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OGC Augmented Reality Markup Language 2.0 (ARML 2.0)

Encoding Standard

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Abstract

This OGC® Standard defines the Augmented Reality Markup Language 2.0 (ARML 2.0). ARML 2.0 allows users to describe virtual objects in an Augmented Reality (AR) scene with their appearances and their anchors (a broader concept of a *location*) related to the real world. Additionally, ARML 2.0 defines ECMAScript bindings to dynamically modify the AR scene based on user behavior and user input.

Keywords

The following are keywords to be used by search engines and document catalogues.

ogcdoc ar augmented reality virtual objects arml virtual reality mixed reality 3d graphics model

Preface

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The following organizations submitted this Document to the Open Geospatial Consortium Inc. as a Request For Adoption:

1. Wikitude GmbH.
2. Georgia Tech
3. SK Telecom
4. Laramie Range Innovations, LLC

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Contents

1 Scope 6

2 Normative References 7

3 Terms and Definitions 7

4 Conventions 8

4.1 Abbreviated terms 8

4.2 Schema language 8

4.3 Scripting Components 8

5 Introduction 8

5.1 History of ARML - ARML 1.0 9

6 ARML 2.0 - Object Model (normative) 9

6.1 General Concepts 9

6.1.1 Features, Anchors and VisualAssets 9

6.1.2 Declarative and Scripting Specification 11

6.1.3 Document Structure 11

6.1.4 ARML 2.0 Object Model Diagram 12

6.1.5 Units 12

6.2 interface ARElement 13

6.3 class Feature 13

6.4 interface Anchor 14

6.4.1 interface ARAnchor 15

6.4.2 class ScreenAnchor 28

6.5 interface VisualAsset 30

6.5.1 VisualAsset Types 32

6.5.2 Orienting VisualAssets 40

6.5.3 class ScalingMode - Scaling VisualAssets 44

6.5.4 interface Condition 47

7 ARML 2.0 – XSD and XML Serialization (normative) 50

7.1 Document Structure 50

7.2 interface ARElement 52

7.3 class Feature 52

7.4 interface Anchor 54

7.4.1 interface ARAnchor 54

7.4.2 class ScreenAnchor 61

7.5 interface VisualAsset 62

7.5.1 VisualAsset Types 63

7.5.2 class Orientation 67

7.5.3 class ScalingMode 68

7.5.4 interface Condition 68

8 ECMAScript Bindings (normative) 71

8.1 Accessing ARElements and Modifying the Scene 71

8.2 Object Creation and Property Access 72

8.3 Object and Constructor Definitions 73

8.3.1 Feature 73

8.3.2 Anchor 73

8.3.3 ARAnchor 74

8.3.4 ScreenAnchor 74

8.3.5 Geometry 74

8.3.6 GMLGeometry 74

8.3.7 Point 75

8.3.8 LineString 75

8.3.9 Polygon 75

8.3.10 RelativeTo 75

8.3.11 Tracker 76

8.3.12 Trackable 76

8.3.13 VisualAsset 76

8.3.14 Orientation 77

8.3.15 ScalingMode 77

8.3.16 VisualAsset2D 77

8.3.17 Label 77

8.3.18 Fill 78

8.3.19 Text 78

8.3.20 Image 79

8.3.21 Model 79

8.3.22 Scale 80

8.3.23 DistanceCondition 80

8.3.24 SelectedCondition 81

8.3.25 Animation 81

8.3.26 NumberAnimation 82

8.3.27 GroupAnimation 83

8.3.28 Event Handling 83

Annex A: Conformance Classes 86

A.1: Conformance Test Class Encoding 86

A.2: Conformance Test Class Descriptive Implementation 90

A.3: Conformance Test Class: Descriptive and Scripting Implementation 108

Annex B: Examples 113

B1: Typical geospatial AR Browser 113

B2: Different Representations based on Distance 114

B3: 3D Model on a Trackable 116

B4: Color the Outline of the artificial marker 117

B5: Color the entire area of a marker 118

Annex C: Revision history 119

Annex D: Bibliography 119

# ****Scope****

The scope of the ARML 2.0 standard is to provide an interchange format for Augmented Reality (AR) applications to describe an AR scene, with a focus on vision-based AR (as opposed to AR relying on audio etc.). The format describes the virtual objects that are placed into an AR environment, as well as their registration in the real world. ARML 2.0 is specified as an XML grammar. Both the specification as well as the XSD schema are provided.

Additionally, ARML 2.0 provides ECMAScript bindings to allow dynamic modification of the scene, as well as interaction with the user. The ECMAScript bindings, described in JSON, use the same core object models as the XML grammar and include event handling and animations.

The goal of ARML 2.0 is to provide an extensible standard and framework for AR applications to serve the AR use cases currently used or developed. With AR, many different standards and computational areas developed in different working groups come together. ARML 2.0 needs to be flexible enough to tie into other standards without actually having to adopt them, thus creating an AR-specific standard with connecting points to other widely used and AR-relevant standards.

As a requirement, a device running an AR implementation using ARML 2.0 must have a component (screen, see-through display etc.) where the virtual objects are projected on. The device must have sensors such as a camera, GPS, and orientation to analyze the real world - .

Users interact with the virtual scene by moving around in the real world. Based on the movement of the user, the scene on the screen is constantly updated. A user can also interact with the scene by selecting virtual objects, typically by touching them on the screen. However, how a user can select a virtual object is application- and device-specific and out of scope for ARML 2.0.

The plan is to extend ARML in the future to support non-visual virtual objects, such as sound and haptic feedback. The current specification of ARML 2.0, however, focuses on visual objects.

# Normative References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

XML Schema Part 1: Structures Second Edition. W3C Recommendation (28 October 2004) <http://www.w3.org/TR/xmlschema-1/>

ECMAScript Language Specification  
<http://www.ecma-international.org/ecma-262/5.1/ECMA-262.pdf>

Web IDL Specification  
<http://www.w3.org/TR/WebIDL/>

OpenGIS® Geography Markup Language (GML) Encoding Standard version 3.2.1 (2007)  
http://www.opengeospatial.org/standards/gml

COLLADA Specification  
http://www.khronos.org/collada/

XML Path Language (XPath) 2.0  
http://www.w3.org/TR/xpath20/

# Terms and Definitions

Terms and definitions used in this document are reused form the AR Glossary developed by the International AR Standards Community [AR Glossary] where applicable. The glossary is a public document (insert URL); the community’s chairperson gave specific permission for use.

The following definitions are used within the document:

**3.1 (AR) Implementation** or **AR Application**: Any service that provides Augmentations to an AR-ready device or system.

**3.2 Device**: the hardware unit the AR implementation is running on.

**3.3 Augmentation**: A relationship between the real world and a digital asset. The realization of an augmentation is a composed scene. An augmentation may be formalized through an authoring and publishing process where the relationship between real and virtual is defined and made discoverable.

**3.4 Digital Asset:** Data that is used to augment users' perception of reality and encompasses various kinds of digital content such as text, image, 3d models, video, audio and haptic surfaces. A digital asset is part of an augmentation and therefore is rendered in a composed scene. A digital asset can be scripted with behaviors. These scripts can be integral to the object (for example, a GIF animation) or separate code artifacts (for example, browser markup). A digital asset can have styling applied that changes its default appearance or presentation. **Visual Assets** are digital assets that are represented visually. As ARML in its current version focuses on visual representations of augmentations, only Visual Assets are allowed.

**3.5 Composed Scene**: Produced by a system of sensors, displays and interfaces that creates a perception of reality where augmentations are integrated into the real world. A composed scene in an augmented reality system is a manifestation of a real world environment and one or more rendered digital assets. It does not necessarily involve 3D objects or even visual rendering. The acquisition of the user (or device)'s current pose is required to align the composed scene to the user's perspective. Examples of composed scenes with visual rendering (AR in camera view) include a smartphone application that presents visualization through the handheld video display, or a webcam-based system where the real object and augmentation are displayed on a PC monitor.

**3.6 Camera View** or **AR View**: the term used to describe the presentation of information to the user (the augmentation) as an overlay on the camera display.

# Conventions

## Abbreviated terms

AR Augmented Reality

ARML Augmented Reality Markup Language

GML Geography Markup Language

JSON JavaScript Object Notation

KML Keyhole Markup Language

OGC Open Geospatial Consortium

XML Extensible Markup Language

XSD W3C XML Schema Definition Language

## Schema language

The XML implementation specified in this Standard is described using the XML Schema language (XSD) [*XML Schema Part 1: Structures* ].

## Scripting Components

The Scripting components described are based on the ECMAScript language specification [ECMAScript Language Specification] and are defined using Web IDL [Web IDL Specification].

# Introduction

Even though AR has been researched for decades, no formal definition of AR exists. Below are two descriptions/definitions of AR:

[Wikipedia AR Definition (insert date pulled)]: Augmented reality (AR) is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. As a result, the technology functions by enhancing one's current perception of reality. AR is about augmenting the real world environment with virtual information by improving people's senses and skills. AR mixes virtual characters with the actual world.

[Ronald Azuma AR Definition]: Augmented Reality is a system that has the following three characteristics:

* Combines real and virtual
* Interactive in real time
* Registered in 3-D

## History of ARML - ARML 1.0

ARML 2.0's predecessor, ARML 1.0 [ARML 1.0 Specification], was developed in 2009 as a proprietary interchange format for the Wikitude World Browser. ARML 2.0 does not extend ARML 1.0. Instead ARML 2.0 is a complete redesign of the format. ARML 1.0 documents are not expected to work with implementations based on ARML 2.0. ARML without a version number implicitly stands for ARML 2.0 in this document.

ARML 1.0 is a descriptive, XML based data format, specifically targeted for mobile AR applications. ARML focuses on mapping geo-referenced Points of Interest (POIs) and their metadata, as well as mapping data for the POI content providers publishing the POIs to the AR application. The creators of the Wikitude World Browser defined ARML 1.0 in late 2009, to enable developers to create content for AR Browsers. ARML 1.0 combines concepts and functionality typically shared by AR Browser, reuses concepts defined in OGC's KML standard and is already used by hundreds of AR content developers around the world.

ARML 1.0 is fairly restrictive and focuses on functionality Wikitude required back in 2009. Thus, ARML 2.0, while still using ideas coming from ARML 1.0, is targeted to be a complete redesign of the 1.0 format, taking the evolution of the AR industry, as well as other concepts and ideas into account.

# ARML 2.0 - Object Model (normative)

|  |  |
| --- | --- |
| **Requirements Class** | |
| [http://www.opengis.net/spec/arml/2.0/req/core](http://www.opengis.net/spec/arml2x0/req/core) | |
| **Target Type** | Software Implementation |

## General Concepts

### Features, Anchors and VisualAssets

In ARML 2.0, a Feature represents a real world object that should be augmented. Using the Ferris Wheel below as an example, the Feature to augment is the Ferris Wheel itself. Technically speaking, a Feature consists of some metadata on the real world object, as well as one or more Augmentations that describe where a Feature is located in the composed scene. In ARML 2.0 terms, an Augmentation is called an Anchor.

Anchors define the link between the digital and the physical world (a broader concept of a location). An Anchor describes where a particular Feature is located in the real world. An Anchor can be either a spatial location that is tracked using location and motion sensors on the device, or a visual pattern (such as markers, QR codes or any sort of reference image) that can be detected and tracked in the camera stream using computer vision technology. In the Ferris Wheel example, the Anchor is the geospatial location of the Ferris Wheel in Vienna.

Finally, VisualAssets describe how a particular Anchor should be represented in the Composed Scene. VisualAssets can either be 2-dimensional (such as text or images) or 3-dimensional. The icon and the text in the example below represent VisualAssets that are attached to the Anchor of the Ferris Wheel, causing the Ferris Wheel to be augmented with the Visual Assets as soon as the Anchor is visible in the scene.

**Examples:**

|  |  |  |
| --- | --- | --- |
| **Geospatial AR** | | |
| Feature |  | The physical object: The Riesenrad (Ferris Wheel) in Vienna, including Metadata |
| Anchor |  | Its location:  48.216581,16.395847 |
| VisualAsset |  | The digital object that is used to represent the Feature in the scene. |
| Result |  | As soon as the location of the Ferris Wheel is detected to be in the field of vision (typically using GPS, motion sensors, magnetometers etc.), the VisualAsset is projected onto the corresponding position on the screen. |

|  |  |  |
| --- | --- | --- |
| **Computer Vision-based AR** | | |
| Feature | The security features of a 10-dollar-note |  |
| Anchor |  | A US 10 Dollar-note (along with the location of the security features on the note). |
| VisualAsset |  | Some buttons that can be pressed to get more information on a particular security feature |
| Result |  | As soon as the 10 Dollar note is detected in the scene, the VisualAssets are projected onto the note in the correct positions. |

### Declarative and Scripting Specification

ARML 2.0 comes with a declarative specification, serialized in XML, describing the objects in the AR scene (section 7), as well as a scripting specification allowing dynamically modifying the scene and reacting on user-triggered events (section 8). The scripting specification uses ECMAScript for the scripting parts and a JSON serialization of the objects for accessing the objects' properties.

The scripting specification declares hooks to the descriptive spec, so both specs, while existing separately from another, work together for a dynamic experience. An implementation can chose to only support the declarative spec (for instance in case scripting parts cannot be implemented on the platform the implementation is running on).

The scripting specification contains sections, which are intended for advanced users only. These sections are clearly marked as Advanced ARML in the title and are intended for those already familiar with the basic concepts of ARML.

### Document Structure

An ARML document is grouped into three parts: The declarative part (AR Elements), the styling part and the scripting part.

* The ARElements element contains a list of ARElement objects, as specified in the ARML specification below.
* The optional style element contains styles (typically CSS) used for styling the virtual objects in the scene.
* The optional script part contains scripting code (typically ECMAScript or JavaScript).

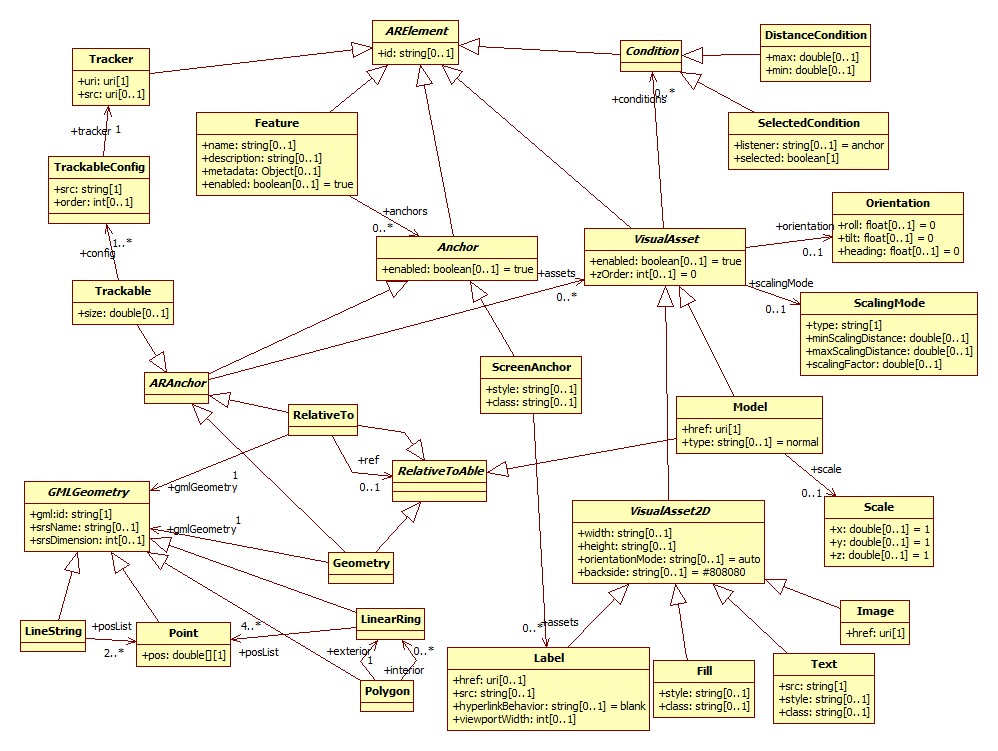
The following section will describe the ARElements section.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/parse\_encoding](http://www.opengis.net/spec/arml2x0/req/core/parse_encoding) |
| An implementation shall be able to parse valid ARML 2.0 XML encodings, as defined in section 7. |

### ARML 2.0 Object Model Diagram

ARML 2.0 is built on top of a generic object model to allow future serializations in different languages, as well as good extensibility for future needs.

The diagram below shows the generic object model in ARML 2.0.



### Units

Units in ARML are given in meters. Whenever any virtual object in ARML has a size of x meters, the size of this object on the screen is equal to a real world object of the same size and the same distance in the camera view.  
**Remark:** The actual size on the screen is dependent on certain camera parameters on the device.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/units](http://www.opengis.net/spec/arml2x0/req/core/units) |
| All units are specified in meters. The specified size of a virtual object corresponds to the size of a real world object of the same size at the same distance. |

## interface ARElement

Most classes specified in ARML 2.0 are derived from ARElement. An ARElement has an optional id property, which uniquely identifies the object. The *user* id is pre-assigned by the system and must not be used in the encoding. If user is used, the attribute must be ignored.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ARElement/id\_user](http://www.opengis.net/spec/arml2x0/req/core/ARElement/id_user) |
| In case an ARElement’s id property is set to *user*, the property shall be ignored. |

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=1;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=1;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=1;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=1;up=0#sorted_table) |
| --- | --- | --- | --- |
| id | The unique ID of the ARElement | string | 0 or 1 |

id  
The unique ID of the ARElement which makes it uniquely accessible and referenceable.

