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Augmented Reality Framework (ARF)
Interoperability Requirements for AR components, systems and services
Part 2: World Storage and AR Authoring 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 2 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".

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.

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 specifies the high level Reference Point requirements between the World Storage and AR Authoring functions as they are identified in ETSI GS ARF 003 [1]. It further defines the requirements of Reference Points "World Anchors" (AR16) and "Reference Objects" (AR17).

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 at https://docbox.etsi.org/Reference/.

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".

2.2 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.

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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.

Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

AR Asset: any kind of content positioned and oriented in the real world to alter the user's 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, radio, Infra Red or sounds.

GeoTrackable: position and orientation on earth in a geodetic referential

Reference Point: point located at the interface of two non-overlapping functions 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: fixed position in relation to one or more elements of the real world

NOTE 1: A World Anchor has a Coordinate Reference System in which AR Assets stay spatially-registered.

NOTE 2: More than one World Anchor can be attached to a Trackable.

NOTE 3: As the AR system updates its knowledge of the environment, the World Anchor's pose adapts to the real world preventing the associated AR Asset attached to the World Anchor from drifting.

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

3.2 Symbols

Void.

3.3 Abbreviations

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

3DT	3D Transform
AI	Artificial Intelligence
AR	Augmented Reality
ARF	Augmented Reality Framework
CAD	Computer-Aided Design
GNSS	Global Navigation Satellite System

4 Interoperability requirements for AR16 and AR17

4.1 AR16 and AR17 Reference Points scope

AR16 "World Anchors" and AR17 "Reference Objects", as specified in ETSI GS ARF 003 [1], define the dialog structure between the AR Authoring and the World Storage functions to ensure a shared description of the real world in order to associate AR Assets with specific places and/or features in the real world.

4.2 AR Assets

An AR Asset is any kind of content positioned and oriented in the real world to alter the user's experience.

Content types include 3D models, images, videos, text, sounds sources, etc.

Figure 1 shows how AR Assets are symbolized in the World Graph diagrams.

Figure 1: AR Asset Representation

4.3 Attaching AR Assets to specific real world places or things

AR Assets are attached and arranged in relation to the real world by using Trackables and/or World Anchors.

Their attachment is specified in the AR Authoring function. The authoring process can be performed by a developer, a designer, the user of the AR experience or by an automated (AI-assisted) process, in advance of the AR experience or at runtime.

4.4 Trackables

4.4.1 Overview

Trackables are models of parts of the real world.

Trackables are elements of the real world of which features are available and/or could be extracted.

Trackables provide a Coordinate Reference System in which a pose can be expressed.

Figure 2 shows how Trackables are symbolized in the World Graph diagrams.

Figure 2: Trackable

RQ-WS-001	A Trackable shall define elements of the real world of which features are available and/or could be extracted.

RQ-WS-002	A Trackable shall define a Coordinate Reference System of the real world.

RQ-WS-003	A Trackable shall have a unique identifier.

4.4.2 Examples of Trackables

When detected in the environment, some Trackables, listed in Figure 3, provide directly the device's position and orientation in the Coordinate Reference System of that Trackable, and some of them provide only the position. In that case, data from accelerometers, magnetometers and gyroscopes can be used to provide the device's orientation.

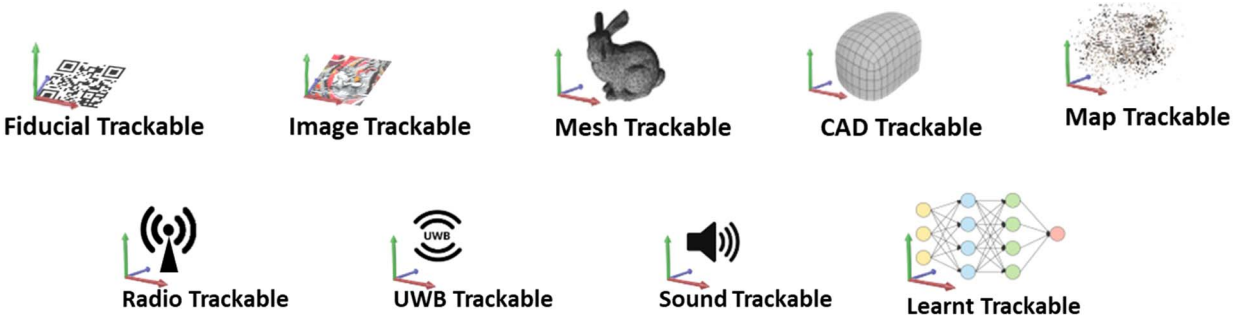


Figure 3: Type of Trackables

4.4.3 GeoTrackables

A GeoTrackable is a position and orientation on earth in a geodetic referential.

A GeoTrackable can be provided by any system providing a position on earth in a geodetic referential and its orientation can be obtained from magnetometers and gyroscopes. Examples of GeoTrackables include GNSS or a Visual Positioning System.

Figure 4 shows how GeoTrackables are symbolized in the World Graph diagrams.

