



**Augmented Reality Framework (ARF);  
Interoperability Requirements for  
AR components, systems and services;  
Part 3: World Capture, World Analysis and  
Scene Management**

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# Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Augmented Reality Framework (ARF).  
<http://standards.iteh.ai/catalog/standards/sist/200001-0004-1119/0004-8542a5ef4100/etsi-gs-arf-004-3-v1-1-1-2021-10>

The present document is part 3 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. The present document specifies the interoperability requirements for Reference Points AR1 and AR2 of the reference architecture for AR solutions defined in ETSI GS ARF 003 [1].

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# 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 reviews the high level Reference Point requirements between the World Capture, World Authoring and Scene Management functions as they are identified in ETSI GS ARF 003 [1]. It further defines the requirements of reference points "Sensors for World Analysis" (AR1) and "Sensors for Scene Management" (AR2).

## 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.

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] OGC®: "Geographic information - Observations and measurements".

NOTE: This standard can be found at [https://portal.ogc.org/files/?artifact\\_id=41579](https://portal.ogc.org/files/?artifact_id=41579).

[i.2] Fowler, Martin (1997): "Analysis Patterns: Reusable Object Models". Addison-Wesley. pp. 35-55. ISBN 978-0-201-89542-1.

NOTE: This document can be found at [https://archive.org/details/analysispatterns00fowl\\_085](https://archive.org/details/analysispatterns00fowl_085).

[i.3] OGC®: "Sensor Web Enablement (SWE)".

NOTE: The page that describes the various parts of the standard suite can be found at <https://www.ogc.org/node/698>.

[i.4] OGC®: "SensorML: Model and XML Encoding Standard".

NOTE: This standard can be found at [https://portal.ogc.org/files/?artifact\\_id=55939](https://portal.ogc.org/files/?artifact_id=55939).

[i.5] OGC®/W3C®: "Semantic Sensor Network Ontology".

NOTE: This standard can be found at <https://www.w3.org/TR/vocab-ssn/>.

[i.6] W3C®: "Web of Things (WoT) Architecture 1.1".

NOTE: This standard can be found at <https://www.w3.org/TR/2020/WD-wot-architecture11-20201124/>.

- [i.7] ISO/IEC 23093 (all parts): "Information technology - Internet of media things".
- NOTE: This standard can be found at <https://www.iso.org/search.html?q=23093>.
- [i.8] W3C®: "Web of Things (WoT) Thing Description".
- NOTE: This standard can be found at <https://www.w3.org/TR/wot-thing-description/>.
- [i.9] OGC®: "SensorThings API".
- NOTE: This standard can be found at <http://docs.openegeospatial.org/is/15-078r6/15-078r6.html>.
- [i.10] W3C®: "Web of Things (WoT) Discovery".
- NOTE: This draft standard can be found at <https://www.w3.org/TR/wot-discovery/>.
- [i.11] ISO/IEC 18038:2020: "Information technology - Computer graphics, image processing and environmental representation - Sensor representation in mixed and augmented reality".
- NOTE: This draft standard can be found at <https://www.iso.org/standard/70720.html>.
- [i.12] IEEE 1451™: "Standard for a Smart Transducer Interface for Sensors and Actuators".
- NOTE: A tutorial about the family of standards can be found at <https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/tutorials/1451d4.pdf>.
- [i.13] ISO/IEC 23093-2 and ISO/IEC 23093-3: "Information technology - Internet of media things - Part 2: Discovery and communication API" and "Information technology - Internet of media things - Part 3: Media data formats and APIs".
- NOTE: These standards can be found at <https://www.iso.org/standard/74332.html> and <https://www.iso.org/standard/74333.html>.
- [i.14] ISO/IEC 23090-5:2021 and ISO/IEC 23090-9: "Information technology -- Coded representation of immersive media -- Part 5: Visual volumetric video-based coding (V3C) and video-based point cloud compression (V-PCC)" and "Information technology -- Coded representation of immersive media -- Part 9: Geometry-based point cloud compression".
- NOTE: These specifications can be found at <https://www.iso.org/standard/73025.html> and <https://www.iso.org/standard/78990.html>. More information about the MPEG PCC family of specifications can be found at <https://mpeg-pcc.org/>.
- [i.15] ISO 19130-1 and ISO 19130-2: "Geographic information -- Imagery Sensor Models for geopositioning -- Part 1: Fundamentals" and "Geographic information -- Imagery sensor models for geopositioning -- Part 2: SAR, InSAR, lidar and sonar".
- NOTE: Available at <https://www.iso.org/standard/66847.html> and <https://www.iso.org/standard/56113.html>.
- [i.16] W3C®: "Generic Sensor API".
- NOTE: The draft Generic Device Sensor API standard is found at <https://www.w3.org/TR/generic-sensor/>.
- [i.17] Internet of Things standards are discussed in a blog post found at this URL <https://www.postscapes.com/internet-of-things-protocols/>.