## class Feature

Inherits From ARElement.

A Feature is an abstraction of a real world phenomenon [*GML Specification*]. In ARML, a Feature has one or more Anchors, which describe how the Feature is registered in the real world. Each of these Anchors has one or more VisualAssets attached to it, which visually represent the Feature in the composed scene.

Example:

|  |  |
| --- | --- |
|  | The physical object: The Riesenrad (Ferris Wheel) in Vienna, including Metadata |

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=2;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=2;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=2;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=2;up=0#sorted_table) |
| --- | --- | --- | --- |
| name | The name of the Feature | string | 0 or 1 |
| description | A description of the Feature | string | 0 or 1 |
| enabled | A boolean flag controlling the state of the Feature | boolean | 0 or 1 |
| metadata | Arbitrary metadata | Any XML | 0or 1 |
| anchors | A list of anchors the Feature is referenced with | Anchor[] | 0 or 1 |

name  
The optional name of the Feature. Can be reused in Label and Text VisualAssets by using $[name] in the Label or Text. Additionally, the name of the Feature is used as a Text-VisualAsset when an Anchor of the Feature has no VisualAsset attached to it. The property can be omitted.

*description*  
The optional description of the Feature. Can be reused in Label and Text VisualAssets by using $[description] in the Label or Text.

*metadata*Allows the storage of arbitrary metadata for the Feature. Any XML content can be used. The content may or may not conform to a custom scheme.

enabled  
Setting the boolean flag to true (enabled) means that VisualAssets attached to the Anchors of the Feature are part of the composed scene, setting it to false (disabled) causes all Assets attached to the Feature to be ignored for the composed scene (i.e. they are never visible in the AR View). Defaults to true if not given.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Feature/enabled](http://www.opengis.net/spec/arml2x0/req/core/Feature/enabled) |
| Setting a Feature’s enabled property to false causes any Anchors and VisualAssets attached to the Feature to be ignored in the scene (i.e. they will not be visible at any time). |

anchors  
contains a list of Anchors describing the Anchors of the Feature in the real world.

## interface Anchor

Inherits From ARElement.

An Anchor describes the registration (location) of a Feature in the real world or on the screen. Two different types of Anchors are used in ARML:

* ARAnchor describes the location of a Feature in the real world. This Anchor is used for virtual objects that are registered in the real world and move around on the screen as the user moves around.
* ScreenAnchor describes a fixed location of a Feature on the screen. This Anchor is used for objects that have a fixed location on the screen (similar to HTML components inside a HTML page). The objects associated with a ScreenAnchor will not move when the user is moving around, but remains static on the screen. Typical use cases are game HUDs or static informational displays on certain Features.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=3;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=3;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=3;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=3;up=0#sorted_table) |
| --- | --- | --- | --- |
| enabled | The state of the anchor | boolean | 0 or 1 |

enabled  
Setting the boolean flag to true (enabled) means that VisualAssets attached to the Anchor are part of the composed scene (if the Feature the Anchor is attached to is also enabled), setting it to false (disabled) causes all VisualAssets attached to the Anchor to be ignored in the composed scene (i.e. they are never visible in the AR View). Defaults to true if not given.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Anchor/enabled](http://www.opengis.net/spec/arml2x0/req/model/Anchor/enabled) |
| Setting an Anchor’s enabled property to false causes any VisualAssets attached to the Anchor to be ignored in the scene (i.e. they will not be visible at any time). |

**Remark:** Anchors are typically used within Features; however, an Anchor can also exist outside a Feature. Regardless if it is located within a Feature or was defined separately (immediately within the ARElements section), it is part of the composed scene.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Anchor/anchor\_without\_feature](http://www.opengis.net/spec/arml2x0/req/model/Anchor/anchor_without_feature) |
| An Anchor is part of the composed scene even when it is not attached to a Feature, i.e. it is an immediate child of the ARElements tag. |

### interface ARAnchor

Inherits From Anchor.

An ARAnchor describes the registration (location) of a Feature in the real world. An ARAnchor might be declared using spatial coordinates, i.e. a location in a (geo-) spatial sense, or an image or marker that is recognized in the live camera video stream and even a sound that is recognized over the microphone.

ARAnchor is an abstract class, which must not be instantiated directly. We define the following concrete types of ARAnchors in ARML:

|  |  |  |
| --- | --- | --- |
| Geometry |  | Either a Point, LineString or Polygon, described with spatial coordinate tuples |
| Trackable |  | A visual pattern that is detected in the camera stream |
| RelativeTo | E:\Mobilizy\OGC\ARML Spec\RelativeTo.jpg | An Anchor relative to other objects (e.g. another ARAnchor); useful to create large scenes relative to another Trackable |

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=4;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=4;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=4;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=4;up=0#sorted_table) |
| --- | --- | --- | --- |
| assets | The assets representing the anchor in the live scene | Asset[] | 1 |

assets   
A list of VisualAssets attached to the ARAnchor. These VisualAssets will represent the ARAnchor.  
  
If no VisualAsset is supplied, a Text VisualAsset, with its text set to the name of Feature the ARAnchor is attached to, is used as the default VisualAsset. In case even the name property is omitted for the Feature, no VisualAsset is attached as default.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ARAnchor/no\_visual\_asset](http://www.opengis.net/spec/arml2x0/req/model/ARAnchor/relative) |
| In case no valid VisualAsset is attached to an ARAnchor in the encoding, the behavior depends on whether the ARAnchor is attached to a Feature with its name property set. In case it is set, an auto-generated VisualAsset of type Text is added automatically. The text of the Text is set to the value of the name property of the Feature. In case no such name is set, no VisualAsset is attached. |

#### Local Coordinate System and Dimensions

Any ARAnchor type, with LineStrings being the only exception, specifies its own local coordinate system. This allows VisualAssets to be placed on top of any ARAnchor (see section 6.5.2 for details), and RelativeTo Anchors created relative to an underlying ARAnchor. For each ARAnchor type, it is explicitly stated how the coordinate system is defined for this particular type of ARAnchor. Additionally, each ARAnchor has a dimension associated with it. As VisualAssets take on different dimensions (a Text is 2D, while a 3D model is 3D), it is important to define the dimension of an ARAnchor as well, to allow a high level definition of how an n-dimensional Visual Asset will be rendered on top of an m-dimensional ARAnchor, without having to specifically consider each ARAnchor and VisualAsset combination.

Wherever a concrete ARAnchor is defined, the dimension and coordinate system is defined as well, except for ARAnchors with a dimension of 1 (Lines). Due to their nature, these ARAnchors do not define a local coordinate system.

#### class Geometry

Inherits from ARAnchor.

A Geometry Anchor is used when a Feature is registered in the real world using spatial coordinates (such as geospatial locations). The Geometry Anchor serves as a wrapper for GMLGeometries, which essentially describe the spatial location of the Feature. A Geometry Anchor contains all properties inherited from ARAnchor, as well as an additional element, which describes the wrapped GMLGeometry and the spatial coordinates.

The following GMLGeometries are allowed in ARML 2.0 and are described below:

* *gml:Point* (a single position)
* *gml:LineString* (a list of positions, connected to form a line)
* *gml:Polygon* (a list of positions, connected to form a planar area)

**Remark:** Geometry anchors can only be considered if an implementation is capable of detecting the user's current position and is thus capable of calculating spatial relationships between the user and the Geometry anchors.

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| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Geometry/no\_position](http://www.opengis.net/spec/arml2x0/req/model/Geometry/wrapper) |
| In case the implementation is not able to detect the current position of the user in the coordinate reference system used in the encoding, any Geometry anchor shall be ignored. |

##### interface GMLGeometries

The GMLGeometries Point, LineString and Polygon are reused from the GML specification [GML Specification].

Complying with the GML specification, each GMLGeometry must have an id property.

The default coordinate reference system (CRS) for Geometries is WGS84 (EPSG code 4326; "longitude latitude"; decimal numbers; no altitude). Alternative CRSes can be specified using srsName, either by supplying the EPSG code [EPSG Codes], or by pointing to an OGC WKT CRS definition. Implementations are required to at least support WGS84. If a certain CRS used in an encoding is unknown to an implementation, the entire Geometry Anchor must be ignored.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/crs](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/interface) |
| Any implementation shall support at least the WGS84 CRS. Any Geometry Anchor using a GMLGeometry with an alternative CRS, which the implementation cannot support, shall be ignored by the implementation. |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/default\_crs](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/interface) |
| In case no *srsName* attribute is specified, the CRS for the GMLGeometry defaults to WGS84 (format: longitude latitude). |

If altitude values are provided, the CRSes dimension must be set to 3 (see srsDimension), and values must be provided in "longitude latitude altitude" format (altitude in meters). If no altitude is supplied, the altitude of every position will be set to the user's current altitude.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/no\_altitude](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/no_altitude) |
| If no altitude information is supplied for a Particular GMLGeometry, the altitude value is set to the same elevation of the user’s current altitude. |

GML Geometries also allow other attributes, such as axis labels etc., which are not relevant in the context of ARML and can thus be safely omitted.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=5;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=5;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=5;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=5;up=0#sorted_table) |
| --- | --- | --- | --- |
| gml:id | A unique ID for the geometry | string | 1 |
| gml:srsName | The link to a well-known CRS or an EPSG code | string | 0 or 1 |
| gml:srsDimension | The dimension of the CRS specified | Positive Integer | 0 or 1 |

gml:id  
A unique ID, required as per the GML specification.

srsName  
optionally specifies either a link to an OGC WKT CRS, or an EPSG code. If srsName is omitted, WGS84 is implicitly assumed to be the default CRS.

srsDimension  
The optional attribute srsDimension specifies the number of coordinate values in a position (i.e. the dimension of the underlying CRS). srsDimension should be used when srsName is specified, and must be a positive integer. If both srsName and srsDimension are not given, srsDimension defaults to 2.

##### class Point

Derived from [GML Specification].

A Point specifies a position in the referenced coordinate reference system by a single coordinate tuple.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=6;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=6;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=6;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=6;up=0#sorted_table) |
| --- | --- | --- | --- |
| pos | The list of doubles, specifying the position of the Point | List of double values | 1 |

pos  
Specifies the coordinate vector describing the position of the Point, in a blank-separated list.

**Remark:** GML allows the specification of a custom *srsName* and *srsDimension* also on the *pos*-level, but states that it is unlikely that this will be used in a useful way. The same applies for ARML 2.0.

##### class LineString

Derived from [GML Specification].

A LineString is defined by two or more coordinate tuples, with linear interpolation between them. The number of direct positions in the list shall be at least two. The segments created by interpolation between the coordinate tuples are called *LineString segments*.

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| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/LineString/definition](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/LineString/definition) |
| A LineString that does not consist of at least two coordinate tuples shall be ignored. |

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=7;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=7;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=7;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=7;up=0#sorted_table) |
| --- | --- | --- | --- |
| posList | The list of doubles, specifying the vector of positions of the LineString | list of double values | 1 |
| pointProperty | A List of gml:Point elements that make up the LineString | List of gml:Point element | 2 .. \* |

posList  
Specifies the list coordinate vectors describing the vertices of the LineString, in a blank-separated list.

**Remark:** GML allows the specification of a custom *srsName* and *srsDimension* also on the *posList*-level, but states that it is unlikely that this will be used in a useful way. The same applies for ARML 2.0.

pointProperty  
Specifies the list of Points describing the vertices of the LineString. Must appear at least twice.

##### class Polygon

Derived from [GML Specification].

A Polygon is a planar object defined by an outer boundary and 0 or more inner boundaries. The boundaries are specified using the exterior and interior elements. The boundaries, in turn, are defined by LinearRings.

A LinearRing is a closed LineString (with at least 4 coordinates) that should not cross itself. It is defined in the exact same way as a LineString, except the element tag is called *LinearRing*. Simplified, a LinearRing is a LineString where the last position equals the first position.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/LinearRing/definition](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/LinearRing/definition) |
| A LinearRing that does not consist of at least 4 coordinate tuples, or its starting point is not equal to its endpoint, shall be ignored. |

|  |
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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/Polygon/definition](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/Polygon/definition) |
| A Polygon shall consist of one and only one exterior LinearRing, and zero or more interior LinearRings. In case the exterior LinearRing is invalid (see [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/LinearRing/definition](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/LinearRing/definition)), the entire Polygon shall be ignored. In case one of the interior LinearRings is invalid, only the particular LinearRing is ignored. |

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=8;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=8;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=8;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=8;up=0#sorted_table) |
| --- | --- | --- | --- |
| exterior | A LinearRing forming the outer boundary of the Polygon | LinearRing | 1 |
| interior | A LinearRing forming a hole in the interior of the Polygon | LinearRing | 0 .. \* |

exterior  
A LinearRing forming the outer boundary of the Polygon

interior  
A LinearRing forming a hole in the Polygon

##### Advanced ARML: Coordinate Reference System and Dimensions

**Dimensions:**

The dimensions of Geometries are defined as specified in GML (Point: 0, LineString : 1, Polygon: 2). The coordinate systems defined below are all of Cartesian type (i.e. orthogonal axes).

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/local\_cs/cs\_type](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/local_cs/cs_type) |
| The local coordinate system of any GMLGeometry is of Cartesian type. |

**Local Coordinate Systems:**

Point  
The ground plane is defined by the projected earth's surface at the specified Point. In case the Point is used relative to a Trackable, the ground plane is formed by the Trackable's surface. The x and y axes run within the ground plane.  
Origin: The point itself  
x-axis: pointing east (or right, parallel to the Trackable's lower and upper edges, when used relative to a Trackable, see RelativeTo Anchor for details)  
y-axis: pointing north (or towards the top edge, running parallel to the left and right edges of the Trackable when used relative to a Trackable)   
z-axis: pointing up, perpendicular to earth's (or Trackable's) surface  
Unit: Meters

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/local\_cs/cs\_type/Point](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/local_cs/cs_type/Point) |
| A Point’s local coordinate reference system shall be defined as stated in paragraph 6.4.1.2.5, section Point. |

LineStringDue to their nature, LineStrings do not define their own local coordinate system. Refer to section 6.5.2 for details how to map VisualAssets onto LineStrings. Consequently, LineStrings cannot be used as an originating Anchor for RelativeTo-Geometries (see section 6.4.1.2.5).

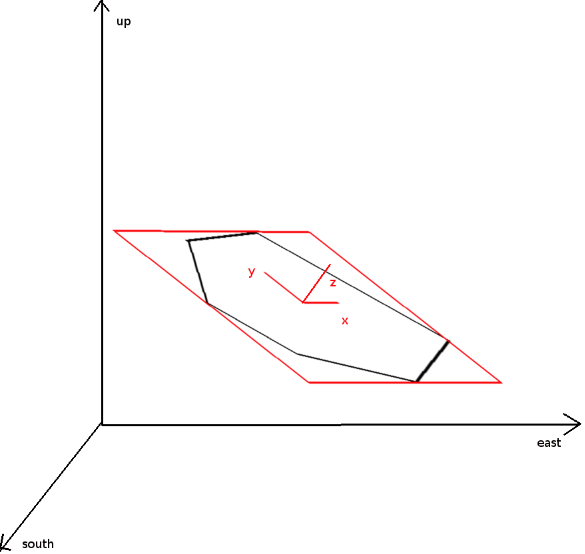
Polygon  
A Polygon's local coordinate system is derived from the (uniquely defined) bounding rectangle (the smallest rectangle fully enclosing the Polygon) having two of the four edges parallel to the earth's surface (or Trackable's surface when used relative to a Trackable, see RelativeTo Anchor for details).

To calculate the BoundingRectangle, take the lowest and highest point (in relation to the altitude) of the Polygon and draw the two lines through these points in the polygon’s plane, parallel to the earth’s surface. Now, take the easternmost and westernmost point and draw the two lines through these points in the polygon’s plane, perpendicular to the earth’s surface. The resulting rectangle is the bounding rectangle of the Polygon.  
If the Polygon is used relative to a Trackable, take the topmost, bottommost, rightmost and leftmost point relative to the Trackable, as well as the Trackable’s surface for the ground plane instead.

This ensures that the bounding rectangle is aligned with the (earth's or Trackable's) surface. The bounding rectangle forms the ground plane of the coordinate system, x and y axis run within the ground plane.  
Origin: The point marking the center of the bounding rectanglex-axis running parallel to the edges of the bounding rectangle which run parallel to the surface. When the origin of the coordinate system is viewed from the center of the lower edge (the one edge parallel to the surface which is closer to the earth's or Trackable's surface) of the bounding rectangle, the x-axis points right  
y-axis running perpendicular to x- and z-axis, creating a left-handed coordinate system  
z-axis is equal to the Polygon’s normal vector  
Unit: Meters

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/local\_cs/cs\_type/Polygon](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/local_cs/cs_type/point) |
| A Polygon’s local coordinate reference system shall be defined as stated in paragraph 6.4.1.2.5, section Polygon. |

**Illustration:**



Special case:   
In case the Polygon is placed parallel to the earth's (or Trackable's) surface (that means altitude is equal for each vertex), the bounding rectangle cannot be determined in the above definition. In this case, the bounding rectangle's edges are aligned with the vectors pointing north/south and east/west from the first vertex of the Polygon (or up/down and left/right when used relative to a Trackable), and the southern/down edge form the lower edge of the Bounding Rectangle (which is used to determine the x axis).