Figure 4: GeoTrackable

When they are available, Trackables are added to the World Graph by the AR Authoring function.

Trackables can also be provided to the World Graph by the World Analysis function.

The taxonomy of Trackables will evolve with future developments in technology.

4.5 Features

Features are characteristics of a real world element that can be searched, recognized or tracked.

Features are extracted from Trackables and stored in a World Storage function.

Figure 5 shows how Features are symbolized in the World Graph diagrams.

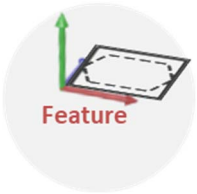


Figure 5: Feature

RQ-WS-004a	Features may be hosted by external systems.
RQ-WS-004b	Features can be accessible or inaccessible.

RQ-WS-005	Positions and orientations of Features shall be expressed in the Coordinate Reference System of the Trackable from which they have been extracted.

4.6 World Anchors

A World Anchor represents a fixed position in relation to one or more elements of the real world. It has a Coordinate Reference System in which AR Assets stay spatially-registered.

Figure 6 shows how World Anchors are symbolized in the World Graph diagrams.

Figure 6: World Anchor

RQ-WS-006	A World Anchor shall define a Coordinate Reference System of the real world.

RQ-WS-007	A World Anchor may have zero, one or several AR Assets placed in its coordinate reference system.

RQ-WS-008	A World Anchor shall have a unique identifier.

4.7 Building the World Graph with AR Assets, Trackables and World Anchors

The relative position of AR Assets, Trackables and World Anchors are defined by 3D Transforms.

4.8 Using 3D Transforms

A 3D Transform defines the relative position and orientation between Trackables, World Anchors or AR Assets.

Figure 7 shows how 3D Transforms are symbolized in the World Graph diagrams.

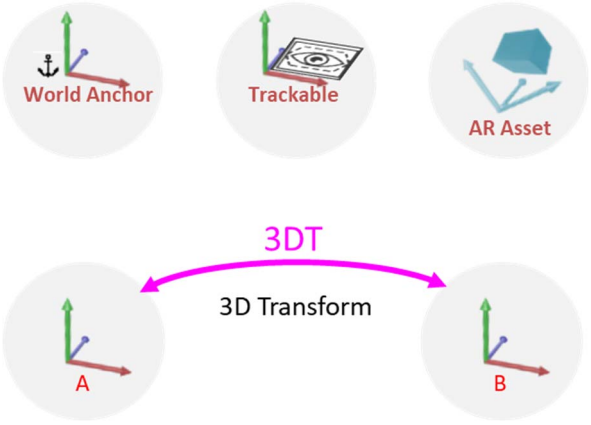


Figure 7: 3D Transform

RQ-WS-009	A 3D Transform shall define the relative position and orientation between Trackables, World Anchors or AR Assets.

RQ-WS-010	Semantic information may be attached to any object whether they are Trackables, World Anchors or AR Assets.

RQ-WS-011	An AR Asset shall be attached to one or more World Anchors or Trackables.

RQ-WS-012	A World Anchor shall be attached to one or more World Anchors or Trackables.

4.9 Building a representation of the world solely with Trackables (informative)

Trackables are detected in the real world through their features. Linking an AR Asset directly to a Trackable is the easiest way to enrich the World Graph.

An example of that usage is the augmentation of a place by attaching an AR Asset to a fiducial marker Trackable as shown in Figure 8.

Figure 8: Marker-based use case

Another example is when AR Assets, here an icon, are associated to a Point of Interest on earth, in GNSS-based applications as shown in Figure 9.

Figure 9: GNSS-based use case

4.10 Building a World Graph with both Trackables and World Anchors (informative)

When the use case requires more complex augmentations of the world, World Anchors will be introduced to help organize AR Assets hierarchically.

Figure 10 illustrates how two AR Assets, both icons, are attached to two Points of Interest associated to one GeoTrackable.

