

ETSI GS ARF 005 V1.1.1 (2022-09)



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

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Reference

DGS/ARF-005

Keywords

API, augmented reality, context capturing and analysis, interoperability, real world capture

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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

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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.

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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 1.0.0. (2022-09)

NOTE: Available at <https://forge.etsi.org/rep/arf/arf005>.
<https://standards.ietf.ai/catalog/standards/sist/a233f202-c309-493f-9138-51f65682e6cb/etsi-gs-arf-005-v1-1-1-2022-09>

2.2 Informative references

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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".

NOTE: Available at <https://datatracker.ietf.org/doc/html/rfc4122>.

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

NOTE: Available at <https://www.ietf.org/rfc/rfc2616.txt>.

- [i.3] OpenAPI Specification v3.0.0.

NOTE: Available at <https://spec.openapis.org/oas/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

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
WS	World Storage
YAML	YAML Ain't Markup Language

4 Basic structure of the World Storage API for World Anchors and Reference Objects

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.

Figure 1 shows a typical architecture used by an AR system. The various authoring processes involve real persons (Author, left-hand side) as well as computing services (right-hand side). While defining a scenario, authors can use the system in different locations, at different times. The API has to assure an easy and elementary access to the World Storage data for creating, managing and deleting World Anchors, Trackables and their connections (World Links).

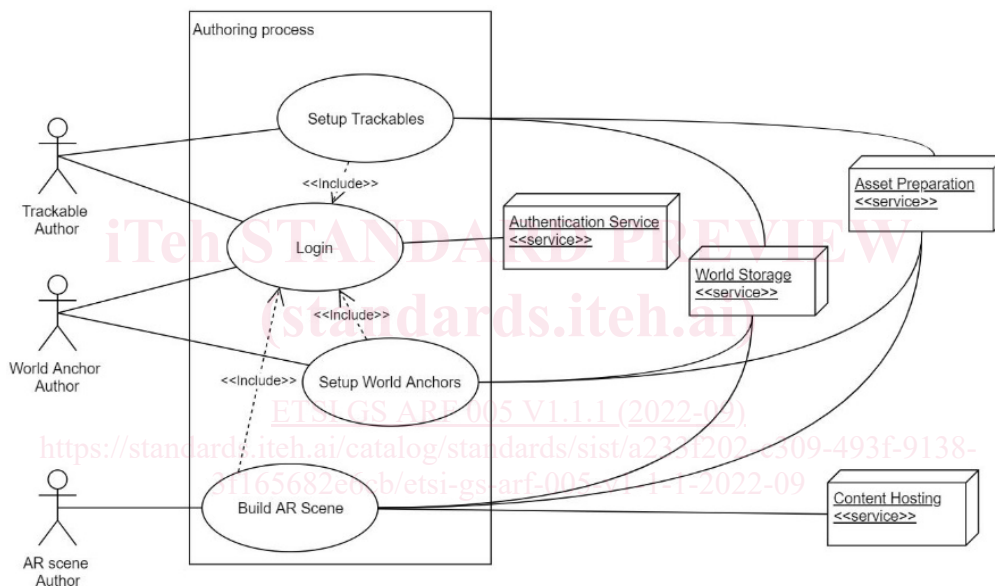


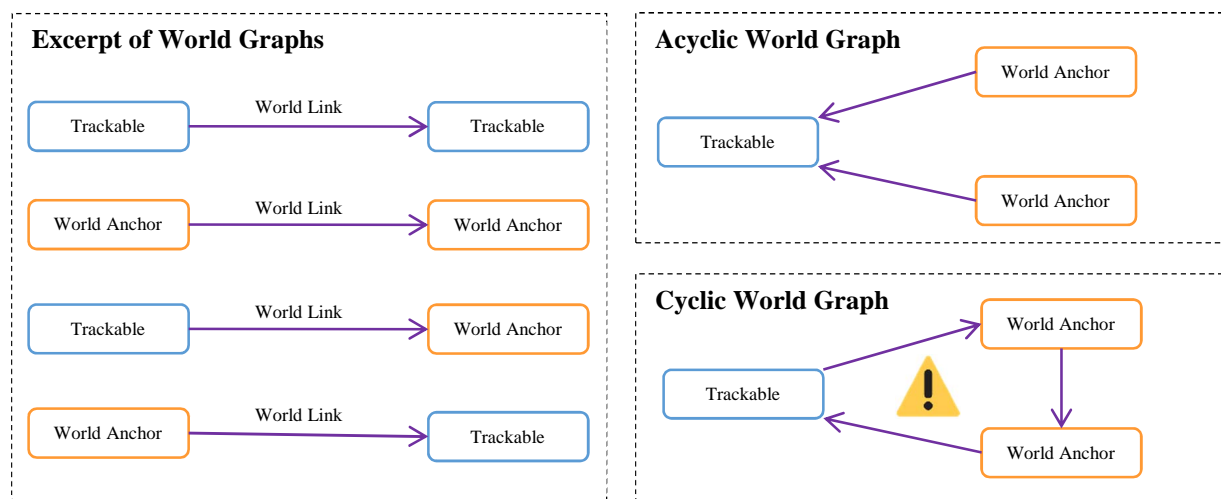
Figure 1: Architecture of a typical AR authoring system