#### Trackable and Tracker

Trackables are a more general concept of a location of a Feature in the real world. Instead of specifying an exact, well known set of coordinates somewhere within a well-known coordinate reference system by using the geometry types specified in the previous section, a Trackable describes something that is tracked in the real world (typically by a camera) and serves as the Anchor of a Feature. As an example, a Trackable could be a 2D image, QR code or 3D model; however, Trackables are not restricted to visual objects. An application could also track Sounds coming in from the microphone. As Trackables are mostly visual in AR implementations, we will put a focus on those.

Two classes are required to specify a Trackable:

* Trackable: The Trackable describes the trigger (in whatever form) that should be tracked in the scene. A Trackable might be an artificial game marker, the reference image or reference 3D model, the description of a face, the referenced song etc.
* Tracker: A Trackable is always linked to one or more specific Trackers, which references the framework(s) that needs to be used to track the referenced Trackable. For instance, if the Trackable is a generic image, the Tracker needs to reference a generic image tracking capability the implementation needs to be bundled with. If the implementation uses face tracking and the Trackable describes a specific face, the Tracker needs to reference an underlying face tracking functionality, which is exposed by the implementation.

##### class Tracker

Inherits From ARElement.

The Tracker describes the tracking framework to be used to track the Trackables associated with this Tracker.

A Tracker is uniquely and globally identified by a URI. It is not required that any meaningful content is accessible via the URI, however, a developer of a Tracker is encouraged to expose some descriptions about the Tracker when the URI is called from a standard web browser. A definition of the exposed content is beyond the scope of ARML 2.0.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=9;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=9;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=9;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=9;up=0#sorted_table) |
| --- | --- | --- | --- |
| uri | The URI identifying the Tracker | string | 1 |
| src | The container the Tracker is operating in | string | 0 or 1 |

uri  
To reference the framework used to track the associated Trackables, a Tracker specifies a uri property that uniquely identifies the underlying tracking software. The URI might be registered in a Tracker dictionary that assigns a unique URI to any publicly used Tracker, so AR implementations using the standard can use this as a reference to what tracking framework should be used. The URI might also point to a custom tracker implementation that is used just within the specific implementation. If the URI cannot be resolved to any of the Trackers available on the implementation, the Tracker cannot be used and must be gracefully ignored along with any associated Trackables.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/unknown\_tracker](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/unknown_tracker) |
| In case an encoding uses a Tracker unknown to the implementation, the implementation shall ignore the Tracker and all its associated Trackables. |

src  
Optionally specifies a URI which references the container the Tracker is operating in, and the associated Trackables can be found in. This mechanism allows a two-level location of the actual Trackable in case it is contained within a container. src must be set if the Trackable is not directly accessible via some sort of URI or any other identifier, but is located in any sort of container, such as a zip file or a proprietary binary container containing all targets.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/contained\_trackable](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/contained_trackable) |
| In case the Trackables of a particular Tracker are located in any sort of container (zip file etc.), the *src* property of the Tracker shall point to the container the Trackables are stored in. |

The following generic tracker URI is defined for every implementation:

* [http://www.opengis.net/arml /tracker/genericImageTracker](http://opengeospatial.org/arml/tracker/genericImageTracker" \t "_top) hosting a tracker, which takes jpeg, png or gif images as image targets. The Trackables can be zipped; the src property must then point to the zip file containing the Trackables.

##### class Trackable

Inherits From ARAnchor.

A Trackable represents the object that will be tracked. It provides the actual Anchor of the Feature in the real world.

Conceptually, a Trackable consists of a digital file that describes the Trackable (marker, image etc.), and a Tracker that is used to track the particular Trackable. This linkage between a digital file and the Tracker is defined in a TrackableConfig. Typically, only one TrackableConfig will be supplied per Trackable (one Trackable is attached to a particular Tracker which can read the digital file provided and track it in the camera), however, if a Trackable can be tracked in multiple ways with multiple Trackers (typically requiring a specific digital file to be provided per Tracker), multiple TrackableConfigs can be supplied.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=10;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=10;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=10;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=10;up=0#sorted_table) |
| --- | --- | --- | --- |
| config | Linking the Trackable with the Tracker | TrackableConfig | 1 .. \* |
| size | The real world size of the Trackable, in meters | double | 0 or 1 |

config  
The config provides the mapping between the Tracker and the Trackable. Each Trackable must have at least one config, but might have more in case the Trackable can be tracked using different Trackers. See TrackableConfig below for details.

size  
The size property allows to specify the size of the real world object that is tracked with the Trackable. If the Trackable is any sort of 2-dimensional object (such as images, face descriptions etc.), the size specifies the width of the Trackable in meters. For example, if a billboard advertisement sized 5 by 10 meters in the real world should be tracked, the image representing the Trackable should be in the same aspect ratio as the real object (1:2), and the size property needs to be set to 5. If the Trackable is a 3-dimensional object, the size property specifies the meters representing one unit in the 3D mesh. For example, if the model is using meters as the unit, set size to 1, if it is using feet, set it to 0.3048.

Certain Trackables might already contain information on the actual size of the Trackable within the referenced file. Examples include 3D models in COLLADA file format [COLLADA Specification]. In this case, the size property of the Trackable can be omitted. However, the usage of the size element is encouraged even in these cases. The size property overrules any size-properties implicitly set in the file format. A Trackable without any defined size (either in the file or with the size property) by the implementation must be ignored.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/trackable\_2D\_size](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/relationship) |
| In case the Trackable is any sort of 2D object, the size in the encoding specifies the width of the tracked object in meters. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/trackable\_3D\_size](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/trackable_3D_size) |
| In case the Trackable is any sort of 3D object, the size in the encoding specifies the meters representing one unit in the 3D mesh. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/trackable\_size\_preset](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/trackable_3D_size_preset) |
| In case the Trackable’s binary representation includes size information and *size* is set in the encoding, the setting in the encoding takes precedence. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/trackable\_missing\_size](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/trackable_missing_size) |
| In case the *size* property is not set in the encoding, and no size information is available in the binary representation of the Trackable, the entire Trackable shall be ignored. |

**TrackableConfig**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=10;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=10;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=10;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=10;up=0#sorted_table) |
| --- | --- | --- | --- |
| tracker | The URI of the Tracker that is used to track the Trackable | string | 1 |
| src | The identification of the Trackable | string | 1 |
| order | An order of the TrackableConfigs | int | 0 .. 1 |

tracker  
The tracker property holds the URI to the referenced Tracker the Trackable will be tracked with (format: #id).

src  
The src property references the digital file that contains the description of the Trackable (a marker, an image etc.). Depending on the src property of the Tracker, the src property of the Trackable must be of different formats:

* If src of the referenced Tracker is not set, src of the Trackable must contain a URI pointing to the Trackable.
* If src of the referenced Tracker is set (e.g. pointing to a zip file), src of the Trackable must be set to a String that uniquely identifies the Trackable for the given Tracker (e.g. the path to the Trackable in a zip file, or any unique ID in another container)

order  
An optional attribute that can be used to set a rank for the config in case multiple configs are available for a particular Trackable. The one with the lowest number is checked first, and only if the referenced Tracker is not available on the implementation, the next configs are considered. If two or more configs have the same order set, it is up to the implementation to decide on an order. If the attribute is not set, it defaults to the maximum integer on the platform, causing these configs to be considered last.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/config\_order\_max](http://www.opengis.net/spec/arml2x0/req/model/Trackable_And_Tracker/config_order_max) |
| In case the order property is not set for a particular TrackableConfig, the value is implicitly set to the maximum integer value available for the implementation. |

##### Advanced ARML: Coordinate Reference System and Dimension

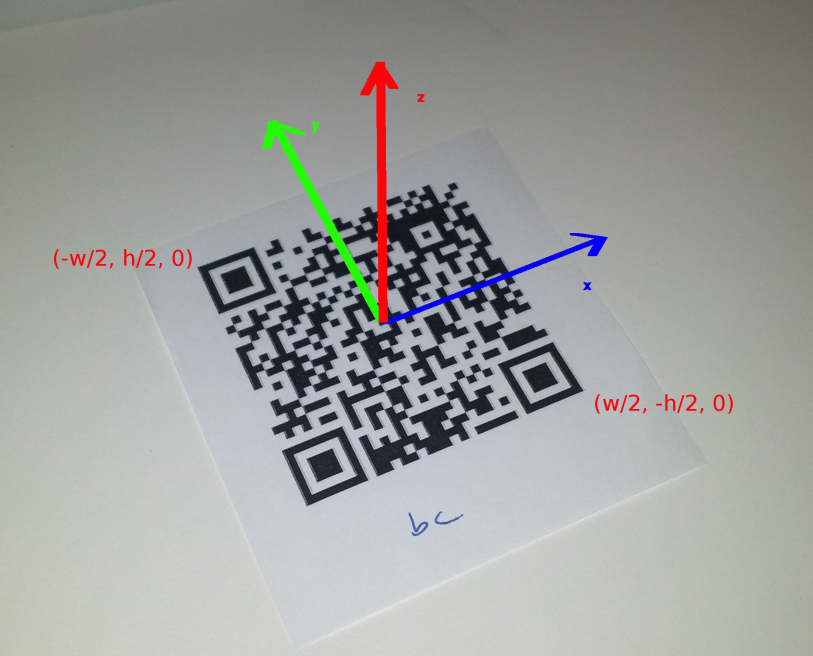
**Dimensions:**

The center (see Local Coordinate Systems below for details) of the Trackable will be tracked, resulting in a 0-dimensional ARAnchor (similar to a Geometry ARAnchor of type Point). Other areas of the Trackable (such as Outline etc.) can be tracked using RelativeTo locations, see RelativeTo section for details.

**Local Coordinate Systems:**

2D Trackables (QR Codes, Markers, Images etc.):

origin: the intersection of the diagonals of the bounding rectangle of the marker (for rectangular markers, this is the natural "center" of the image).  
x-axis: pointing right with respect to the Trackable, running parallel to the top and bottom edge of the marker  
y-axis: pointing up, parallel to the left and right edge of the marker  
z-axis: perpendicular to x and z axis (i.e. the plane the Trackable is forming), pointing upwards (out of the marker)  
Unit: Meters



w := width of Trackable  
h := height of Trackable (calculated based on aspect ratio)

3D Trackables (tracked 3D models):

origin: the origin of the model.  
x, y and z axis are reused from the model  
Unit: As specified in the size property of the model (or any implicit size detected in the model file itself)

Other Trackables:

Trackables that do not fall into or cannot be mapped onto one of the above categories must specify their local coordinate system on their own.

#### Advanced ARML: class RelativeTo

Inherits From ARAnchor.

RelativeTo Anchors are defined relative to another ARAnchor (except LineStrings), to the user or relative to a Model. RelativeTo allows ARAnchors to be defined relative to other objects, regardless of where they are actually located. A Trackable, for example, defaults to a 0-dimensional ARAnchor. RelativeTo can be used to track the outline or any specific area in the Trackable without having to specify the Trackable again. The area can be specified using the local coordinate system of a Trackable.

RelativeTo is specified using GMLGeometryElements. The coordinate system is calculated according to the rules set forth in Local Coordinate Systems of GMLGeometryElements, based on the underlying ARAnchor or Model (in which case the model's x/z plane serves as the surface plane for coordinate system calculations).

While it is technically possible to define RelativeTo anchors relative to another RelativeTo anchor, usage of this construct is discouraged due to complex local coordinate system handling. It is advised to always base a RelativeTo-Anchor directly on a non-RelativeTo ARAnchor, a Model or the user.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=11;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=11;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=11;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=11;up=0#sorted_table) |
| --- | --- | --- | --- |
| ref | The ARAnchor or Model the RelativeTo Anchor is referencing | string | 1 |
| GMLGeometry | The geometry describing the RelativeTo ARAnchor | GMLGeometryElement | 1 |

ref  
Specifies the URI to the object the Anchor is referencing. Either another ARAnchor (except LineStrings) or Model, or #user is allowed as reference. If an ARAnchor is specified as ref, the ARAnchor's local coordinate system is used to calculate the relative location (based on the GMLGeometryElement of the RelativeTo Anchor). If a Model is used, the engineering coordinate system of the Model is used as coordinate system for the calculation of the relative location.  
If #user is provided as reference, the current location of the user is considered a Point-Anchor (with its local coordinate system set accordingly).

GMLGeometry  
The GMLGeometry describes the location relative to the object specified in ref. Thus, the resulting RelativeTo-Anchor can either be a gml:Point, gml:LineString or gml:Polygon, and the coordinates are given with respect to the underlying coordinate system of the ARAnchor or the coordinate system of the Model.  
srsName and srsDimension for the GMLGeometryElement are ignored, srsDimension is implicitly set to 3. The local coordinate system of the underlying ARAnchor or Model will be used.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/RelativeTo/GMLGeometry\_properties](http://www.opengis.net/spec/arml2x0/req/model/RelativeTo/GMLGeometry_properties) |
| The GMLGeometry properties *srsName* and *srsDimension* are ignored when used within RelativeTo anchors. *srsDimension* is implicitly set to 3. |

### class ScreenAnchor

Inherits From Anchor.

A ScreenAnchor describes a fixed location on the screen which can be used to draw HTML components on the screen which are not registered in the real world and will not move on the screen as the user moves through the environment. A ScreenAnchor describes a rectangular area on the screen, aligned with the edges of the screen.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=12;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=12;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=12;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=12;up=0#sorted_table) |
| --- | --- | --- | --- |
| style | inline styling for the element | String | 0 or 1 |
| class | References a CSS class | String | 0 or 1 |
| assets | The Labels representing the anchor in the live scene | Label[] | 1 |

style and class  
see CSS styling for details

CSS Styles are used to position the ScreenAnchor on the screen, similar to absolute positioning of an iframe in a HTML page. The following CSS properties are available for ScreenAnchor:

* top specifies how far the top edge of the ScreenAnchor is offset below the top edge of the screen
* bottom specifies how far the bottom edge of the ScreenAnchor is offset above the bottom edge of the screen
* left specifies how far the left edge of the ScreenAnchor is offset to the right of the left edge of the screen
* right specifies how far the right edge of the ScreenAnchor is offset to the left of the right edge of the screen
* width specifies the width of the ScreenAnchor
* height specifies the height of the ScreenAnchor

top, bottom, left, right, width and height can either be non-negative integer values (representing pixels on the screen) or percentage values (top, bottom and height in percentage of screen height, left, right and width in percentage of screen width). Only one value of top and bottom should be set.

In case of conflicting top/bottom/height values, top takes precedence over height, which takes precedence over bottom. In case of conflicting left/right/width values, left takes precedence over width, which takes precedence over right.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/property\_conflicts](http://www.opengis.net/spec/arml2x0/req/model/ScreenAnchor/precedence) |
| In case of conflicting top/bottom/height values, top takes precedence over height, which takes precedence over bottom. In case of conflicting left/right/width values, left takes precedence over width, which takes precedence over right. |

If neither top, nor bottom is given, the ScreenAnchor will be placed as if top would be set to 0. If neither left, nor right is given, the ScreenAnchor will be placed as if left would be set to 0. width and height default to 100% if not given.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/missing\_properties](http://www.opengis.net/spec/arml2x0/req/model/ScreenAnchor/missing_properties) |
| If neither top, nor bottom is given, top is set to 0. If neither left, nor right is given, left is set to 0; width and height default to 100% if not given. |

It is advised that out of top/bottom/height and left/right/width respectively, 2 out of the 3 values are always specified.

assets  
A list of Labels attached to the ScreenAnchor which will be projected on the screen, see *Anchor.assets* for details.

When Labels are attached to a ScreenAnchor, the following properties of the Label will be ignored:

* width and height
* Orientation
* orientationMode
* ScalingMode
* any DistanceConditions

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/ignored\_properties](http://www.opengis.net/spec/arml2x0/req/model/ScreenAnchor/ignored_properties) |
| An implementation shall ignore the following properties for any Asset attached to a screen anchor:   * width and height * Orientation * orientationMode * ScalingMode * any DistanceConditions |

Additionally, the distance from the user to any ScreenAnchor is always 0, causing Labels attached to ScreenAnchors to occlude any other VisualAsset with a lesser or equal zOrder. Two overlapping ScreenAnchors should never have the same zOrder value set.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/default\_properties](http://www.opengis.net/spec/arml2x0/req/model/ScreenAnchor/default_properties) |
| The distance from the user to any ScreenAnchor is always 0. |

Absolute width and height values of a Label attached to a ScreenAnchor represent pixels on the screen. Percentage values represent the length in percent of the total screen width or height. If the content of the Label does not fit in the specified ScreenAnchor, the content should be made scrollable.

## interface VisualAsset

Inherits From ARElement.