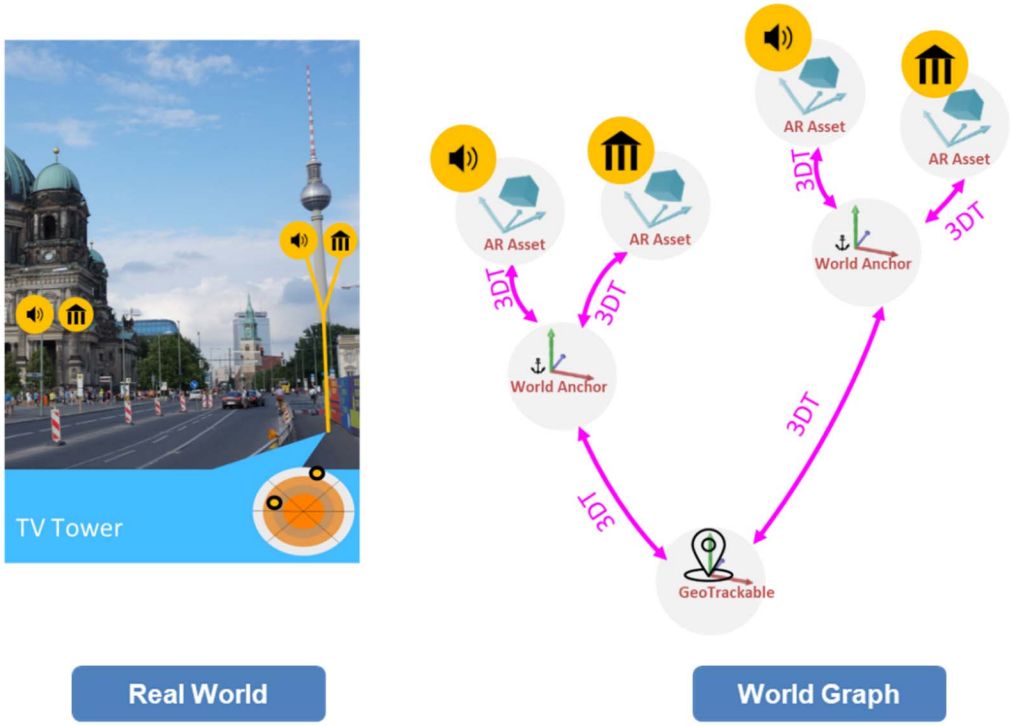
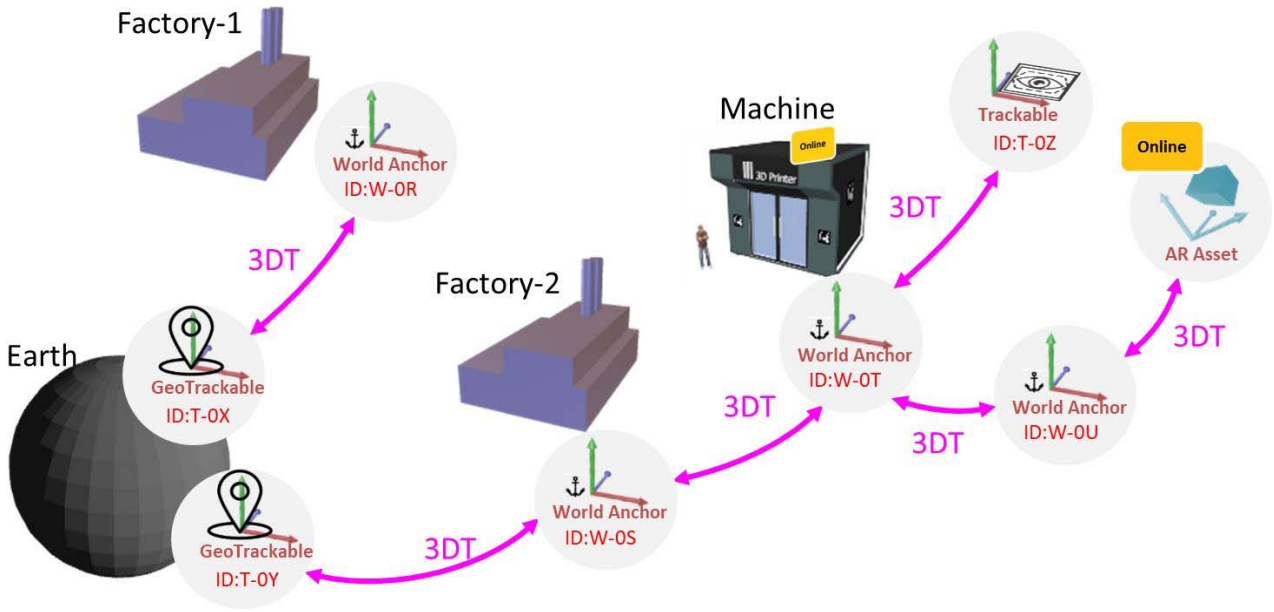


Figure 10: Complex GNSS-based use case

The construction of more complex World Graphs are described in Annex A.

4.11 Anchoring several World Graphs in the same geodetic referential (informative)

As shown in Figure 11, Trackables and World Anchors can be linked through a hierarchical graph to an earth position through a nested chain of references, enabling the system to transform a pose from a local Cartesian Coordinate Reference System to a global geodetic Coordinate Reference System.



NOTE: Both GeoTrackables are defined in the same global geodetic Coordinate Reference System.

Figure 11: Earth anchored World Graphs

4.12 AR Authoring function requirements

RQ-WS-013	The AR Authoring function may define a specific set of Trackables involved in the pose estimation calculation of a World Anchor in the AR Scene.
RQ-WS-014	The AR Authoring function may provide a world structure defining a logical relationship between World Anchors.
RQ-WS-015	The AR Authoring function shall maintain the relative poses between the Trackables and AR Assets and between the World Anchors and AR Assets.

