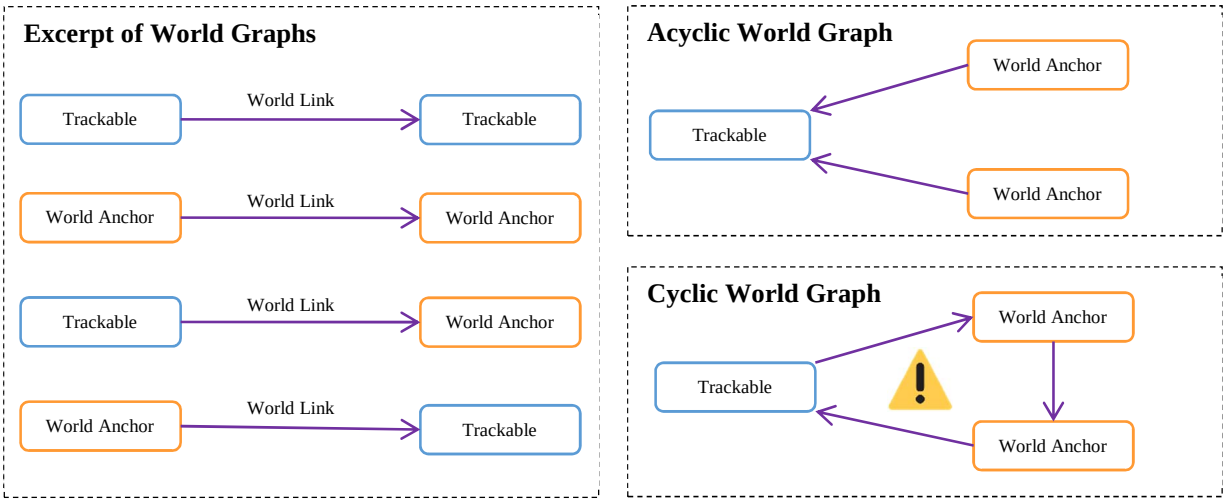

**Figure 1: Architecture of a typical AR authoring and World Analysis system**

## 4.2 Elements for world description

A World Graph describes a scene of the real world used at runtime by AR systems to spatially register AR assets with the real world, ETSI GS ARF 004-2 [2]. It consists of Trackables and World Anchors linked together. Trackables shall denote information to track objects of the real world. A World Anchor shall represent a pose in the real world in relation to one or multiple Trackables. World Anchors should be used to attach AR assets at a specific position and orientation in the real world (see Asset Preparation service in Figure 1). AR assets may also be attached to a Trackable directly, e.g. to give the trackable a graphical representation.

To define complex structures and scenarios representing the real world, Trackables and World Anchors should be linked together with World Links. World Links represent the relative position and orientation between Trackables and World Anchors. This allows for retrieving from World Anchors all Trackables and their relative positions useful to estimate the pose of the World Anchors. This World Graph composed of World Anchors, Trackables and their spatial structure may be considered as a graph representing the real world.

The World Storage API may allow relations as shown by Figure 2 (left side).




NOTE: It is recommended to avoid cyclic World Graphs to ease the spatial consistency of Trackables and World Anchors (see the right side of the figure).

**Figure 2: Left: Allowed links between Trackables and World Anchors within a World Graph; Right: Acyclic vs. cyclic World Graph**



## 4.3 Structure of the API

The World Storage API v2.0.0 is available on the ETSI Forge at following URL:



- https://forge.etsi.org/rep/arf/openapi/-/tree/2.0.0

The OpenAPI yaml file is located here [3]:

- https://forge.etsi.org/rep/arf/openapi/-/blob/2.0.0/API/worldstorage/worldstorageopenapi.yaml

NOTE 1: The world storage OpenAPI yaml file depends on a OpenAPI file defining common schemas shared with the World Analysis OpenAPI.

- https://forge.etsi.org/rep/arf/openapi/-/blob/2.0.0/API/common/commonopenapi.yaml

The structure of the file is based on the OpenAPI™ 3.0.0 specification [i.3].

The file has 4 main parts:

- Header part (copyrights, info, servers, tags, etc.).
- Paths for administration (/**ping**, /**admin**, /**version**).
- Paths for the objects of the world (/**trackables**, /**worldAnchors and** /**worldLinks**) - for the description of the actions (REST) and return values.
- Path for the retrieval of the localization of selected objects of the World (/**relocalizationInformation**) - also for the description of the actions (REST) and return values.
- Components part - containing the various schemas (in/out parameters).