Visual Assets are the visual representations of the Features (and their Anchors) on the screen. The following VisualAssets are defined:

* 2-dimensional
  + Label: a VisualAsset specified through HTML elements
  + Fill: a colored area
  + Text: plain text
  + Image: an image
* 3-dimensional
  + Model: a 3D model

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=13;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=13;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=13;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=13;up=0#sorted_table) |
| --- | --- | --- | --- |
| enabled | The state of the VisualAsset | boolean | 0 or 1 |
| zOrder | Defines the Drawing order | int | 0 or 1 |
| conditions | Conditions in which the VisualAsset will be projected | Condition[] | 0 or 1 |
| Orientation | An Orientation object that describes how the VisualAsset is oriented in the Anchor's coordinate system | Orientation | 0 or 1 |
| ScalingMode | The scaling mode of the VisualAsset | ScalingMode | 0 or 1 |

enabled  
Setting the boolean flag to true (enabled) means that the VisualAsset is part of the composed scene (if the corresponding Anchor and Feature is enabled as well), setting it to false (disabled) causes the VisualAsset to be ignored in the composed scene. Defaults to true if not given.

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| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset/enabled](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset/enabled) |
| Setting a VisualAsset’s *enabled* property to false causes the VisualAsset to be ignored in the scene (i.e. they will not be visible at any time). |

zOrder  
Visual Assets are projected onto the screen according to their distance, with Assets of closer Anchors occluding assets of Anchors further away. To customize the drawing order, any VisualAsset has a zOrder property. Assets with higher zOrder values will occlude assets with lower zOrder values, independent on their distance. Only if the zOrder values of two assets are equal, the distance is taken into account again. If not given, zOrder defaults to 0.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset/projection\_order](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset/enabled) |
| Visual Assets are projected onto the screen according to their distance, with Assets of closer Anchors occluding assets of Anchors further away. |

conditionsA list of conditions controlling when the VisualAsset will be drawn. This is particularly useful for a Level Of Detail (LOD) control over how an anchor is represented. From further away, an Anchor might have a Label representation, when the user gets closer, the representation might change to a 3D Model. Refer to Conditions for details.

Orientation   
A VisualAsset's orientation can be manually configured using an Orientation object. See Orientation-class for details.

ScalingMode  
Defines how the VisualAsset will be scaled, see Scaling VisualAssets for details.

### VisualAsset Types

#### interface VisualAsset2D

Inherits From VisualAsset.

VisualAsset2D is an abstract class that provides common properties for every concrete instance of 2-dimensional VisualAssets.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=14;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=14;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=14;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=14;up=0#sorted_table) |
| --- | --- | --- | --- |
| width | The width of the VisualAsset | string | 0 or 1 |
| height | The height of the VisualAsset | string | 0 or 1 |
| orientationMode | defines how VisualAssets are automatically aligned in the underlying Anchor | string | 0 or 1 |
| backside | Customization of the back side of the VisualAsset2D | string | 0 or 1 |

width and height  
2-dimensional VisualAssets like Images do not have an implicit width and height in the composed scene. Thus, width and height can be explicitly set for 2-dimensional VisualAssets.

Both width and height can be set in absolute values (representing meters in the real world), as well as percentage values (the percentage of the total area of the underlying ARAnchor covered by the VisualAsset). If only one of width and height is set, the other value is implicitly calculated based on the aspect ratio of the VisualAsset (for Fill where an aspect ratio is not applicable, the unset value is always implicitly set to 100%). If neither width, nor height is set, width is implicitly set to 100% and height is calculated based on the aspect ratio. If both width and height are set, the VisualAsset is stretched accordingly.

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| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset2D/width\_and\_height](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset2D/width_and_height) |
| If only one of width and height is set, the other value is implicitly calculated based on the aspect ratio of the VisualAsset. For Fill where an aspect ratio is not applicable, the unset value is always implicitly set to 100%. If neither width, nor height is set, width is implicitly set to 100% and height is calculated based on the aspect ratio. |

**Examples**:

The Anchor used in the examples below is a flat polygon with a real world width of 20 meters and height of 18 meters. The Visual Asset projected onto it is a simple Text with content "This is my example Text". The examples showcase different settings of width and height; the actual measures are only approximate to show the effects of different settings.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Image** | C:\Users\MLJ\AppData\Local\Temp\Width100perc.png | C:\Users\MLJ\AppData\Local\Temp\WidthHeight100Perc.png | C:\Users\MLJ\AppData\Local\Temp\Height100Perc.png | C:\Users\MLJ\AppData\Local\Temp\Width5m.png | C:\Users\MLJ\AppData\Local\Temp\Width10mHeight5m.png |
| **Setting** | - | <width>  100% </width> <height>  100% </height> | <height>  100% </height> | <width>  5 </width> | <width>  5 </width> <height>  2 </height> |
| **Automatically Calculated** | width = 100%; height according to aspect ratio |  | width according to aspect ratio | height according to aspect ratio | - |

If the underlying Anchor does not have an extent in width and/or height direction (like a Point (no width and height) or a LineString (no height)), the Anchor's extent in the affected direction is set to 1 meter. For example, when an Image is projected onto a Point Anchor, and the Image's width is set to 100%, the Image is rendered 1 meter wide. Height is calculated according to the aspect ratio of the Image.

orientationMode   
This property controls how the VisualAsset2D is initially oriented in the Anchor's coordinate system (before roll, tilt and heading are applied) and can take on three different values: auto (default), user and absolute.  
Setting the value to user orients the VisualAsset2D towards the user. absolute positions the VisualAsset2D according to the coordinate system specification of the VisualAsset and the Anchor. auto sets the orientationMode implicitly to absolute when the VisualAsset2D is attached to a Trackable (or a RelativeTo Anchor referencing a Trackable), and sets it to user for all other cases. See Orienting VisualAssets for details on how this affects the orientation of a VisualAsset.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset2D/orientationMode](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset2D/orientationMode) |
| Setting the *orientationMode* value to user orients the VisualAsset2D towards the user. absolute positions the VisualAsset2D according to the coordinate system specification of the VisualAsset and the Anchor. auto sets the orientationMode implicitly to absolute when the VisualAsset2D is attached to a Trackable (or a RelativeTo Anchor referencing a Trackable), and sets it to user for all other cases. |

backside  
Backside defines how the back side of the VisualAsset should appear. Naturally, this is only relevant in case orientationMode is set to absolute.  
The following values are possible for backside:

* any hex value: paints the back side of the VisualAsset2D in the color referenced by the hex value. The hex value start with # and must be given in RGBA. If backside is not given, the value defaults to #808080.
* *mirrored*: the front face of the VisualAsset is mirrored onto the back face. This effect gives the impression of the front face shining through.
* ***copied*: the front side is copied onto the back side (making the front- and backside indistinguishable.**

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset2D/backSide](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset2D/backSide) |
| Setting *backside* to a hex value (#RBGA) paints the back side in that color, setting it to mirrored mirrors the front side onto the back side, setting it to copied copies the front side onto the backside. |

##### class Label

Inherits From VisualAsset2D .

A Label is a VisualAsset representing a HTML view, and its content is specified in HTML. The content can either be specified using a URI pointing to a HTML file, or specified with inline HTML. Any HTML5 content is allowed, and implementations are encouraged to support the full feature set of HTML5, ECMAScript and CSS.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=16;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=16;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=16;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=16;up=0#sorted_table) |
| --- | --- | --- | --- |
| href | A link to a HTML page that describes the rendered content | String | 0 or 1 |
| src | Inline HTML that will be used to describe the content | String | 0 or 1 |
| hyperlinkBehavior | A flag indicating how the implementation should handle clicks on hyperlinks in the Label | String | 0 or 1 |
| viewportWidth | An optional viewport setting | positive integer | 0 or 1 |

href and src  
href and src describe the content of the Label; href is a URI pointing to a HTML page that is rendered in the Label, src holds inline HTML content. If both properties are set, src takes precedence over href. At least one of the properties must be set; otherwise, the Label must be ignored.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/href\_and\_src\_precedence](http://www.opengis.net/spec/arml2x0/req/model/Label/href_and_src_precedence) |
| *src* takes precedence over *href* when set. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/href\_and\_src\_required](http://www.opengis.net/spec/arml2x0/req/model/Label/href_and_src_required) |
| At least one of *src* and *href* are required, otherwise the Label shall be ignored. |

hyperlinkBehavior  
hyperlinkBehavior allows to control how the implementation should handle clicks on hyperlinks in the Label, as well as any other location changes to the HTML document. The value can be set to either *block*, *blank* or *self*.

* *block*: Hyperlinks are not followed.
* *blank*: Hyperlinks are followed, the resulting page is opened full-screen in a new browser window. This is the default.
* *self*: Hyperlinks are followed, the resulting page is opened within the Label, replacing the original content of the Label.

The hyperlinkBehavior is independent from any onClick-event listeners set on the Label (see section 8.3.28), or the selected state of the Label (see section 6.5.4.2).

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/hyperlinkBehavior](http://www.opengis.net/spec/arml2x0/req/model/Label/hyperlinkBehavior) |
| Any Label that has the *hyperlinkBehavior* set to *block* does not follow hyperlinks when clicked. The property set to *blank* causes any hyperlinks to open in full screen windows. The property set to *self* causes the content of the Label to change to the content behind the hyperlink when clicked. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/hyperlinkBehavior\_default](http://www.opengis.net/spec/arml2x0/req/model/Label/hyperlinkBehavior_default) |
| If not set, *hyperlinkBehavior* defaults to *blank*. |

viewportWidth  
An optional setting to control the viewport width of the Label, in pixels. This setting effectively controls the size of the content in the Label (contrary to width and height of the Label, which only describe the size of the Label itself), as well as how much space is available in the Label. If not set or set to a non-positive value, viewportWidth defaults to 256. The larger the value, the smaller the content is rendered. Implementations are allowed to set an implicit maximum threshold for viewportWidth.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/viewportWidth\_default](http://www.opengis.net/spec/arml2x0/req/model/Label/viewportWidth_default) |
| If not set or set to a negative value, *viewportWidth* defaults to *256*. |

Consider an image, 256 pixels wide. Setting the viewport to 256 pixels causes the Image to horizontally span across the entire Label. Setting viewportWidth to 512 causes the Image to span across the first half of the Label, with the right half of the Label being blank.

*Accessing metadata through src and href*The Feature element in ARML 2.0 allows the definition of metadata (in the name, description and metadata tag, see section 6.3). In *src* and *href* of a Label, that metadata can be referenced supplying special character sequences in the HTML. *$[name]* and *$[description]* will be replaced by the name and description of the Feature, or an empty string if not specified. To reference metadata in the metadata tag, XPath 2.0 expressions *[XML Path Language (XPath) 2.0]* enclosed in $[ and ] must be used (see examples below). The root node for the XPath evaluation is the metadata-tag in the Feature section. The character sequence is only replaced with the resulting node’s value if an XPath evaluation returns a single TextNode, and is replaced with an empty string otherwise.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/metadata\_name\_description](http://www.opengis.net/spec/arml2x0/req/model/Label/metadata_name_description) |
| Any occurrences of *$[name]* and *$[description]* in the Label’s *src* property (or the content behind *href*) shall be replaced with the name and description of the Feature’s metadata the Label is linked to. If a property is missing, it shall be replaced with an empty string. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Label/metadata\_general](http://www.opengis.net/spec/arml2x0/req/model/Label/metadata_general) |
| Any occurrences of *$[(XPath-Expression)]* shall be replaced with the corresponding metadata in the Feature the Label is linked to. *(XPath-Expression)* shall be a valid XPath 2.0 expression with the Feature’s metadata node the Label is linked to as root node. The replacement will only be done when the XPath evaluation returns a single TextNode, and is replaced with an empty string otherwise. |

##### class Fill

Inherits From VisualAsset2D.

Fill is used when an Anchor should appear colored. It is most useful for coloring LineStrings and Polygons. Fill can be styled using CSS styles.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=17;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=17;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=17;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=17;up=0#sorted_table) |
| --- | --- | --- | --- |
| style | inline styling for the element | String | 0 or 1 |
| class | References a CSS class | String | 0 or 1 |

style and class  
see CSS styling for details

The following CSS properties are available for Fill:

* color defines the fill color of the Fill, in #RGB or #RGBA; defaults to #000000 (black)

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Fill/color\_default](http://www.opengis.net/spec/arml2x0/req/model/Fill/color_default) |
| If the color CSS property of Fill is not set, it defaults to #000000 (black). |

##### class Text

Inherits From VisualAsset2D.

Text allows plain text to be rendered. Contrary to Label, where HTML styling can be used, Text only allows a limited set of styling options. Developers are encouraged to use Text when no HTML content is necessary, as Text does not need viewport settings to be correctly set. The size of the text is dependent on the width and height settings of the Text and will be automatically calculated.  
Text can be styled using CSS styles.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=18;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=18;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=18;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=18;up=0#sorted_table) |
| --- | --- | --- | --- |
| src | The text that will be rendered | String | 1 |
| style | Achieve inline styling for the element | String | 0 or 1 |
| class | References a CSS class | String | 0 or 1 |

src  
The text to be rendered. Implementations use the platform's primary font style to render the text. No control sequences such as \n or \t are available, use Label in these cases.  
Replacement tags such as *$[name]* etc. can be used in the same way as for Labels (see section 6.5.1.1.1, paragraph *Accessing metadata through src and href* for details).

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Text/metadata\_name\_description](http://www.opengis.net/spec/arml2x0/req/model/Text/metadata_name_description) |
| Any occurrences of *$[name]* and *$[description]* in the Text’s *src* property shall be replaced with the name and description of the Feature’s metadata the Text is linked to. If a property is missing, it shall be replaced with an empty string. |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Text/metadata\_general](http://www.opengis.net/spec/arml2x0/req/model/Text/metadata_general) |
| Any occurrences of *$[(XPath-Expression)]* shall be replaced with the corresponding metadata in the Feature the Text is linked to. *(XPath-Expression)* shall be a valid XPath 2.0 expression with the Feature’s metadata node the Text is linked to as root node. The replacement will only be done when the XPath evaluation returns a single TextNode, and is replaced with an empty string otherwise. |

style and class  
see CSS styling for details

The following CSS properties are available for Text:

* font-color defines the font color of the Text, in #RGB or #RGBA; defaults to black
* background-color defines the color of the background, in #RGB or #RGBA; defaults to transparent

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Text/font-color\_default](http://www.opengis.net/spec/arml2x0/req/model/Text/font-color_default) |
| If the font-color CSS property of Text is not set, it defaults to #000000 (black). |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Text/background-color\_default](http://www.opengis.net/spec/arml2x0/req/model/Text/background-color_default) |
| If the background-color CSS property of Text is not set, it defaults to #00000000 (transparent). |

##### class Image

Inherits From VisualAsset2D.

Image allows an image to be rendered. Developers are encouraged to use Image instead of Label when only an image should be displayed, as Image does not need viewport settings to be correctly set. The size of the image is dependent on the width and height settings of the Image and will be automatically calculated.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=19;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=19;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=19;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=19;up=0#sorted_table) |
| --- | --- | --- | --- |
| href | A URI to an image | string | 1 |

href  
A URI to the image that will be displayed on the screen. The format of the image is not restricted. If an implementation cannot render the image format of a particular image, it must ignore the entire image.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Image/formats](http://www.opengis.net/spec/arml2x0/req/model/Image/formats) |
| In case an implementation cannot support the type of a particular image, it shall ignore the entire image. |

#### class Model

Inherits From VisualAsset.

A Model is a Visual Asset representing a 3D Model. The format of the model is not restricted. If an implementation cannot parse the format of a particular Model, it must ignore the entire Model.  
Implementations are encouraged to make sure that COLLADA Common Profile is fully supported as a minimum, however this is not a requirement. Implementations are also allowed to support additional file formats, however, these will not be standardized.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Model/formats](http://www.opengis.net/spec/arml2x0/req/model/Model/formats) |
| In case an implementation cannot support the type of a particular Model, it shall ignore the entire Model. |

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=20;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=20;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=20;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=20;up=0#sorted_table) |
| --- | --- | --- | --- |
| href | A URI to a model file | string | 1 |
| type | The type of the Model, either normal or infrastructure | string | 0 or 1 |
| Scale | Setting the scale of the Model | Scale | 0 or 1 |

href  
The Model file itself is specified using a URI containing the source of the Model.

type  
defines the role of the model in the augmented scene. Type can take on two different values, normal (default) and infrastructure.  
Models with type normal are rendered in the composed scene. Infrastructure models are declared in the scene and used for occlusion detection, but are not visible in the scene (for example, a real world building might be modeled as an infrastructure model, so it's not rendered on the screen, but it is used to virtually occlude other VisualAssets behind the real world building).

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Model/type](http://www.opengis.net/spec/arml2x0/req/model/Model/formats) |
| Models of type *normal* are visible in the scene. Models of type *infrastructure* are not rendered in the scene and are solely used for occlusion detection. |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Model/type\_default](http://www.opengis.net/spec/arml2x0/req/model/Model/type_default) |
| If the type property of a Model is not set, it defaults to *normal*. |

Scale  
allows scaling of the Model; see class Scale for details.