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## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

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

**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.

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

### 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
DAS	Devices And Sensors
GPS	Global Positioning System
ISG	Industry Specification Group
JSON	JavaScript Object Notation
MPEG	Motion Pictures Experts Group
PCC	Point Cloud Compression
RFID	Radio Frequency Identifier
RGB	Red Green Blue
RGB-D	Red Green Blue + Depth
RP	Reference Point
SAR	Synthetic Aperture Radar
SC	SubCommittee
SDO	Standard Development Organization
SM	Scene Management
SOSA	Sensor, Observation, Sample and Actuator
SSN	Semantic Sensor Network
SWE	Sensor Web Enablement
TEDS	Transducer Electronic Data Sheets
UID	Unique Identifier
WA	World Analysis
WC	World Capture
WG	Working Group

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## 4 Interoperability Requirements for AR1 and AR2

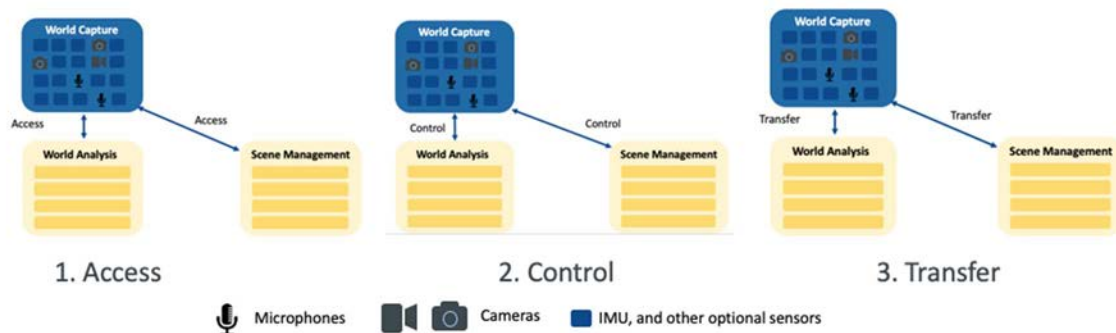
### 4.1 AR1 and AR2 Reference Points Scope

AR1 "Sensors for World Analysis" and AR2 "Sensor Data for Scene Management" Reference Points (RP), as specified in ETSI GS ARF 003 [1] define the dialog structure between the World Capture, World Analysis (WA) and the Scene Management (SM) functions respectively to ensure that relevant features in the real world which are captured by sensors are available, received and useable by the WA and SM subfunctions.

The AR1 and AR2 are separate Reference Points because they connect two different functions to the World Capture function, however, their requirements are identical because both the World Analysis and Scene Management use the World Capture capabilities. They may be implemented together or separately, depending on system requirements and design.

## 4.2 High-level requirements

There are three high level requirements. Figure 1 shows how the high level requirements are in sequence.



**Figure 1: Sequence of AR1 and AR2 requirements**

In clause 6.2 of ETSI GS ARF 003 [1], the requirements of AR1 reference point are defined as:

- Access to sensor capabilities and characteristics:
  - Type of sensor (e.g. RGB camera, RGB-D camera, accelerometer, magnetometer, microphone, or GPS).
  - Identifier of the sensor provided by the **World Capture** function.
  - Number of devices of similar type.
  - Measuring characteristics (e.g. range and resolution, acquisition frequency, conditions of use, or coverage).
  - Information about the extrinsic, intrinsic and distortion parameters of the sensors.
- Control of the sensor:
  - Initializing and shutting-down sensors.
  - Starting and stopping the access to sensors.
  - Setting of identifiers as used by the **World Analysis** function.
  - Setting of measurement characteristics (e.g. ranges, systems of units, resolutions, or acquisition frequency).
  - Switching between sensors.
  - Requesting conditions for data delivery to the AR implementation (e.g. event-based, temporal, or synchronized with other sensors).
- Transfer of captured data:
  - Sensor data as e.g. raw data or aggregated or converted data.
  - The ID of the sensor which has captured the data.
  - Metadata associated to data captured by the sensor.

In clause 6.3 of ETSI GS ARF 003 [1], the requirements are defined as:

- Access to sensor capabilities and characteristics:
  - Type of sensor (e.g. RGB camera, RGB-D camera, accelerometer, magnetometer, microphone, or GPS).
  - Identifier of the sensor provided by the **World Capture** function.
  - Number of devices of similar type.
  - Measuring characteristics (e.g. range and resolution, acquisition frequency, conditions of use, or coverage).
  - Information about the extrinsic, intrinsic and distortion parameters of the sensors.
- Control of the sensor:
  - Initializing and shutting-down sensors.
  - Starting and stopping the access to sensors.
  - Setting of identifiers as used by the **Scene Management** function.
  - Setting of measurement characteristics (e.g. ranges, systems of units, resolutions, or acquisition frequency).
  - Switching between sensors.
  - Requesting conditions for data delivery to the AR implementation (e.g. event-based, temporal, or synchronized with other sensors).
- Transfer of captured data:
  - Sensor data as e.g. raw data or aggregated or converted data.
  - The ID of the sensor which has captured the data.
  - Metadata associated to data captured by the sensor.