The common file has a single part:

- Components part - containing various common schemas (in/out, mode and geometry parameters) and HTTP responses (client and server errors, warnings). All responses are now packaged into a schema with a separate "message" string component.

JSON should be used as coding protocol for parameter object structures and return values.

NOTE 2: Information about the definition and the characteristics of UUIDs can be found in IETF RFC 4122 [i.1]. The HTTP semantics are described in IETF RFC 2616 [i.2].

The administration paths can be used to test a server, to get the state of a server, and to request the API version.

The API may be tested in the "rendered file" view on the ETSI Forge, directly from the repository.

An implementation of the API shall follow the specification in the linked OpenAPI yaml file.

# 5 Description of the API

## 5.1 Trackables

The OpenAPI path **/trackables** in the YAML file " worldstorageopenapi.yaml" defines the CRUD operations Create (POST), Read (GET), Update (PUT) and Delete (DELETE) for the Trackables (described in the AR Framework architecture document ETSI GS ARF 003 [1] as the reference point "AR 17-Reference Objects").

Operations:

- Creating and updating a Trackable returns the UUID of the Trackable.
- Accessing one Trackable by UUID returns a JSON document containing the information about that Trackable.
- Accessing all Trackables returns a JSON list of all Trackables.
- Deleting one Trackable (by UUID) removes it from the World Storage.

By deleting a Trackable, the World Storage server shall update all World Links referring this Trackable.

A server shall implement all operations for managing Trackables. Anyway, it may refrain from accepting operation calls for creating updating and deleting Trackables to prevent unauthorized changes in the database.

NOTE: See https://forge.etsi.org/rep/arf/openapi/-/blob/2.0.0/API/worldstorage/worldstorageopenapi.yaml#L144.

## 5.2 World Anchors

The OpenAPI path **/worldAnchors** in the YAML file " worldstorageopenapi.yaml" defines the CRUD operations Create (POST), Read (GET), Update (PUT) and Delete (DELETE) for the World Anchors (described in the AR Framework architecture document ETSI GS ARF 003 [1] as the reference point "AR 16-World Anchors").

Operations:

- Creating and updating a World Anchor returns the UUID of the World Anchor.
- Accessing one World Anchor by UUID returns a JSON document containing the information about that World Anchor.
- Accessing all World Anchors returns a JSON list of all World Anchors.
- Deleting one World Anchor (by UUID) removes it from the World Storage.

By deleting a World Anchor, the World Storage server shall update all World Links referring this World Anchor.

A server shall implement all operations for managing World Anchors. Anyway, it may refrain from accepting operation calls for creating updating and deleting World Anchors to prevent unauthorized changes in the database.

NOTE: See https://forge.etsi.org/rep/arf/openapi/-/blob/2.0.0/API/worldstorage/worldstorageopenapi.yaml#L299.

## 5.3 World Links

The OpenAPI path **/worldLinks** in the YAML file " worldstorageopenapi.yaml" defines the CRUD operations Create (POST), Read (GET), Update (PUT) and Delete (DELETE) for the World Links.

Operations:

- Creating and updating a World Link returns the UUID of the World Link.
- Accessing one World Link by UUID returns a JSON document containing the information about that World Link.
- Accessing all World Links returns a JSON list of all World Links.
- Deleting one World Link (by UUID) removes it from the World Storage.

A server shall implement all operations for managing World Anchors. Anyway, it may refrain from accepting operation calls for creating updating and deleting World Anchors to prevent unauthorized changes in the database.

NOTE: See https://forge.etsi.org/rep/arf/openapi/-/blob/2.0.0/API/worldstorage/worldstorageopenapi.yaml#L454.

## 5.4 Relocalization Information

The OpenAPI path **/relocalizationInformation** in the YAML file "worldstorageopenapi.yaml" defines the operation Read (GET) for the Relocalization Information.

Operation:

- Accessing relocalization information from one World Anchor or Trackable returns a JSON document containing the relocalization information related to the requested World Anchor or Trackable. This is a list of triplets of 3D transforms, trackables and modes. The Trackable in a triplet is connected to the requested World Anchor or Trackable by one or several world links. The 3D transform of a triplet is the accumulation of all 3D transforms of the World Links connecting the trackable to the requested Trackable or World Anchor. The mode of the triplet defines if the transform is given from the Trackable to the requested World Anchor or Trackable or inversely.
- Accessing relocalization information from several World Anchors or Trackables returns a JSON document containing an array of relocalization information for each requested World Anchor or Trackable.

A server shall implement all operations for retrieving relocalization information.

NOTE: See https://forge.etsi.org/rep/arf/openapi/blob/2.0.0/API/worldstorage/worldstorageopenapi.yaml#L82.