##### class Scale

Scale allows scaling of the Model along the x-, y- and z-axis. The values default to 1 if not specified. As with orientations, applying scales does not affect the axes of the Model itself, only the object is scaled.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scale/defaults](http://www.opengis.net/spec/arml2x0/req/model/Scale/defaults) |
| If not set, the x, y and z values default to 1. |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scale/axis](http://www.opengis.net/spec/arml2x0/req/model/Scale/defaults) |
| Applying scales does not affect the axis and their dimensions, only the object itself is scaled. |

### Orienting VisualAssets

Depending on the dimension of the VisualAsset and dimension of the ARAnchor it is attached to, different rules apply how VisualAssets are rendered on ARAnchors. The orientation is also dependent on the properties orientationMode (VisualAsset2D only) and Orientation.

#### Orienting VisualAsset2Ds

VisualAsset2Ds come with an orientationMode property (see interface VisualAsset2D), which controls how the VisualAsset is oriented.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/AutomaticOrientation\_VisualAssets/2D](http://www.opengis.net/spec/arml2x0/req/model/AutomaticOrientation_VisualAssets/2D) |
| The *orientationMode* of a VisualAsset2D and the dimension of the underlying ARAnchor control the automatic orientation of VisualAsset2Ds. Any implementation shall implement the orientation of VisualAsset2Ds as specified in section 6.5.2.1. |

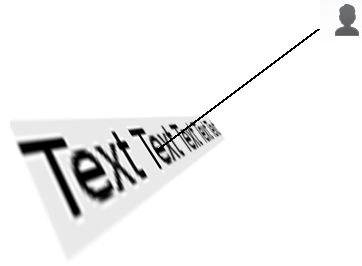
**Case 1: Underlying ARAnchor is of Dimension 0, orientationMode = "user"**

In this case, the center point of the VisualAsset2D is placed right onto the position of the ARAnchor in 3D space (either the geospatial location for Point-Geometries, or the center point of the Trackable for Trackables). The upper face of the VisualAsset2D is always oriented towards the user's current location. The upper and lower edges of the VisualAsset2D run parallel to the earth's surface in case of a Point-Geometry, and parallel to the Trackable's surface in case of a Trackable.

**Case 2: Underlying ARAnchor is of Dimension 1, orientationMode = "user"**

The VisualAsset2D runs along the defined LineString. The horizontal centerline of the Asset (the line being equidistant from the top and bottom of the VisualAsset) is placed onto the defined LineString. The horizontal center of the 2-dimensional VisualAsset (the point being equidistant from the center point of the left and right edge of the VisualAsset) is placed on the point being equidistant from the left and right end of the LineString (the origin of the coordinate system of the Anchor). This ensures that the VisualAsset expands from the center of the LineString, equally in both directions.

For each line segment of the LineString (the lines between the positions that form the LineString), the VisualAsset is directly facing the user. For each segment, the shortest distance from the LineString segment to the user’s viewing point is calculated, the resulting vector forms the normal vector of the plane the VisualAsset will be drawn into for this particular LineString segment (see figure below).



Remark: In case a LineString consists of more than one segment, the tie points of the segments might cause issues when the VisualAsset is rendered onto them. It is up to the implementation to smooth these artifacts.

**Case 3: Underlying ARAnchor is of Dimension 2, orientationMode = "user"**

The center of the VisualAsset2D is placed in the center of the BoundingRectangle of the ARAnchor, which can be considered the center of the Polygon forming the ARAnchor (see Local Coordinate System of a Polygon for details). The lower and upper edges and the left and right edges of the VisualAsset respectively are parallel to the lower and upper edges and the left and right edges of the BoundingRectangle of the Polygon respectively. The front face of the VisualAsset2D faces the user.

In case the Polygon and the VisualAsset are not of the same shape, the Polygon's boundaries will cut off any areas of the VisualAsset that do not lie within the Polygon's boundaries. This also applies to any holes in the Polygon defined by interior LinearRings.

**Case 4: Underlying ARAnchor is of Dimension 0, orientationMode = "absolute"**

This is handled in the same way as case 1, with the exception that the VisualAsset is placed into the x/z plane of the coordinate system of the Anchor, regardless of the user's position. The top and bottom edges of the VisualAsset are parallel to the x-axis; the left and right edges of the VisualAsset are parallel to the y-axis of the ARAnchor’s coordinate system. The top edge of the VisualAsset is located in the positive y-half; the right edge of the VisualAsset is located in the positive x-half.

**Case 5: Underlying ARAnchor is of Dimension 1, orientationMode = "absolute"**

The basic setup is equal to case 2. However, instead of calculating the plane as facing the user, the VisualAsset's left and right edges are placed parallel to the earth's surface for LineStrings associated with a Geometry, and parallel to the Trackable's surface for LineStrings associated with Trackables. This ensures the VisualAsset appears to be lying flat on top of the LineString when viewed from above.

The VisualAsset's front face is always facing up, whereat up is defined as:  
When viewing the first LineSegment in a way that the first specified vertex is on the left side, and the second vertex is on the right side, the side facing the viewer is the upper side.

**Case 6: Underlying ARAnchor is of Dimension 2, orientationMode = "absolute"**

This is handled in the same way as in case 3, with the exception that the VisualAsset's front face is always facing up (depending on the order the vertices of the Polygon were specified).

#### Orienting 3D VisualAssets

**Case 1: Underlying ARAnchor is of Dimension 0**

3-dimensional assets are projected into the coordinate system of a 0-dimensional location. Both the Model and the ARAnchor use the same coordinate system origin and the same axis alignment.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/AutomaticOrientation\_VisualAssets/3D\_dim\_0](http://www.opengis.net/spec/arml2x0/req/model/AutomaticOrientation_VisualAssets/3D_dim_0) |
| Any implementation shall implement the orientation of 3D VisualAssets (Models) attached to 0-dimensional ARAnchors as specified in section 6.5.2.2. |

**Case 2: Underlying ARAnchor is of Dimension 1 or 2**

3-dimensional assets cannot be attached to 1- or 2-dimensional Anchors and must be ignored in these cases.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/AutomaticOrientation\_VisualAssets/3D\_dim\_1\_2](http://www.opengis.net/spec/arml2x0/req/model/AutomaticOrientation_VisualAssets/3D_dim_1_2) |
| 3D VisualAssets (Models) attached to 1- or 2-dimensional ARAnchors shall be ignored. |

#### class Orientation - Manual Orientation of VisualAssets

The Orientation class allows to manually adjusting the orientation of a VisualAsset in 3D space after it was automatically oriented according to the above rules.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=21;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=21;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=21;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=21;up=0#sorted_table) |
| --- | --- | --- | --- |
| roll | rotation around a certain rotation axis, see below for details | double | 0 or 1 |
| tilt | rotation around a certain rotation axis, see below for details | double | 0 or 1 |
| heading | rotation around a certain rotation axis, see below for details | double | 0 or 1 |

The orientation object has 3 properties, roll, tilt and heading, which define rotations of the VisualAsset in 3 directions. The following rules apply:

* The rotation is applied using static axes (meaning that the axes are not transformed, only the object inside the coordinate system is rotated)
* The orientation steps are executed in the following order: roll - tilt - heading
* roll, tilt and heading are specified in degrees from -180 to 180.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ManualOrientation\_VisualAssets/order](http://www.opengis.net/spec/arml2x0/req/model/ManualOrientation_VisualAssets/rules) |
| The orientation is executed in the following order: roll – tilt – heading |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ManualOrientation\_VisualAssets/axes](http://www.opengis.net/spec/arml2x0/req/model/ManualOrientation_VisualAssets/rules) |
| Applying orientation does not affect the axis and their dimensions, only the object itself is rotated. |

|  |
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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/ManualOrientation\_VisualAssets/application](http://www.opengis.net/spec/arml2x0/req/model/ManualOrientation_VisualAssets/rules) |
| The *orientationMode* of a VisualAsset and the dimension of the underlying ARAnchor control the manual orientation of VisualAssets. Any implementation shall implement the manual orientation of VisualAssets as specified in section 6.5.2.3. |

Depending on the orientationMode and the type of the Anchor, the rotations are applied slightly differently:

**Case 1: 0-dimensional Anchor, orientationMode absolute or VisualAsset is 3-dimensional**

* roll rotates the VisualAsset about the y axis. A positive rotation is clockwise around the y-axis when viewed from the origin of the coordinate system looking along the positive axis.
* tilt rotates the VisualAsset about the x axis. A positive rotation is clockwise around the x-axis when viewed from the origin of the coordinate system looking along the positive axis.
* heading rotates the VisualAsset about the z axis. A positive rotation is clockwise around the z-axis when viewed from the origin of the coordinate system looking along the positive axis.

**Case 2: 0-dimensional Anchor, orientationMode user**

* tilt rotates the VisualAsset about the line parallel to the (earth's or Trackable's) surface, running through the center of the VisualAsset (the user will see the VisualAsset flipping towards or away from him). A positive rotation moves the top towards the user at first.
* heading rotates the VisualAsset about the line connecting the center of the screen with the center of the VisualAsset (the user will see the VisualAsset rotating in the plane that is facing him). A positive rotation is clockwise when viewed from the user looking towards the VisualAsset.
* roll rotates the VisualAsset about the axis that is perpendicular to the other two axes specified above, pointing away from the surface. A positive rotation moves the right edge of the VisualAsset towards the user first.

**Case 3: 1-dimensional Anchor**

* roll does not apply
* tilt rotates the VisualAsset about each LineSegment of the LineString. A positive rotation is to the right when viewed from the start of each LineSegment towards the end of the LineSegment.
* heading does not apply

**Case 4: 2-dimensional Anchor**

* roll does not apply
* tilt does not apply
* heading rotates the VisualAsset inside the plane the Polygon is forming around the center of the VisualAsset (and the coordinate system of the Anchor). A positive rotation is clockwise when viewed from above the Polygon.

### class ScalingMode - Scaling VisualAssets

VisualAssets appear smaller when their attached Anchors are further away, and appear bigger when the user moves towards the Anchor.

Consider, for example, a Polygon geometry representing a billboard on the street, which measures 20x10 meters, where a Label is attached to it (with width set to 100%). As the Anchor (and thus the Label) is scaled naturally, the further away the user, the smaller the Label is rendered, so it always fits the billboard. This is called natural scaling.

However, as the user walks away from the billboard, pretty soon the Label will become almost invisible, as a width of 20 meters, seen from a distance of 1000 meters, will appear very tiny. Contrary, if standing right in front of the billboard, the Label will obstruct the entire screen, occluding any other objects.

To overcome this, a Visual Asset can be scaled in custom mode. In custom scaling mode, a minScalingDistance and maxScalingDistance are supplied along with a scalingFactor. *min-* and *maxScalingDistance* specify the distance of the user to the anchor of the VisualAsset (precisely: the distance of the origin of the coordinate system of the anchor) where custom scaling should start and stop. Outside of those boundaries, no scaling will apply. *scalingFactor* controls how much VisualAssets are scaled between those two boundaries.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scaling\_VisualAssets/minMaxScalingDistance](http://www.opengis.net/spec/arml2x0/req/model/Scaling_VisualAssets/application) |
| In *custom* scaling mode, *minScalingDistance* and *maxScalingDistance* specify the distance of the user to the origin of the coordinate system of the ARAnchor the VisualAsset is attached to when scaling should start (min) and stop (max). Before *minScalingDistance* and behind *maxScalingDistance*, no scaling applies. |

For example, setting a minScalingDistance to 10 meters causes the Label to be rendered as if the billboard would be 10 meters away, even if the user were standing closer. Similarly, setting a maxScalingDistance to 100 meters causes the Label to be rendered as if the billboard would be 100 meters away, even if the user were standing a lot further away. Between 10 and 100 meters, natural scaling is applied if no scalingFactor is set.

The amount of scaling between min and maxScalingDistance can be controlled using a scaling factor. scalingFactor specifies the size of the VisualAsset at maxScalingDistance in percentage of the size of the VisualAsset at minScalingDistance. Setting scalingFactor to 0.5, minScalingDistance to 10 meters and maxScalingDistance to 100 meters causes the VisualAsset to lose 50% of its size (on the screen) between 10 and 100 meters distance.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scaling\_VisualAssets/scalingFactor](http://www.opengis.net/spec/arml2x0/req/model/Scaling_VisualAssets/scalingFactor) |
| In *custom* scaling mode, *scalingFactor* specifies the size of the VisualAsset at *maxScalingDistance* in percentage of the size of the VisualAsset at *minScalingDistance*. |

If both minScalingDistance and *maxScalingDistance* are set to the same value and *scalingFactor* is omitted, the VisualAsset will appear at the same size on the screen, regardless of the distance. If *scalingFactor* is set to 50%, the VisualAsset has a constant size until *maxScalingDistance* is reached, then drops to 50% of the size and keeps this size for any distances further than *maxScalingDistance*.

**Illustration:**

The following three diagrams show the effect of applying different settings to the size of a VisualAsset on the screen. The horizontal axis of the diagram shows the distance from the user to the Visual Asset, the vertical axes shows the size of the VisualAsset on the screen.

|  |  |
| --- | --- |
|  | Natural Scaling: The Visual Asset has a certain natural size at distance 0 and is scaled according to natural scaling. |
|  | Custom Scaling:  minScalingDistance: 20 maxScalingDistance: 80 scalingFactor: not set  The VisualAsset is not scaled between 0 and 20 meters distance (at 20 meters, it is at its natural size), then naturally scaled between 20 and 80 meters. At 80 meters distance, it takes on its natural size. Beyond 80 meters distance, the VisualAsset does not change its screen size. |
|  | Custom Scaling:  minScalingDistance: 20 maxScalingDistance: 80 scalingFactor: 0.75  Scaling behaves similar to the previous example. The main difference is that at 80 meters distance, the VisualAsset is now at 75% of its size at 20 meters. |

**Example:**

|  |  |
| --- | --- |
| Natural scaling of a Label, with viewing distances 10 meters, 20 meters, 30 meters and 40 meters | C:\Users\MLJ\AppData\Local\Temp\naturalScaling.PNG |
| Custom scaling of a Label, with viewing distances 10 meters, 20 meters, 30 meters and 40 meters, minScalingDistance set to 20, maxScalingDistance  set to 30 and scalingFactor omitted. | C:\Users\MLJ\AppData\Local\Temp\customScaling.PNG |

In the second example, natural scaling applies between 20 and 30 meters distance. If the user is closer than 20 meters, the Label is rendered on the screen as if the Anchor would be 20 meters away (minScalingDistance set to 20 meters). Similarly, if the user is further than 30 meters away, the Label is rendered on the screen as if the Anchor would be 30 meters away (maxScalingDistance set to 30).

The scaling mode calculations are applied after the VisualAsset was positioned, scaled (according to width and height for VisualAsset2D, and Scaling for Model) and aligned according to the orientation settings.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=23;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=23;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=23;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=23;up=0#sorted_table) |
| --- | --- | --- | --- |
| type | The type of the scaling mode, either "natural" or "custom" | string | 1 |
| minScalingDistance | The distance the natural scaling effect should start | double | 0 or 1 |
| maxScalingDistance | The distance the natural scaling effect should stop | double | 0 or 1 |
| scalingFactor | The size of the VisualAsset at maxScalingDistance in percentage of the size of the VisualAsset at minScalingDistance | double | 0 or 1 |

type  
Either natural or custom

minScalingDistanceThe distance the natural scaling effect should start. Should only be specified when type is set to custom and is ignored for natural. If not specified or set to a negative value, custom scaling acts as if the value would be set to 0. Must be less than or equal to maxScalingDistance.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scaling\_VisualAssets/minScalingDistance\_default](http://www.opengis.net/spec/arml2x0/req/model/Scaling_VisualAssets/minsScalingDistance_default) |
| If not set, *minScalingDistance* is implicitly set to 0. *minScalingDistance* shall be less than or equal to *maxScalingDistance*. |

maxScalingDistanceThe distance the natural scaling effect should stop. Must be specified when type is set to custom and is ignored for natural. Must be greater than or equal to minScalingDistance.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scaling\_VisualAssets/maxScalingDistance\_ignored](http://www.opengis.net/spec/arml2x0/req/model/Scaling_VisualAssets/maxScalingDistance_ignored) |
| *maxScalingDistance* shall be ignored when *natural* scaling is used, and shall be greater than or equal to *minScalingDistance*. |

scalingFactorscalingFactor is a percentage value (0 <= scalingFactor <= 1) that defines how rapidly the VisualAssets should be scaled between min and maxScalingDistance. It specifies the size of the VisualAsset at maxScalingDistance in percentage of the size of the VisualAsset at minScalingDistance. If minScalingDistance is not supplied, it must be temporarily set to 1 meter for the purpose of the scalingFactor calculations. scalingFactor should only be specified when type is set to custom and maxScalingDistance is set, and is ignored otherwise.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Scaling\_VisualAssets/scalingFactor\_ignored](http://www.opengis.net/spec/arml2x0/req/model/Scaling_VisualAssets/scalingFactor_default) |
| *scalingFactor* shall be ignored when *natural* scaling is used. |

### interface Condition

Inherits from ARElement.