NOTE 1: Extrinsic parameters can provide the pose of the sensor relatively to reference coordinate systems related to the AR device, to another sensor, or to the real world.

NOTE 2: The metadata associated to the captured data can be an actual measurement unit or a time stamp for representing time of data acquisition (essential to merge data supplied by multiple sensors).

NOTE 3: This reference point can be used to update video background information as part of the AR scene for video see-through AR systems.

NOTE 4: This reference point can be used to update the audio background in case of an implementation offering augmented audio functions.

### 4.3 World Analysis Function Access to World Capture Sensors

The first set of AR1 requirements pertain to the function's access to World Capture sensors. "Access" assumes that prior to request for access, the WC registry service has discovered and registered all relevant sensors. The WC function will also perform all initialization of relevant sensors to which the World Analysis requests access.

RQ-AR1-001	The WA shall have ability to receive from the WC registration service all requested information including UID, type, data formats available, and other parameters (e.g. embedded, external, synchronization) about any, some or all sensors.
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Requested information can include:

- Type of sensors available to the WA system.
- # of sensors of each type.
- Capabilities of each sensor (e.g. computation, resolution, frequency, etc.):
  - Measuring characteristics (e.g. range and resolution, acquisition frequency, conditions of use, or coverage).
  - Information about the extrinsic parameters of the sensors.

Extrinsic parameters:

- Reference (the UID, and provide information about) of the rig(s) (if one level of hierarchy is sufficient) and its position and orientation in relation to a coordinate reference system.
- Specify if rig has another "level" (if there are more than one nested rigs).

RQ-AR1-001a For camera sensors (e.g. RGB, Depth, LiDAR), the WA function shall have the ability to receive from the WC registration service additional requested information.

The additional camera sensor information requested from WC should include:

- Intrinsic parameters: focal length, optical centre, pixel size, pixel skew, radial distortion, tangential distortion.
- Image size in pixels.
- Capture method: rolling or global shutter.
- Camera position: e.g. front-facing or rear-facing camera, left or right camera.

## 4.4 World Analysis Function Control of World Capture Sensors

Once the World Analysis has established access to World Capture sensors, it will have the ability to control them.

RQ-AR1-002 The WA subfunctions shall have the ability to subscribe/unsubscribe individually to data streams being sent (aka "published") by each of the chosen WC function sensors.

RQ-AR1-003 If supported by WC, WA subfunctions should specify synchronized or asynchronous data streams.

Recommendation: Each WA subfunction should specify parameters for data streams it receives from each sensor (and/or sensor type).

## 4.5 Transfer of Data between World Capture and World Analysis

When under the control of the World Analysis, World Capture sensors will send and World Analysis function will receive data streams.

RQ-AR1-004 Data streams from WC shall be sent to WA in formats requested during negotiation with WC registry.

RQ-AR1-005 Data streams from WC shall have time stamp(s) which shall be synchronized with the master AR system clock in use by WA.

Implementers can choose to support supplementary levels of control. In some cases, the AR1 can transmit messages regarding the availability of new data to the WA function. Alternatively, the WA will receive all data requested as configured during the control phase.

## 4.6 Scene Management Function Access to World Capture Sensors

The first set of AR2 requirements pertain to the function's access to World Capture sensors. "Access" assumes that prior to request for access, the WC registry service has discovered and registered of all relevant sensors. The WC function will also perform all initialization of relevant sensors to which the Scene Management requests access.

RQ-AR2-001 The SM shall have ability to receive from the WC registration service all requested information including UID, type, data formats available, and other parameters (e.g. embedded, external, synchronization) about any, some or all sensors.

Requested information can include:

- Type of sensors available to the SM system.
- # of sensors of each type.
- Capabilities of each sensor (e.g. computation, resolution, frequency, etc.):
  - Measuring characteristics (e.g. range and resolution, acquisition frequency, conditions of use, or coverage).
  - Information about the extrinsic parameters of the sensors.

Extrinsic parameters:

- Reference (the UID, and provide information about) of the rig(s) (if one level of hierarchy is sufficient) and its position and orientation in relation to a coordinate reference system.
- Specify if rig has another "level" (if there are more than one nested rigs).

RQ-AR2-001a For camera sensors (e.g. RGB, Depth, LiDAR), the SM function shall have the ability to receive from the WC registration service additional requested information.

The additional camera sensor information requested from WC should include:

- Intrinsic parameters: focal length, optical centre, pixel size, pixel skew, radial distortion, tangential distortion.
- Image size in pixels.
- Capture method: rolling or global shutter.
- Camera position: e.g. front-facing or rear-facing camera, left or right camera.

## 4.7 Scene Management Function Control of World Capture Sensors

Once the Scene Management function has established access to World Capture sensors, it will have the ability to control them.

RQ-AR2-002 The SM subfunctions shall have the ability to subscribe/unsubscribe individually to data streams being sent (aka "published") by each of the chosen WC function sensors.

RQ-AR2-003 If supported by WC, SM subfunctions should specify synchronized or asynchronous data streams.