4.13 World Storage function requirements

RQ-WS-016	The World Storage function shall provide the World Anchor unique identifier.
RQ-WS-017	The World Storage function shall provide the Trackable unique identifier.
RQ-WS-018	The World Storage function shall maintain the relative poses of Trackables and World Anchors.
RQ-WS-019	The World Storage function shall extract the features from Trackables.
RQ-WS-020	The World Storage function shall provide features to compute the pose of the AR device in relation to a World Anchor or the pose of the World Anchor in relation to the device according to one or a set of Trackables.
RQ-WS-021	The World Storage function may check the World Graph for consistency.

Annex A (informative): Example implementations

A.1 Example Implementation 1

In this marker-based example, an industrial machine will be augmented in order to provide contextually-relevant information. The user's position relative to the machine is determined by recognition of different 2D markers.

STEP 1

As shown in Figure A.1, at authoring time, the AR experience designer defines the places where AR Assets will be attached. These positions will be defined as World Anchors in the World Graph.

World Anchors are identified with a unique ID.

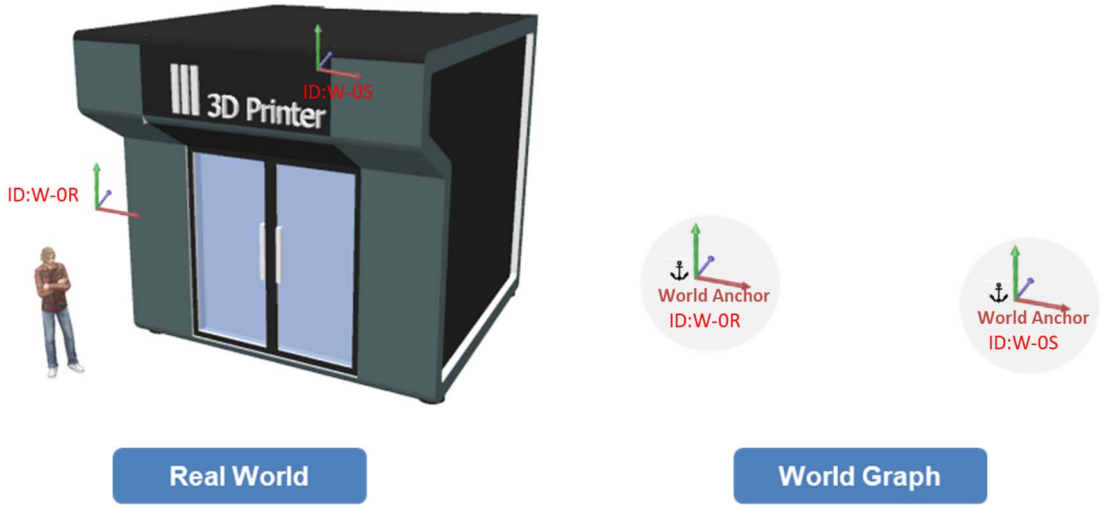


Figure A.1: Example implementation step 1

STEP 2

As shown in Figure A.2, AR Assets are positioned in the Coordinate Reference System of the World Anchors.

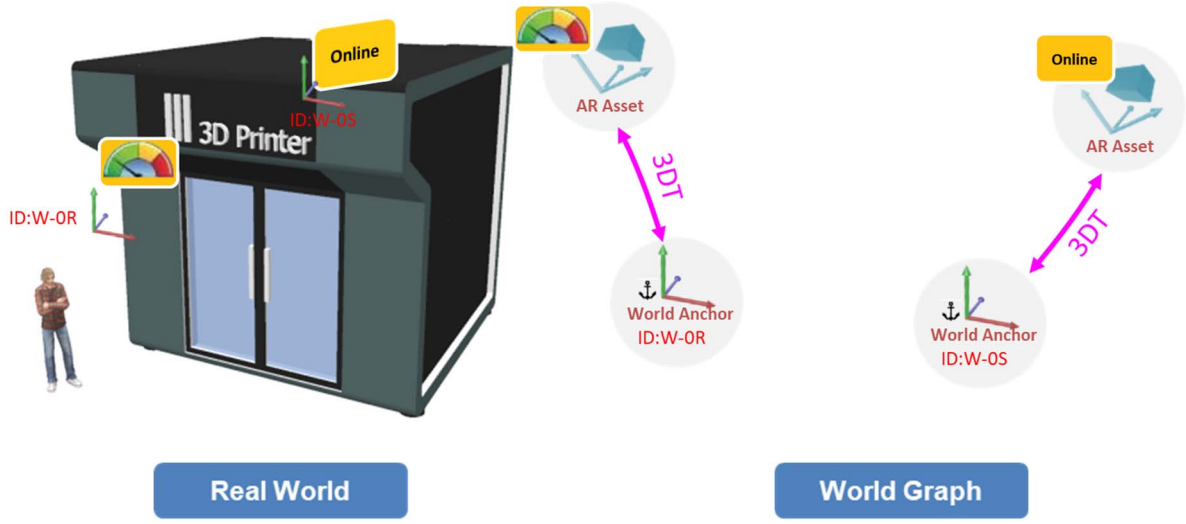


Figure A.2: Example implementation step 2

STEP 3

As shown in Figure A.3, Trackables are added in the World Graph and positioned relative to the associated World Anchors.