Depending on the situation, certain VisualAssets might be visible on the screen at different times. Consider a mountain with a mountain hut on its summit, which should be remodeled. The mountain hut has a representation as a 3D model, showing the shape of the mountain hut in the future. However, from further away, the 3D model is not visible at all. Hikers starting at the valley ground, however, want to see a big Label indicating where the Mountain hut is actually located.

The following conditions are available:

* distance (min and max distance)
* selected (true/false)

If multiple conditions are supplied for a particular VisualAsset, all these conditions must yield true for the VisualAsset to be visible.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Condition/multiple](http://www.opengis.net/spec/arml2x0/req/model/Condition/interface) |
| If multiple Conditions are set for a VisualAsset, they all shall yield true for the VisualAsset to be rendered. |

**Remark:** To achieve a "condition1 or condition2" situation, the VisualAsset must be duplicated (asset1 and asset2), where asset1 is tied to condition1, and asset2 is tied to condition2.

#### class DistanceCondition

Inherits from Condition.

DistanceCondition allows VisualAssets to be activated and deactivated based on the distance of the user to the anchor (precisely: the origin of the coordinate system of the anchor).

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=24;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=24;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=24;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=24;up=0#sorted_table) |
| --- | --- | --- | --- |
| max | The maximum distance the VisualAsset will be visible for | double | 0 or 1 |
| min | The minimum distance the VisualAsset will be visible for | double | 0 or 1 |

max  
denotes the maximum distance the VisualAsset will be visible at, in meters. For example, if it is set to 100, VisualAssets attached to Anchors with a distance of more than 100 meters are not visible.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Distance/max](http://www.opengis.net/spec/arml2x0/req/model/Condition/interface) |
| VisualAssets further away from the user than the distance specified in *max* shall not be visible. |

min  
denotes the minimum distance the VisualAsset will be visible at, in meters. For example, if it is set to 100, VisualAssets attached to Anchors with a distance of less than 100 meters are not visible.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Distance/min](http://www.opengis.net/spec/arml2x0/req/model/Condition/Distance/min) |
| VisualAssets closer to the user than the distance specified in *min* shall not be visible. |

If both min and max are set, both conditions must yield true for the visual asset to be rendered

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Distance/min\_and\_max](http://www.opengis.net/spec/arml2x0/req/model/Condition/Distance/min_and_max) |
| If both *min* and *max* are set, both conditions shall yield true for the VisualAsset to be visible. |

#### class SelectedCondition

Inherits from Condition.

The selected condition allows VisualAssets to be activated and deactivated based on the selected-status of the Feature or Anchor.

An Anchor is considered *selected* if one of its VisualAssets has been selected in the most recent selection process. It is expected that for most implementations, a click or touch on a VisualAsset will be considered a selection of that VisualAsset, however, the definition is implementation- and platform-specific. In turn, a Feature is considered selected if one of its Anchors is selected.

**Properties:**

| [**Name**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=0;table=25;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=1;table=25;up=0#sorted_table) | [**Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=2;table=25;up=0#sorted_table) | [**Multiplicity**](https://portal.opengeospatial.org/wiki/ARML2x0swg/Spec?cover=print;sortcol=3;table=25;up=0#sorted_table) |
| --- | --- | --- | --- |
| listener | The element type the selected-condition is listening for, either "feature" or "anchor" | String | 0 or 1 |
| selected | The selected state the VisualAsset should be visible | boolean | 1 |

listener  
One of feature or anchor, defaults to anchor.  
If *listener* is set to feature, the selected-condition listens on the selected state of the Feature the VisualAsset is attached (i.e. also the selection of another Anchor that is attached to the same Feature can trigger the select-state of the particular Feature). If *listener* is set to anchor, the selected-condition listens on the selected state of the Anchor the VisualAsset is attached to.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Selected/listener\_default](http://www.opengis.net/spec/arml2x0/req/model/Condition/Selected/listener_default) |
| If *listener* is not set, it defaults to *anchor*. |

selected  
If set to true, the VisualAsset is only visible when the Anchor or Feature (see listener) is currently selected; if set to false, it is only visible when the Anchor or Feature is not currently selected.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Selected/selected](http://www.opengis.net/spec/arml2x0/req/model/Condition/Selected/selected) |
| If selected is set to true, the VisualAsset is only visible when the listener is in selected state. When set to false, the VisualAsset is only visible when the listener is not in selected state. |

# 

# ARML 2.0 – XSD and XML Serialization (normative)

|  |  |
| --- | --- |
| **Requirements Class** | |
| [http://www.opengis.net/spec/arml/2.0/req/model](http://www.opengis.net/spec/arml2x0/req/model) | |
| **Target Type** | Encoding |

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| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/general/xsd\_verification](http://www.opengis.net/spec/arml2x0/req/model/general/xsd_verification) |
| Any ARML 2.0 XML encoding shall validate correctly against the XSD defined in section 7. |

This chapter defines an XML serialization of the ARML 2.0 object model. The XML serialization is defined in XSD. The following XSD header, namespaces and imports are used:

<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"  
 targetNamespace="http://www.opengis.net/arml/2.0"  
 xmlns="http://www.opengis.net/arml/2.0"  
 xmlns:xlink="http://www.w3.org/1999/xlink"  
 xmlns:gml=" http://www.opengis.net/gml/3.2"  
 elementFormDefault="qualified"  
 version="2.0">

<!-- Xlink import -->  
 <xsd:import namespace="http://www.w3.org/1999/xlink"  
 schemaLocation="http://www.w3.org/1999/xlink.xsd" />  
 <!-- GML import -->  
 <xsd:import namespace="http://www.opengis.net/gml/3.2"   
 schemaLocation="http://schemas.opengis.net/gml/3.2.1/gml.xsd" />

## Document Structure

The root element of the document is <arml>, which contains the following elements:

* The <ARElements> element, containing a list of ARElement objects.
* Multiple optional <style> elements, including and optional type-attribute that allows the specification of the style-mime type (typically text/css).
* Multiple optional <script> elements, including and optional type-attribute that allows the specification of the script-mime type (typically text/javascript).

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/general/root\_element](http://www.opengis.net/spec/arml2x0/req/model/general/root_element) |
| <arml> is the root element of the encoding and shall be present. |

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/ARElement/container](http://www.opengis.net/spec/arml2x0/req/model/ARElement/container) |
| Only objects derived from ARElement are allowed as immediate child elements in the <ARElements> tag. |

**XML Example (shortest possible ARML document):**

<?xml version="1.0" encoding="UTF-8"?>  
<arml xmlns=<http://www.opengis.net/arml/2.0>  
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"   
 xsi:schemaLocation="http://www.opengis.net/arml/2.0   
 http://schemas.opengis.net/arml/2.0/arml.xsd">  
 <ARElements>  
 </ARElements>  
</arml>

**XML Example:**

<arml xmlns="[http://www.opengis.net/arml/2.0](http://opengeospatial.org/arml/2.0)">  
 <ARElements>  
 <Feature id="myFeature">  
 <name>My first Feature</name>  
 <anchors>  
 <gml:Point gml:id="myPoint">  
 <gml:pos>48.123 13.456</gml:pos>  
 </gml:Point>  
 </anchors>  
 </Feature>  
 </ARElements>

<style type="text/css">  
 <![CDATA[  
 ... CSS style definitions of any Visual Assets  
 ]]>  
 </style>

<script type="text/ecmascript"> <!--might also be javascript and other derivatives -->  
 <![CDATA[  
 ... ECMAScript goes here ... ]]>  
 </script>  
</arml>

**XSD:**

<xsd:complexType name="ArmlType">  
 <xsd:sequence>  
 <xsd:element name="ARElements" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:element ref="ARElement" minOccurs="0" maxOccurs="unbounded" />  
 </xsd:sequence>  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="style" maxOccurs="unbounded" minOccurs="0">  
 <xsd:complexType>  
 <xsd:simpleContent>  
 <xsd:extension base="xsd:string">  
 <xsd:attribute name="type" type="xsd:string" use="optional" />  
 <xsd:attribute ref="xlink:href" use="optional" />  
 </xsd:extension>  
 </xsd:simpleContent>  
 </xsd:complexType>  
 </xsd:element>  
  
 <xsd:element name="script" maxOccurs="unbounded" minOccurs="0">  
 <xsd:complexType>  
 <xsd:simpleContent>  
 <xsd:extension base="xsd:string">  
 <xsd:attribute name="type" type="xsd:string" use="optional" />  
 <xsd:attribute ref="xlink:href" use="optional" />  
 </xsd:extension>  
 </xsd:simpleContent>  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
</xsd:complexType>

<xsd:element name="arml" type="ArmlType" />

## interface ARElement

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/ARElement/interface](http://www.opengis.net/spec/arml2x0/req/model/ARElement/container) |
| ARElement only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/ARElement/id](http://www.opengis.net/spec/arml2x0/req/model/ARElement/id) |
| Any object derived from ARElement may contain an optional id attribute used to uniquely reference the ARElement by other objects. In case the attribute is set, it shall be unique within the document. |

**XSD:**

<xsd:complexType name="ARElementType" abstract="true">  
 <xsd:attribute name="id" type="xsd:ID" use="optional" />  
</xsd:complexType>

<xsd:element name="ARElement" abstract="true" type="ARElementType" />

## class Feature

**A Feature contains a list of Anchors, which** can either be defined directly in the anchors-tag, or referenced using the anchorRef tag. Both ways can be mixed within one Feature, and a Feature can have an arbitrary number of Anchors.  
If an Anchor is referenced with *anchorRef*, the URI to the Anchor is specified in the xlink:href attribute.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/Feature/anchors/relative](http://www.opengis.net/spec/arml2x0/req/model/Feature/anchors/relative) |
| Anchors attached to a Feature by reference (i.e. using *anchorRef*) shall be referenced via a URI using the xlink:href attribute. |

**XSD:**

<xsd:complexType name="FeatureType">  
 <xsd:complexContent>  
 <xsd:extension base="ARElementType">  
 <xsd:sequence>  
 <xsd:element name="name" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="description" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="enabled" type="xsd:boolean" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="metadata" maxOccurs="1" minOccurs="0">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:any processContents="lax" minOccurs="0" maxOccurs="unbounded"/>  
 </xsd:sequence>  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="anchors" maxOccurs="1" minOccurs="0">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:element ref="Anchor" minOccurs="0" maxOccurs="unbounded" />  
 <xsd:element name="anchorRef" maxOccurs="unbounded" minOccurs="0">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Feature" type="FeatureType" substitutionGroup="ARElement" />

**XML Example:**

<Feature id="ferrisWheel">  
 <name> Ferris Wheel</name>  
 <enabled>true</enabled>  
 <metadata>  
 <constructed>1896-1897</constructed>  
 <height>64,75</height>  
 </metadata>  
 <anchors>  
 <!-- either defined directly in the tag -->  
 <Geometry>  
 ...  
 </ Geometry>  
 <!-- or referenced -->  
 <anchorRef xlink:href="#myAnchor" />  
 </anchors>  
</Feature>

## interface Anchor

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/Anchor/interface](http://www.opengis.net/spec/arml2x0/req/model/Anchor/interface) |
| Anchor only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

**XSD:**

<xsd:complexType name="AnchorType" abstract="true">  
 <xsd:complexContent>  
 <xsd:extension base="ARElementType">  
 <xsd:sequence>  
 <xsd:element name="enabled" type="xsd:boolean" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>  
  
<xsd:element name="Anchor" type="AnchorType" abstract="true" substitutionGroup="ARElement" />

### interface ARAnchor

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/ARAnchor/interface](http://www.opengis.net/spec/arml2x0/req/model/ARAnchor/interface) |
| ARAnchor only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

**An ARAnchor contains a list of VisualAssets,** which can either be defined directly in the assets-tag, or referenced using the assetRef tag. Both ways can be mixed within one ARAnchor, and an ARAnchor can have an arbitrary number of VisualAssets.   
In case VisualAssets are referenced with *assetRef*, the URI to the VisualAsset is specified in the xlink:href attribute.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/ARAnchor/relative](http://www.opengis.net/spec/arml2x0/req/model/ARAnchor/relative) |
| VisualAssets attached to an Anchor by reference (i.e. using *assetRef*) shall be referenced via a URI using the xlink:href attribute. |

**XSD:**

<xsd:complexType name="ARAnchorType" abstract="true">  
 <xsd:complexContent>  
 <xsd:extension base="AnchorType">  
 <xsd:sequence>  
 <xsd:element name="assets" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:element ref="VisualAsset" maxOccurs="unbounded" minOccurs="0" />  
 <xsd:element name="assetRef" maxOccurs="unbounded" minOccurs="0">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="ARAnchor" type="ARAnchorType" abstract="true" substitutionGroup="Anchor" />

#### class Geometry

**XSD:**

<xsd:complexType name="GeometryType">  
 <xsd:complexContent>  
 <xsd:extension base="ARAnchorType">  
 <xsd:choice>  
 <xsd:element ref="gml:Point" />  
 <xsd:element ref="gml:LineString" />  
 <xsd:element ref="gml:Polygon" />  
 </xsd:choice>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Geometry" type="GeometryType" substitutionGroup="ARAnchor" />

**Example:**

<Feature id="myFeature">  
 <anchors>  
 <Geometry>  
 <enabled>true</enabled>  
 <assets>  
 ...  
 </assets>  
 <gml:Point gml:id="point1">  
 <gml:pos>1 2</gml:pos>  
 </gml:Point>  
 </Geometry>  
 </anchors>  
</Feature>

##### interface GMLGeometries

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/GMLGeometries/interface](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/interface) |
| GMLGeometries only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

##### class Point

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/Point/xsd](http://www.opengis.net/spec/arml2x0/req/model/Point/xsd) |
| The Point class in ARML reuses the Point model, including the XSD, from the [GML Specification]. |

**XML Example:**

<gml:Point gml:id="myPointWithAltitudeOfUser">  
 <gml:pos>  
 47.48 13.14  
 </gml:pos>  
</gml:Point>

<gml:Point gml:id="myPointWithExplicitAltitude" srsDimension="3">  
 <gml:pos>  
 47.48 13.14 520  
 </gml:pos>  
</gml:Point>

##### class LineString

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/LineString/xsd](http://www.opengis.net/spec/arml2x0/req/model/LineString/xsd) |
| The LineString class in ARML reuses the LineString model, including the XSD, from the [GML Specification]. |

**XML Example:**

<gml:LineString gml:id="myLineString">  
 <gml:posList>  
 47.48 13.14 48.49 14.15  
 </gml:posList>  
</gml:LineString>

##### class Polygon

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/Polygon/xsd](http://www.opengis.net/spec/arml2x0/req/model/Polygon/xsd) |
| The Polygon class in ARML reuses the Polygon model, including the XSD, from the [GML Specification]. |

As a convention, the vertices of the Polygon (especially the vertices of the exterior LinearRing) should be specified in counter-clockwise direction to correctly define the VisualAsset’s front face. See Orienting VisualAssets for details.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/GMLGeometries/LinearRing/order](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/LinearRing/order) |
| A LinearRing’s coordinate tuples shall be specified in counter-clockwise order. |

**XML Example:**

<gml:Polygon gml:id="myPolygon">  
 <gml:exterior>  
 <gml:LinearRing>  
 <gml:posList>  
 47.48 13.14 48.49 14.15 48.49 14.13 47.48 13.14  
 </gml:posList>  
 </gml:LinearRing>  
 </gml:exterior>  
 <gml:interior>  
 <gml:LinearRing>  
 <gml:posList>  
 48.00 14.00 48.01 14.01 48.01 13.99 48.00 14.00  
 </gml:posList>  
 </gml:LinearRing>  
 </gml:interior>  
 <gml:interior>  
 <gml:LinearRing>  
 ...  
 </gml:LinearRing>  
 </gml:interior>   
</gml:Polygon>

#### Trackable and Tracker

##### class Tracker

The src and uri properties are specified in xlink:href attributes, see the XSD below.