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 [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 Figure 2, right side).

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 v1.0.0 is available on the ETSI Forge at following URL:

- <https://forge.etsi.org/rep/arf/arf005/-/tree/1.0.0>

The OpenAPI yaml file is located here [3]:

- <https://forge.etsi.org/rep/arf/arf005/-/blob/1.0.0/API/openapi.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).
- Paths for administration (**/ping**, **/admin**, **/version**).
- Paths for objects (**/trackables**, **/worldAnchors** and **/worldLinks**) - for the description of the actions (REST) and return values.
- Components part - containing the various schemas (in/out parameters) and HTTP responses (errors, warnings).

JSON should be used as coding protocol for parameter and object structures. The functions' return values for single UUIDs shall be non-encoded strings. Other text as well as binary data formats may also be used if some systems request this.

NOTE: Information about the definition and the characteristics of UUIDs can be found in [i.1]. The HTTP semantics are described in [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 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 "openapi.yaml" defines the CRUD operations Create (POST), Read (GET), Update (PUT) and Delete (DELETE) for the Trackables (described in the AR Framework architecture document [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/arf005/-/blob/1.0.0/API/openapi.yaml#L76>.

5.2 World Anchors

The OpenAPI path **/worldAnchors** in the YAML file "openapi.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 [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/arf005/-/blob/1.0.0/API/openapi.yaml#L219>.

5.3 World Links

The OpenAPI path **/worldLinks** in the YAML file "openapi.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/arf005/-/blob/1.0.0/API/openapi.yaml#L362>.

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Annex A (informative): Example Usage of the World Storage API

A.1 Introduction

This annex provides an example (Validation Application 'Museum') illustrating the application of the World Storage API file specified in the present document. The example is kept simple and uses a frequent scenario where a physical object (in the real world) is enriched with some virtual content (placed in the AR scene).

A.2 Specification of the Validation Application 'Museum'

An ordinary object (e.g. a statue in a museum) is to be enriched (documented) with some virtual content via the help of AR techniques.

Use case:

A staff member (generally speaking an author) of the museum decides to augment a statue with a mesh (a geometric model) and a text label (a GUI element) and will propose an access to this virtual content to his visitors from two positions, from the left and the right side of the statue.

For this use case, the author decides to use the World Storage API to create a World Graph of the scenario according to the specification at hand. The use case representing an application of the World Storage API (Validation Application) is visualized in Figure A.1. For this, the author needs to create a structure using Trackable, World Anchor and World Link objects. The author should delegate the various tasks to different persons like a Trackable Author, a World Anchor Author or an AR Scene Author.

Technical specification:

- a) Two AR markers are needed (Trackables).
- b) Two locations are needed to position virtual content (World Anchors).
- c) Some spatial relations between the markers and the locations are needed (World Links).

Task descriptions:

- 1) The author places AR markers on the left and right side of the statue and registers them as Trackables.
- 2) For the first content (mesh of the statue) the author decides to place a first World Anchor on the top of the statue's pedestal knowing that the geometry model has its origin here.
- 3) The second content will be a description (GUI) for the nose of the statue, so the author places the second World Anchor on the nose.
- 4) Because the content will be accessed by both AR markers, the author first connects the pedestal World Anchor to the two Trackables.
- 5) Then, the author connects the nose World Anchor to the pedestal World Anchor.
- 6) Finally, the mesh of the statue is attached to the pedestal World Anchor, and the GUI element is attached to the nose World Anchor (this information is not saved in the World Storage but is defined in the AR scene of the application).