Each World Anchor is linked to every Trackable the designer decides to involve in the computation of the pose of the associated World Anchor in the real world.

The first AR Asset (the gauge) can be triggered only if Trackable T-0X Is detected.

The other AR Asset (the word Online) can be triggered by any of the 3 Trackables or a combination of them.

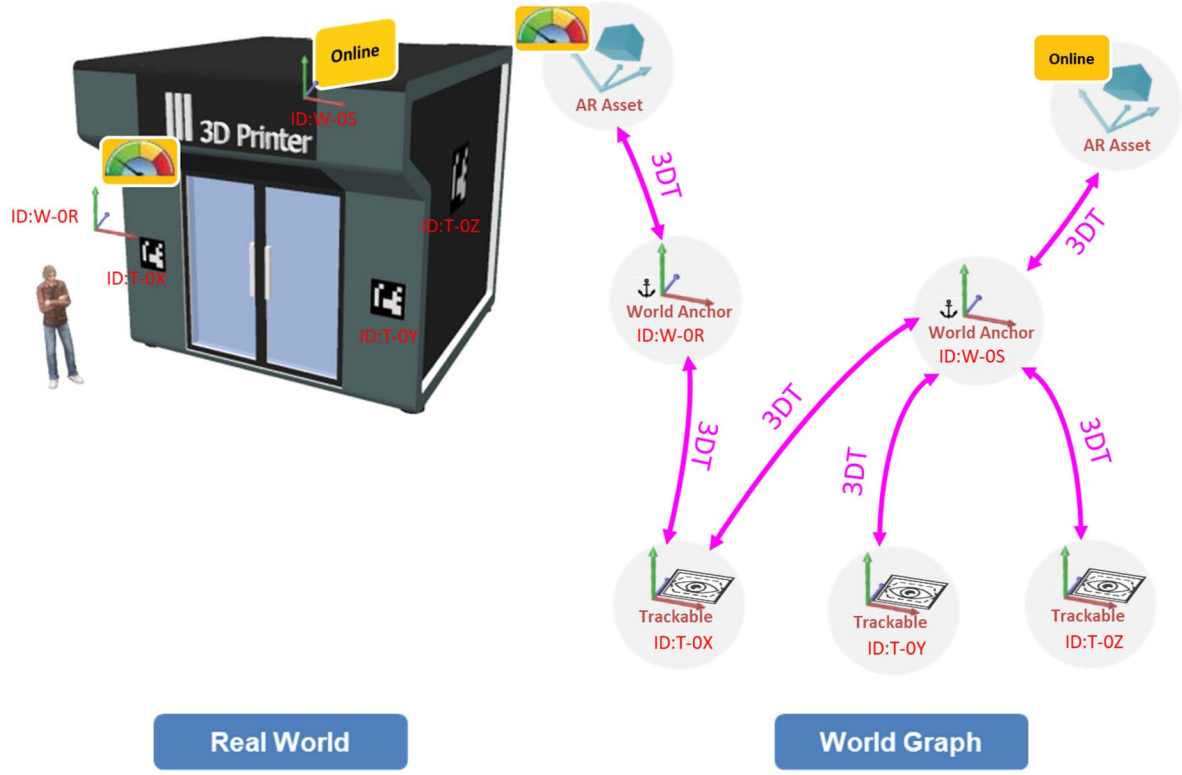


Figure A.3: Example implementation step 3

A.2 Example implementation 2

In this example, an office will be augmented with information about each room and the AR experience will provide navigation information to guide a user along a specific path. The user's pose relative to its environment is determined by recognition of different 2D markers and/or by using radio fingerprinting and/or a 3D point cloud.

STEP 1

At authoring time, as shown in Figure A.4, the AR experience designer defines the places where AR Assets will be attached. These positions will be defined as World Anchors in the World Graph. World Anchors are identified with a unique identifier (ID:W-0S, ID:W-0T)

World Anchors can be introduced to organize World Anchors relative to each other through 3D Transforms (ID:W-0R).