**XSD:**

<xsd:complexType name="TrackerType">  
 <xsd:complexContent>  
 <xsd:extension base="ARElementType">  
 <xsd:sequence>  
 <xsd:element name="uri" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="src" maxOccurs="1" minOccurs="0">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Tracker" type="TrackerType" substitutionGroup="ARElement" />

**XML Example:**

<!-- a generic image Tracker -->  
<Tracker id="myGenericImageTracker">  
 <uri xlink:href="http://www.opengis.net/arml/tracker/genericImageTracker" />  
</Tracker>   
  
<!-- a generic image Tracker operating on a set of image targets supplied via a zip file -->  
<Tracker id="myGenericImageTrackerWithZip">  
 <uri xlink:href="http://www.opengis.net/arml/tracker/genericImageTracker" />  
 <src xlink:href="http://www.myserver.com/myTargets/myTargets.zip" />  
</Tracker>

<!-- a custom Tracker -->  
<Tracker id="myCustomTracker">  
 <uri xlink:href="http://www.myServer.com/myTracker" />  
 <src xlink:href="http://www.myServer.com/myTrackables/binary.file" />  
</Tracker>

##### class Trackable

**XSD:**

<xsd:complexType name="TrackableType">  
 <xsd:complexContent>  
 <xsd:extension base="ARAnchorType">  
 <xsd:sequence>  
 <xsd:element name="config" maxOccurs="unbounded" minOccurs="1">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:element name="tracker" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="src" type="xsd:string" maxOccurs="1" minOccurs="1" />  
 </xsd:sequence>  
 <xsd:attribute name="order" type="xsd:int" use="optional" />  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="size" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Trackable" type="TrackableType" substitutionGroup="ARAnchor" />

**XML Example:**

<!-- using the trackers specified above -->  
<!-- a png image tracked with the generic image tracker -->  
<Trackable id="myBirdTrackable">  
 <config>  
 <tracker xlink:href="#myGenericImageTracker" />  
 <src>http://www.myserver.com/myTrackables/bird.png</src>  
 </config>  
 <size>0.2</size> <!-- in real word dimensions, the bird image is 20 cm wide -->  
</Trackable>

<!-- a jpg image tracked with the generic image tracker operating on a zip file-->  
<Trackable id="myBirdTrackableInZip">  
 <config>  
 <tracker xlink:href="#myGenericImageTrackerWithZip" />  
 <src>/images/bird.png</src>  
 </config>  
 <size>0.2</size>  
</Trackable>

<!-- a jpg image tracked with the generic image tracker operating on a zip file-->  
<Trackable id="myCustomBirdTrackable">  
 <config>  
 <tracker xlink:href="#myCustomTracker" />  
 <src>bird</src> <!-- the custom tracker is supposed to understand the ID "bird" in the Tracker's binary container -->  
 </config>  
 <size>0.2</size>  
</Trackable>  
  
<!—a Trackable that can be tracked in two different ways, preferably with a custom implementation that takes a binary file, and if this configuration is not available, a generic imagetracker should be used-->  
<Trackable id="myTrackable">  
 <config order="1">  
 <tracker xlink:href="#myCustomSuperSpeedyTracker" />  
 <src>http://www.myserver.com/myTrackables/bird.dat</src>  
 </config>  
 <!—fallback -->  
 <config order="2">  
 <tracker xlink:href="#myGenericImageTracker" />  
 <src>http://www.myserver.com/myTrackables/bird.png</src>  
 </config>  
 <size>0.2</size>  
</Trackable>

#### class RelativeTo

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/RelativeTo/ref](http://www.opengis.net/spec/arml2x0/req/model/RelativeTo/ref) |
| A RelativeTo element shall have its *ref* property set to either reference another ARAnchor (except LineStrings), another Model or the user’s position (using #user), using the xlink:href attribute. |

**XSD:**

<xsd:complexType name="RelativeToType">  
 <xsd:complexContent>  
 <xsd:extension base="ARAnchorType">  
 <xsd:sequence>  
 <xsd:element name="ref" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:choice>  
 <xsd:element ref="gml:Point" />  
 <xsd:element ref="gml:LineString" />  
 <xsd:element ref="gml:Polygon" />  
 </xsd:choice>  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="RelativeTo" type="RelativeToType" substitutionGroup="ARAnchor" />

**Example (to mark the outline of a Trackable):**

<Trackable id="myTrackable">  
 <size>5</size> <!-- assuming a square Trackable for this example-->  
 ...  
</Trackable>

<RelativeTo>  
 <ref xlink:href="#myTrackable" />  
 <gml:LineString gml:id="trackableOutline">  
 <gml:posList dimension="3"> <!-- will describe the outline of the square marker (2.5 meters from origin to top, bottom, left and right edge -->  
 2.5 2.5 0 2.5 -2.5 0 -2.5 -2.5 0 -2.5 2.5 0 2.5 2.5 0  
 </gml:posList>  
 </gml:LineString>  
</ RelativeTo>

### class ScreenAnchor

**XSD:**

<xsd:complexType name="ScreenAnchorType">  
 <xsd:complexContent>  
 <xsd:extension base="AnchorType">  
 <xsd:sequence>  
 <xsd:element name="style" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="class" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="assets" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:element ref="Label" maxOccurs="unbounded" minOccurs="0" />  
 <xsd:element name="assetRef" maxOccurs=" unbounded " minOccurs="0">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="ScreenAnchor" type="ScreenAnchorType" substitutionGroup="Anchor" />

**Example (a Feature also contains a ScreenAnchor showing some information on the Feature):**

<Feature id="myPlacemark">  
 <anchors>  
 <ScreenAnchor style="bottom:0; left:0; width: 100%;">  
 <!-- area spans the entire screen width, and is located at the bottom of the screen; top is dynamic -->  
 <assets>  
 <Label>  
 <src><![CDATA[<div><b>My Restaurant</b> is wonderful, come in and have a seat!</div>]]></src>  
 </Label>  
 </assets>  
 </ScreenAnchor>  
 </anchors>  
</Feature>

## interface VisualAsset

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/VisualAsset/interface](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset/interface) |
| VisualAsset only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

**XSD** **:**

<xsd:complexType name="VisualAssetType" abstract="true">  
 <xsd:complexContent>  
 <xsd:extension base="ARElementType">  
 <xsd:sequence>  
 <xsd:element name="enabled" type="xsd:boolean" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="zOrder" type="xsd:int" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="conditions" maxOccurs="1" minOccurs="0">  
 <xsd:complexType>  
 <xsd:sequence>  
 <xsd:element ref="Condition" maxOccurs="unbounded" minOccurs="1" />  
 </xsd:sequence>  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="Orientation" type="OrientationType" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="ScalingMode" type="ScalingModeType" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="VisualAsset" type="VisualAssetType" abstract="true" substitutionGroup="ARElement" />

**Example:**

<VisualAsset id="myVisualAsset">  
 <enabled>true</enabled>  
 <zOrder>0</zOrder>  
 <Orientation>  
 <roll>90</roll>  
 <tilt>90</tilt>  
 <heading>90</heading>  
 </Orientation>  
 <Conditions>  
 ...  
 </Conditions>  
</VisualAsset>

### VisualAsset Types

#### interface VisualAsset2D

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/VisualAsset2D/interface](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset2D/interface) |
| VisualAsset2D only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

**XSD:**

<xsd:complexType name="VisualAsset2DType" abstract="true">  
 <xsd:complexContent>  
 <xsd:extension base="VisualAssetType">  
 <xsd:sequence>  
 <xsd:element name="width" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="height" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="orientationMode" maxOccurs="1" minOccurs="0">  
 <xsd:simpleType>  
 <xsd:restriction base="xsd:string">  
 <xsd:enumeration value="user" />  
 <xsd:enumeration value="absolute" />  
 <xsd:enumeration value="auto" />  
 </xsd:restriction>  
 </xsd:simpleType>  
 </xsd:element>  
 <xsd:element name="backside" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="VisualAsset2D" type="VisualAsset2DType" abstract="true" substitutionGroup="VisualAsset" />

##### class Label

**XSD:**

<xsd:complexType name="LabelType">  
 <xsd:complexContent>  
 <xsd:extension base="VisualAsset2DType">  
 <xsd:sequence>  
 <xsd:element name="href" maxOccurs="1" minOccurs="0">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="src" type="xsd:anyType" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="hyperlinkBehavior" maxOccurs="1" minOccurs="0">  
 <xsd:simpleType>  
 <xsd:restriction base="xsd:string">  
 <xsd:enumeration value="block"></xsd:enumeration>  
 <xsd:enumeration value="blank"></xsd:enumeration>  
 <xsd:enumeration value="self"></xsd:enumeration>  
 </xsd:restriction>  
 </xsd:simpleType>  
 </xsd:element>  
 <xsd:element name="viewportWidth" type="xsd:positiveInteger" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Label" type="LabelType" substitutionGroup="VisualAsset2D" />

**Example:**

<Label id="mySrcLabel">  
 <src>  
 <div>Here's my Label in a div</div>  
 </src>  
</Label>

<Label id="myHrefLabel">  
 <href xlink:href="http://www.myserver.com/myLabel.html" />  
</Label>   
  
<!-- Example of replacing name and metadata fields -->  
<Feature id="empireStateBuilding">  
 <name>The Empire State Building</name>  
 <metadata>  
 <constructed>1929-1931</constructed>  
 <height>381m</height>  
 </metadata>  
 ...  
</Feature>  
<!-- The Label could be attached to multiple buildings conforming with the same metadata-layout -->  
<Label id="myBuildingLabel">  
 <src>  
 $[name]<br/>Constructed: $[/constructed]<br/>height: $[/height]  
 </src>  
</Label>

##### class Fill

**XSD:**

<xsd:complexType name="FillType">  
 <xsd:complexContent>  
 <xsd:extension base="VisualAsset2DType">  
 <xsd:sequence>  
 <xsd:element name="style" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="class" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Fill" type="FillType" substitutionGroup="VisualAsset2D" />

**Example:**

<Fill id="myFill" style="color:#FF0000;" />

<!-- the same can be achieved with -->  
<!-- style-section in arml document -->  
<style type="text/css">  
 Fill.redFill {  
 color : #FF0000;  
 }  
</style>

<!-- ARElements section of arml document -->  
<Fill id="myFill" class="redFill" />

##### class Text

**XSD:**

<xsd:complexType name="TextType">  
 <xsd:complexContent>  
 <xsd:extension base="VisualAsset2DType">  
 <xsd:sequence>  
 <xsd:element name="src" type="xsd:string" maxOccurs="1" minOccurs="1" />  
 <xsd:element name="style" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="class" type="xsd:string" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Text" type="TextType" substitutionGroup="VisualAsset2D" />

**Example:**

<Text id="myText" style="font-color:#FF0000;">  
 <src>This text will be displayed</src>  
</Text>

##### class Image

**XSD:**

<xsd:complexType name="ImageType">  
 <xsd:complexContent>  
 <xsd:extension base="VisualAsset2DType">  
 <xsd:sequence>  
 <xsd:element name="href" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Image" type="ImageType" substitutionGroup="VisualAsset2D" />

**Example:**

<Image id="myImage">  
 <href xlink:href="http://www.myserver.com/myImage.png" />  
</Image>

#### class Model

**XSD:**

<xsd:complexType name="ModelType">  
 <xsd:complexContent>  
 <xsd:extension base="VisualAssetType">  
 <xsd:sequence>  
 <xsd:element name="href" maxOccurs="1" minOccurs="1">  
 <xsd:complexType>  
 <xsd:attribute ref="xlink:href" use="required" />  
 </xsd:complexType>  
 </xsd:element>  
 <xsd:element name="type" maxOccurs="1" minOccurs="0">  
 <xsd:simpleType>  
 <xsd:restriction base="xsd:string">  
 <xsd:enumeration value="normal" />  
 <xsd:enumeration value="infrastructure" />  
 </xsd:restriction>  
 </xsd:simpleType>  
 </xsd:element>  
 <xsd:element name="Scale" type="ScaleType" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Model" type="ModelType" substitutionGroup="VisualAsset" />

**Example:**

<Model id="myModel">  
 <href xlink:href="http://domain.com/myColladaFile.zip" /> <!-- a URI to a zip file, containing the COLLADA dae file, textures and any other ressources required -->  
 <type>infrastructure</type> <!-- one of normal|infrastructure -->  
 <Orientation>  
 <roll>0</roll>  
 <tilt>0</tilt>  
 <heading>0</heading> <!-- Model is oriented towards north -->  
 </Orientation>  
 <Scale>  
 <x>1</x>  
 <y>1</y>  
 <z>1</z>  
 </Scale>  
 <zOrder>0</zOrder> <!-- int value controlling the rendering order (defaults to 0)-->   
</Model>

##### class Scale

**XSD:**

<xsd:complexType name="ScaleType">  
 <xsd:sequence>  
 <xsd:element name="x" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="y" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="z" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
</xsd:complexType>

### class Orientation

**XSD:**

<xsd:complexType name="OrientationType">  
 <xsd:sequence>  
 <xsd:element name="roll" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="tilt" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="heading" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
</xsd:complexType>

### 

### class ScalingMode

**XSD:**

<xsd:complexType name="ScalingModeType">  
 <xsd:complexContent>  
 <xsd:extension base="ARElementType">  
 <xsd:sequence>  
 <xsd:element name="minScalingDistance" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="maxScalingDistance" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="scalingFactor" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 <xsd:attribute name="type" use="required">  
 <xsd:simpleType>  
 <xsd:restriction base="xsd:string">  
 <xsd:enumeration value="natural" />  
 <xsd:enumeration value="custom" />  
 </xsd:restriction>  
 </xsd:simpleType>  
 </xsd:attribute>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

**Example:**

<VisualAsset id="myVisualAsset">  
 ... <!-- visual asset definition -->  
 <ScalingMode type="custom">  
 <minScalingDistance>50</minScalingDistance>  
 <maxScalingDistance>5000</maxScalingDistance>   
 <scalingFactor>0.75</scalingFactor>  
 </ScalingMode>  
</VisualAsset>

<VisualAsset id="myVisualAsset2">  
 ... <!-- visual asset definition -->  
 <ScalingMode type="natural" /> <!-- this is the default behavior -->  
</VisualAsset>

### interface Condition

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/model/Condition/interface](http://www.opengis.net/spec/arml2x0/req/model/Condition/interface) |
| Condition only serves as an interface for other objects defined in the encoding and may not be used directly in the encoding. |

**XSD:**

<xsd:complexType name="ConditionType" abstract="true">  
 <xsd:complexContent>  
 <xsd:extension base="ARElementType" />  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="Condition" type="ConditionType" abstract="true" substitutionGroup="ARElement" />

#### class DistanceCondition

**XSD:**

<xsd:complexType name="DistanceConditionType">  
 <xsd:complexContent>  
 <xsd:extension base="ConditionType">  
 <xsd:sequence>  
 <xsd:element name="max" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 <xsd:element name="min" type="xsd:double" maxOccurs="1" minOccurs="0" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="DistanceCondition" type="DistanceConditionType" substitutionGroup="Condition" />

**Example:**

<Model id="myModel">  
 ... <!-- representation of the mountain hut as a 3D model  
 <conditions>  
 <DistanceCondition>  
 <min>200</min> <!-- only visible when distance is more than 200 meters -->  
 </DistanceCondition>  
 </conditions>  
</Model>

<Label id="myLabel">   
 ... <!-- representation of the mountain hut as a Label  
 <conditions>  
 <DistanceCondition>  
 <max>500</max>  
 <min>200</min> <!-- only visible when distance more than 200 meters, but less than 500 meters -->  
 </DistanceCondition>  
 </conditions>  
</Label>

#### class SelectedCondition

**XSD:**

<xsd:complexType name="SelectedConditionType">  
 <xsd:complexContent>  
 <xsd:extension base="ConditionType">  
 <xsd:sequence>  
 <xsd:element name="listener" maxOccurs="1" minOccurs="0">  
 <xsd:simpleType>  
 <xsd:restriction base="xsd:string">  
 <xsd:enumeration value="feature" />  
 <xsd:enumeration value="anchor" />  
 </xsd:restriction>  
 </xsd:simpleType>  
 </xsd:element>  
 <xsd:element name="selected" type="xsd:boolean" maxOccurs="1" minOccurs="1" />  
 </xsd:sequence>  
 </xsd:extension>  
 </xsd:complexContent>  
</xsd:complexType>

<xsd:element name="SelectedCondition" type="SelectedConditionType" substitutionGroup="Condition" />

**Example:**

<Model id="myModel">  
 <conditions>  
 <SelectedCondition>  
 <listener>feature</listener>  
 <selected>true</selected> <!-- only visible when the Feature the VisualAsset is attached to is selected -->  
 <SelectedCondition>  
 </conditions>  
 <href xlink:href="http://myserver.com/myModel.dae" />  
</Model>

# ECMAScript Bindings (normative)

|  |  |
| --- | --- |
| **Requirements Class** | |
| [http://www.opengis.net/spec/arml/2.0/req/scripting](http://www.opengis.net/spec/arml2x0/req/scripting) | |
| **Target Type** | Software Implementation |

The following section describes the scripting part of ARML 2.0. Throughout this section, an WebIDL translation of the object model is introduced to define ECMAScript bindings and a JSON serialization of the ARML 2.0 object model.

ARML provides ECMAScript (the standardized version of JavaScript) bindings to allow the dynamic access and modification of objects in the AR scene, as well as event handlers to react on user input. In addition to the XML serialization, each class defined in ARML also has a JSON serialization, which is used to access and modify the properties of the objects in the scene.

Implementations are encouraged to support ARML's ECMAScript bindings to allow the developer dynamic access to the scene. However, if ECMAScript bindings cannot be provided for whatever reason, the implementation must clearly state that only the descriptive ARML specification is supported.

## Accessing ARElements and Modifying the Scene

Implementations must ensure that an arml object is injected into the ECMAScript runtime context on startup. This object is the root node for any scripting operations on the AR scene and serves as the namespace for the objects defined in ARML 2.0.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/general/arml\_injection](http://www.opengis.net/spec/arml2x0/req/scripting/general/arml_injection) |
| On startup, the *arml* object shall be injected into the ECMAScript runtime. |

In addition to serving as the namespace, arml has the following properties and methods:

module arml {  
 readonly attribute ARElement[] arElements;

ARElement getARElementById(String id);  
 void addToScene(ARElement element);  
 void removeFromScene(ARElement element);

void addEventListener(String type, EventListener listener);  
 void removeEventListener(String type, EventListener listener);  
  
 ... all interface objects from below   
}

getARElementById(String id)  
returns the object having its id property set to the passed String. In case no such object exists, or id is empty, the call returns null.

addToScene(ARElement element)  
adds the given element to the AR scene

removeFromScene(ARElement element)  
removes the given element from the AR scene

## Object Creation and Property Access

Each concrete subclass of ARElement has its own constructor. To make an object accessible in the scene, arml.addToScene(element) must be invoked first, only then is the element accessible via arml.getARElementById(element.id).