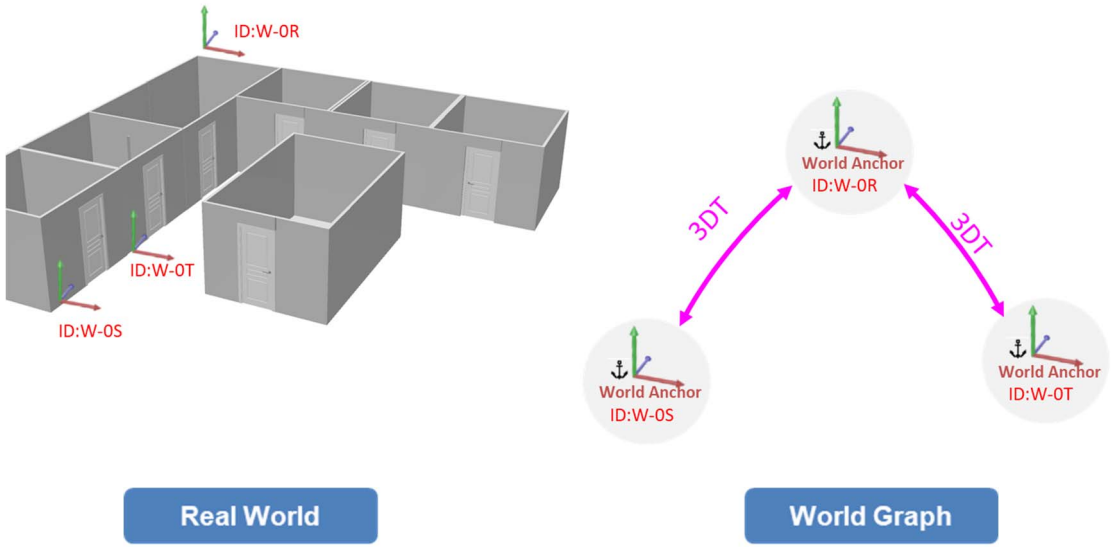


Figure A.4: Example implementation step 1

STEP 2

In step 2, as shown in Figure A.5, AR Assets are positioned in the Coordinate Reference System of the World Anchors.

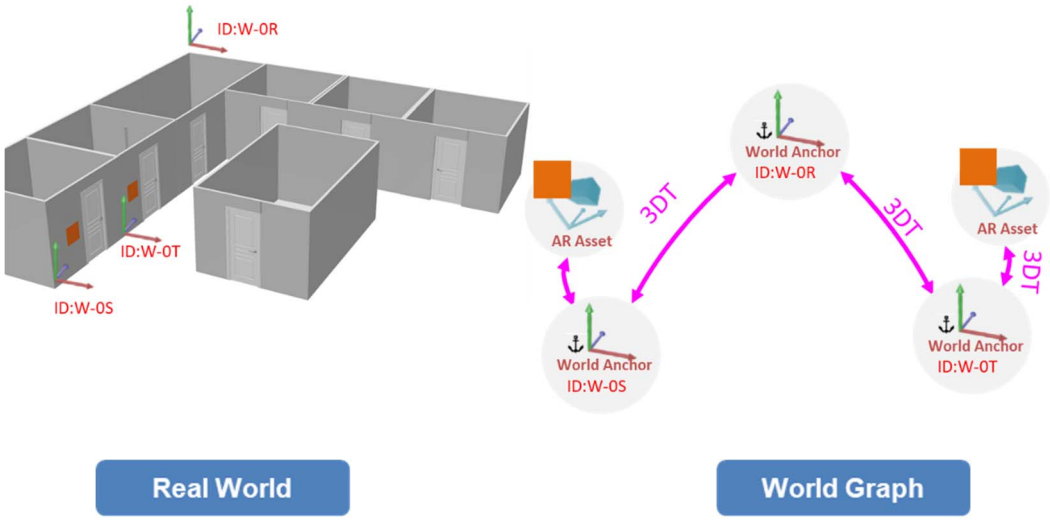


Figure A.5: Example implementation step 2

STEP 3

As shown in Figure A.6, Trackables are added in the World Graph and positioned relative to the associated World Anchors.

Each World Anchor is linked to every Trackable the designer decides to involve in the computation of the pose of the associated World Anchor in the real world.

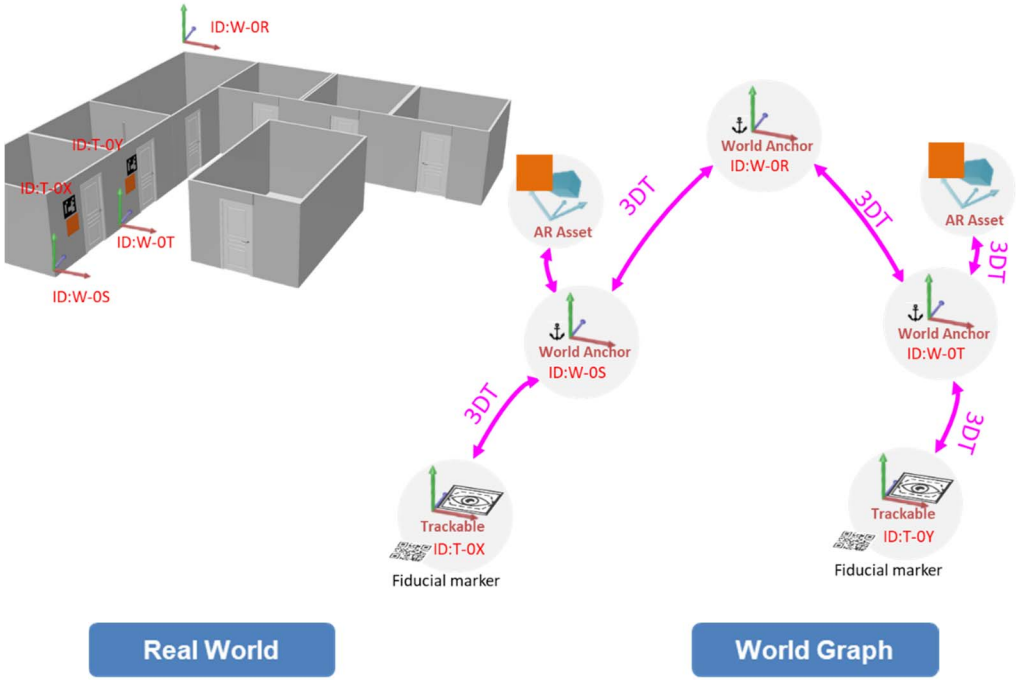


Figure A.6 :Example implementation step 3

STEP 4

As shown in Figure A.7, a radio fingerprinting Trackable is added.

The World Anchors can take advantage of this additional Trackable to improve the pose calculation.

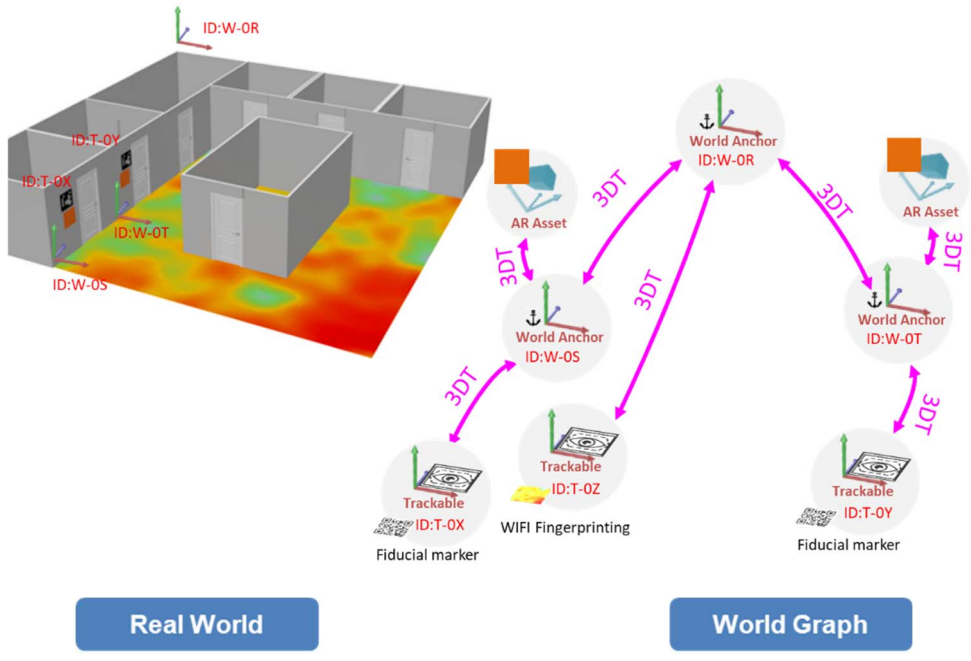


Figure A.7: Example implementation step 4

STEP 5

As shown in Figure A.8, as the radio fingerprinting Trackable provides the coverage of the entire floor, AR Assets depicting arrows are attached to the top World Anchor to provide navigation facilities.

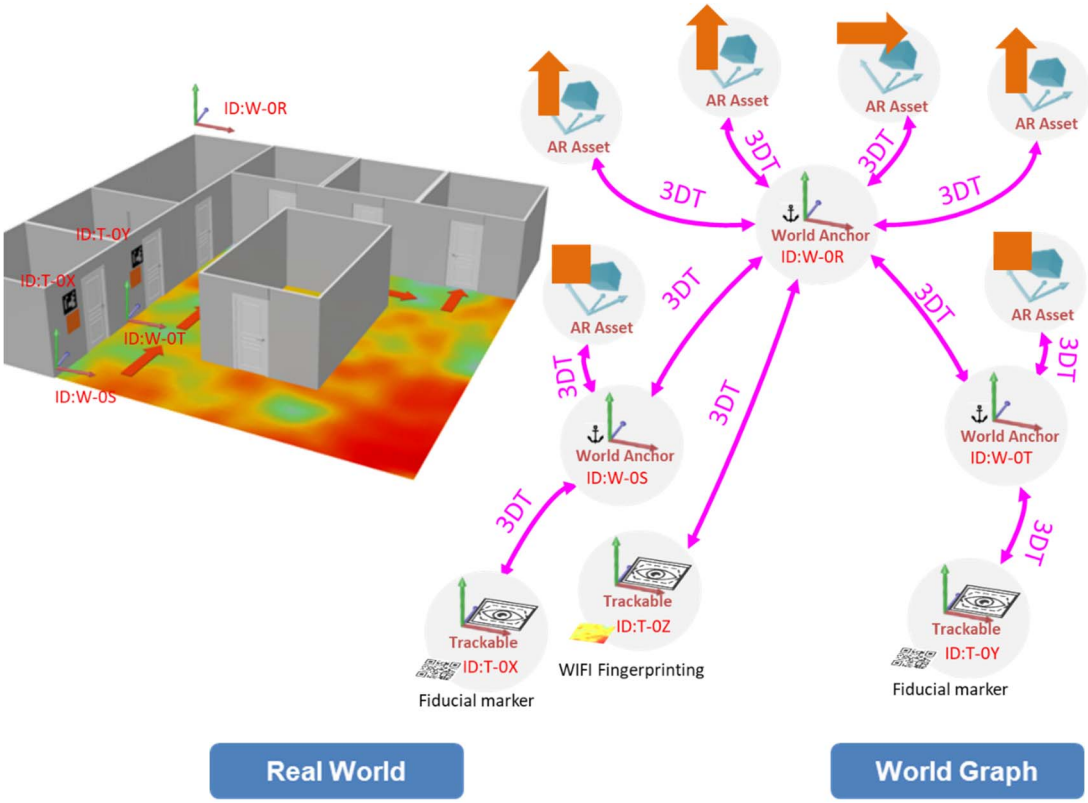


Figure A.8: Example implementation step 5

STEP 6

As shown in Figure A.9, a new Trackable has been added to improve the accuracy of the pose calculation.

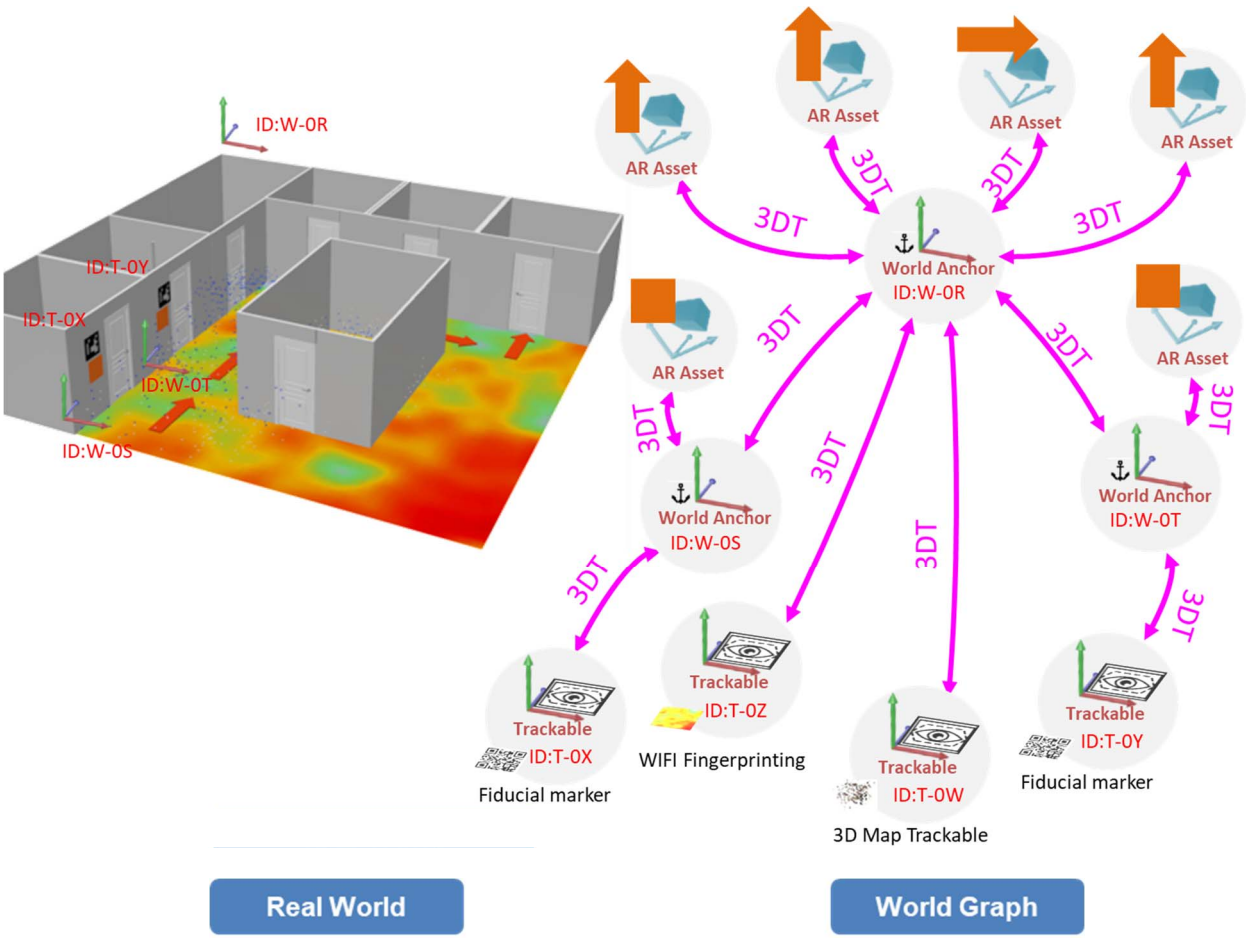


Figure A.9: Example implementation step 6

History

Document history		
V1.1.1	August 2021	Publication