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/general/object\_access](http://www.opengis.net/spec/arml2x0/req/scripting/general/object_access) |
| After an *ARElement* was added to the scene (either through descriptive definition or by calling *arml.addToScene*), its ECMAScript representation is accessible through arml.getARElementById with the id of the ARElement as parameter. |

An implementation must ensure that properties set in the descriptive spec are always in sync with the matching properties in the scripting spec. For example, if the following feature is defined in the declarative spec:

<Feature id="empireStateBuilding">  
 <name>The Empire State Building</name>  
 <enabled>true</enabled>  
 <anchors>  
 ...  
 </anchors/>  
</Tracker>

Then the implementation shall ensure that the following object is accessible:

var empireState = arml.getARElementById("empireStateBuilding");

Furthermore, the implementation shall ensure that the object stored in *empireState* has its properties set to the following values:

empireState = {  
 "id" : "empireStateBuilding",  
 "name" : "The Empire State Building",  
 "enabled" : true,  
 anchors : [  
 ... //the array of Anchors defined for the Feature  
 ]  
}

The properties of empireState can now be accessed and modified using empireState.name etc.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/general/synchronization](http://www.opengis.net/spec/arml2x0/req/scripting/general/synchronization) |
| An implementation shall ensure that properties set in the descriptive spec are always in sync with the matching properties in the scripting spec. |

## Object and Constructor Definitions

The ECMAScript bindings of the objects specified in ARML follow some simple principles.

1. Only concrete classes of ARML can be constructed in a valid way.
2. Constructor parameters consist of all mandatory attributes of the class, plus an optional dictionary (key/value JSON object) parameter allowing the population of all optional parameters.
3. Read-only parameters can only be populated at construction time of the object and must not be altered later.

Any misuse of constructors, methods or properties (e.g. wrong number of parameters or illegal values) provided must result in an Exception.

|  |
| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/general/misuse](http://www.opengis.net/spec/arml2x0/req/scripting/general/misuse) |
| Any misuse of constructors, methods and properties shall result in an Exception |

**Remark:** All objects defined below are accessible through the *arml* namespace and, in WebIDL terms, belong to the *arml* module. For example, a new Feature can be created with *new arml.Feature()*;

interface ARElement {  
 readonly attribute string id;  
};

dictionary ARElementDict {  
 string id;  
};

### Feature

[Constructor(optional FeatureDict initDict)]   
interface Feature : ARElement {  
 attribute string name;  
 attribute string description;  
 attribute boolean enabled;  
 attribute object metadata;  
 attribute Anchor[] anchors;  
};

dictionary FeatureDict : ARElementDict {  
 string name;  
 string description;  
 boolean enabled;  
 object metadata;  
 Anchor[] anchors;  
};

### Anchor

interface Anchor : ARElement {  
 attribute boolean enabled;  
};

dictionary AnchorDict : ARElementDict {  
 boolean enabled;  
};

### ARAnchor

interface ARAnchor : Anchor {  
 attribute VisualAsset[] assets;

void addEventListener(string type, EventListener listener);  
 void removeEventListener(string type, EventListener listener);  
};

dictionary ARAnchorDict : AnchorDict {  
 VisualAsset[] assets;  
};

### ScreenAnchor

[Constructor(Label[] assets, optional ScreenAnchorDict initDict)]   
interface ScreenAnchor : Anchor {  
 attribute string class;  
 attribute ScreenAnchorStyleDict style;  
 attribute Label[] assets;  
};

dictionary ScreenAnchorDict : AnchorDict {  
 string class;  
 ScreenAnchorStyleDict style;  
};

dictionary ScreenAnchorStyleDict {  
 string top;  
 string bottom;  
 string left;  
 string right;  
 string width;  
 string height;  
};

### Geometry

interface Geometry : ARAnchor {  
 readonly attribute GMLGeometry gmlGeometry;  
};

dictionary GeometryDict : ARAnchorDict {   
 GMLGeometry gmlGeometry;  
};

### GMLGeometry

interface GMLGeometry {  
 readonly attribute string id;  
};

### Point

[Constructor(string id, double[] pos, optional PointDict initDict)]  
interface Point : GMLGeometry {  
 attribute double[] pos;  
 readonly attribute string srsName;  
 readonly attribute string srsDimension;  
};

dictionary PointDict {   
 string srsName;  
 string srsDimension;  
};

### LineString

[Constructor(string id, Point[] posList)]  
interface LineString : GMLGeometry {  
 readonly attribute string id;  
 attribute Point[] posList;  
};

**Remark:** The descriptive specification allows setting the srsName and srsDimension for the entire LineString, as well as single Points separately. The scripting specification only supports setting the srsName for each single Point. In case the srsName and srsDimension should be set for the entire LineString, the implementation needs to make sure it runs through the entire list of Points and sets the srsName and srsDimension accordingly.

### Polygon

[Constructor(string id, LineString exterior, optional PolygonDict initDict)]  
interface Polygon : GMLGeometry {  
 readonly attribute string id;  
 attribute LineString[] interior;  
 attribute LineString exterior;  
};

dictionary PolygonDict {   
 LineString[] interior;  
};

**Remark 1:** As LinearRings are closed LineStrings from a technical perspective, ARML's ECMAScript bindings avoid an additional LinearRing type and use LineString instead.

**Remark 2:** The descriptive specification allows setting the srsName and srsDimension for the entire Polygon, as well as single LinearRings and Points separately. The scripting specification only supports setting the srsName for each single Point. In case the srsName and srsDimension should be set for the entire Polygon or LinearRing, the implementation needs to make sure it runs through the entire list of Points and sets the srsName and srsDimension accordingly.

### RelativeTo

[Constructor(object ref, GMLGeometry gmlGeometry)]   
interface RelativeTo : ARAnchor {  
 readonly attribute object ref;   
 attribute GMLGeometry gmlGeometry;  
};

ref can either be an object or a String with its value set to "#user", thus the type has to be a general object.

### Tracker

[Constructor(string uri, optional TrackerDict initDict)]   
interface Tracker : ARElement {  
 readonly attribute string uri;  
 attribute string src;  
};

dictionary TrackerDict : ARElementDict {   
 string src;  
};

### Trackable

[Constructor(TrackableConfig[] configs, optional TrackableDict initDict)]  
interface Trackable : ARAnchor {  
 readonly attribute TrackableConfig[] configs;  
 attribute double size;

void addEventListener(string type, EventListener listener);  
 void removeEventListener(string type, EventListener listener);  
};

dictionary TrackableDict : ARAnchorDict {  
 double size;  
};

[Constructor(Tracker tracker, string src, optional int order)]  
interface TrackableConfig {  
 readonly attribute Tracker tracker;  
 readonly attribute string src;  
 readonly attribute int order;  
};

### VisualAsset

interface VisualAsset : ARElement {  
 attribute boolean enabled;  
 attribute int zOrder;  
 attribute Condition[] conditions;  
 attribute Orientation orientation  
 attribute ScalingMode scalingMode;

void addEventListener(string type, EventListener listener);  
 void removeEventListener(string type, EventListener listener);  
};

dictionary VisualAssetDict : ARElementDict {  
 boolean enabled;  
 int zOrder;  
 Condition[] conditions;  
 Orientation orientation;  
 ScalingMode ScalingMode;  
};

### Orientation

[Constructor(OrientationDict initDict)]  
interface Orientation {  
 attribute double roll;  
 attribute double tilt;  
 attribute double heading;  
}

dictionary OrientationDict {  
 double roll;  
 double tilt;  
 double heading;  
};

### ScalingMode

[Constructor(string type, optional ScalingModeDict initDict)]  
interface ScalingMode {  
 readonly attribute string type;  
 attribute double minScalingDistance;  
 attribute double maxScalingDistance;  
 attribute double scalingFactor;  
};

dictionary ScalingModeDict {  
 double minScalingDistance;  
 double maxScalingDistance;   
 double scalingFactor;  
};

### VisualAsset2D

interface VisualAsset2D : VisualAsset {  
 attribute string width;  
 attribute string height;  
 attribute string orientationMode;  
 attribute string backside;  
};

dictionary VisualAsset2DDict : VisualAssetDict {  
 string width;  
 string height;  
 string orientationMode;  
 string backside;  
};

### Label

ARML’s *arml* root object is injected into each Label before it is constructed. From the *arml* object a Label can access any object in the scene.

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| --- |
| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/core/Label/injection](http://www.opengis.net/spec/arml2x0/scripting/core/Label/injection) |
| In case ARML 2.0’s ECMAScript bindings are supported, ARML’s *arml* root object shall be injected into each Label before it is constructed |

[Constructor(LabelDict initDict)]  
interface Label : VisualAsset2D {  
 attribute string href;  
 attribute string src;  
 attribute string hyperlinkBehavior;  
 attribute int viewportWidth;  
};

dictionary LabelDict : VisualAsset2DDict {  
 string href;  
 string src;  
 string hyperlinkBehavior;  
 int viewportWidth;   
};

### Fill

[Constructor(FillDict initDict)]  
interface Fill : VisualAsset2D {  
 attribute FillStyleDict style;  
 attribute string class;  
};

dictionary FillDict : VisualAsset2DDict {  
 FillStyleDict style;  
 string class;  
};

dictionary FillStyleDict {  
 string color;  
};

### Text

[Constructor(string src, TextDict initDict)]  
interface Text : VisualAsset2D {  
 attribute string src;  
 attribute TextStyleDict style;  
 attribute string class;  
};

dictionary TextDict : VisualAsset2DDict {  
 TextStyleDict style;  
 string class;   
};

dictionary TextStyleDict {  
 string fontColor;  
 string backgroundColor;  
};

### Image

[Constructor(string href)]  
interface Image : VisualAsset2D {  
 attribute string href;  
};

### Model

[Constructor(string href, ModelDict initDict)]  
interface Model : VisualAsset {  
 attribute string href;  
 attribute string type;  
 attribute Scale scale;

string start3DAnimation(string id, int loopCount, EventListener callback);  
 void stop3DAnimation(string animationId);  
 void pause3DAnimation(string animationId);  
 void resume3DAnimation(string animationId);  
};

dictionary ModelDict : VisualAssetDict {  
 string href;  
 string type;  
 Scale scale;   
};

***start3DAnimation*** starts an animation that was declared in the Model's file.  
**Parameters:**  
id: The animation to start is referenced by an id with which the animation can be identified in the Model file. In case the animations in the Model file are not referenceable with IDs, the position of the Animation in the file (starting with 1) can be used as a reference. In case no such animation exists, an Exception must be thrown.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Model/animationId](http://www.opengis.net/spec/arml2x0/req/scripting/Model/animationId) |
| In case the animationId cannot be resolved, an Exception shall be thrown. |

loopCount: An optional parameter specifying how often the animation should loop. If *loopCount* is set to -1, the animation will loop infinitively often. If not set, the value defaults to 1.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Model/animationLoopCount](http://www.opengis.net/spec/arml2x0/req/scripting/Model/animationLoopCount) |
| If loopCount is not set, it defaults to 1. If it is set to -1, the animation will loop infinitely often. |

callback: An optional callback function can be supplied which will be executed right after the animation finished with all the loops provided. The callback will not be executed when the animation was manually stopped (see stop3DAnimation). For more details on EventListeners, see Event Handling.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Model/animationCallback](http://www.opengis.net/spec/arml2x0/req/scripting/Model/animationCallback) |
| If set, the callback will be triggered when the animation finished playing all the defined loops. It shall not be triggered when the animation was stopped manually. |

**Returns:**  
a string identifying the 3DAnimation. This String can be used to stop the Animation.

**stop3DAnimation** stops an animation before it regularly finishes.   
**Parameters:**  
animationId: The id returned when the animation was started  
**Returns:**void

**pause3DAnimation** pauses a currently running animation. Has no effect if the Animation is not running.   
**Parameters:**  
animationId: The id returned when the animation was started  
**Returns:**void

**resume3DAnimation** resumes a currently paused animation. Has no effect if the Animation is not paused.   
**Parameters:**  
animationId: The id returned when the animation was started  
**Returns:**void

### Scale

[Constructor(ScaleDict initDict)]  
interface Scale {  
 attribute double x;  
 attribute double y;  
 attribute double z;  
};

dictionary ScaleDict {  
 double x;  
 double y;  
 double z;   
};

### DistanceCondition

[Constructor(DistanceConditionDict initDict)]  
interface DistanceCondition : ARElement {  
 attribute double max;  
 attribute double min;  
};

dictionary DistanceConditionDict : ARElementDict {  
 double max;  
 double min;   
};

### SelectedCondition

[Constructor(boolean selected, SelectedConditionDict initDict)]  
interface SelectedCondition : ARElement {  
 attribute string listener;  
 attribute boolean selected;  
};

dictionary SelectedConditionDict : ARElementDict {  
 string listener;  
 boolean selected;   
};

### Animation

interface Animation {  
 void addEventListener(string type, EventListener listener);  
 void removeEventListener(string type, EventListener listener);

void start(int loopCount, int delay);  
 void stop();  
 boolean isRunning();  
};

Animations cannot be defined in the declarative part of ARML; they can only be declared and controlled in the scripting part. Animations constantly modify the value of a property over a certain time period.  
2 different types of Animations are supported in the ECMAScript bindings of ARML: NumberAnimations and GroupAnimations. They all inherit from Animation.

**start** starts an animation.  
**Parameters:**  
loopCount: An optional parameter specifying how often the animation should loop. If *loopCount* is set to -1, the animation will loop infinitively often. If not set, the value defaults to 1.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/loopCount](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/loopCount) |
| If loopCount is not set, it defaults to 1. If it is set to -1, the animation will loop infinitely often. |

delay: The number of milliseconds the start of the animation will be delayed. If not set, the value defaults to 0 (immediate start).

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/delay](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/loopCount) |
| If delay is not set, it defaults to 0, causing the animation to start immediately. |

**Returns:**  
void

**stop** stops an animation before it regularly finished.  
**Parameters:**  
-  
**Returns:**  
void

**isRunning** returns if an animation is currently running.  
**Parameters:**  
-  
**Returns:**  
true if the Animation is currently running, false otherwise.

### NumberAnimation

[Constructor(ARElement target, string property, float start, float end, float duration)]  
interface NumberAnimation : Animation {  
 readonly attribute ARElement target;  
 readonly attribute string property;  
 readonly attribute float start;  
 readonly attribute float end;  
 readonly attribute int duration;  
};

NumberAnimations constantly modify a numeric value over a certain period of time from a given start value to a specified end value. Between start and end, the value is linearly interpolated.

**Properties**:  
target specifies the ARElement that holds the property that will be animated. Must not be null.  
property holds the name of the property that will be animated. The property must hold a numeric value.  
start holds the start value of the Animation. If null, the current value of the property is used as start value.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/Number/start](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/loopCount) |
| If no explicit *start* value is set, the animation’s start value is equal to the property’s current value. |

end holds the end value of the Animation. The property will take on this value after the Animation completed.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/Number/end](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/loopCount) |
| After the Animation completed successfully, the animated property takes on the value as specified in the *end* property. |

duration, supplied in milliseconds, specifies the duration of one loop of the Animation.

### GroupAnimation

[Constructor(string type, Animation[] animations)]

interface GroupAniimation : Animation {  
 readonly attribute string type;  
 readonly attribute Animation[] animations;  
};

A GroupAnimation groups multiple Animations and runs them depending on the type of the GroupAnimation. Type can either be parallel, causing all Animations in the GroupAnimation to start at the same time, or sequential, causing the Animations to run one after another.

**Properties**:  
type specifies the type of the GroupAnimation, either parallel or sequential.  
animations holds the array of Animations contained in the GroupAnimation.

A parallel GroupAnimation loop has finished when the longest Animation in the group has finished. A sequential GroupAnimation loop has finished when the last Animation in the group has finished.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/Group/endDefinition](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/Group/endDefinition) |
| A parallel GroupAnimation loop has finished when the longest Animation in the group has finished. A sequential GroupAnimation loop has finished when the last Animation in the group has finished. |

### Event Handling

Event handling in ARML is based on concepts of event handling in HTML; see [http://www.w3.org/TR/2000/REC-DOM-Level-2-Events-20001113/events.html](http://www.w3.org/TR/2000/REC-DOM-Level-2-Events-20001113/events.html" \t "_top) for details.

Developers can react on certain events by registering EventListeners listening on the occurrence of a certain Event type on specific event targets.

The following ARML classes serve as event targets, with their corresponding Events.

| [**EventTarget**](https://portal.opengeospatial.org/wiki/ARML2x0swg/SpecEcmascript?cover=print;sortcol=0;table=1;up=0#sorted_table) | [**Event Type**](https://portal.opengeospatial.org/wiki/ARML2x0swg/SpecEcmascript?cover=print;sortcol=1;table=1;up=0#sorted_table) | [**Description**](https://portal.opengeospatial.org/wiki/ARML2x0swg/SpecEcmascript?cover=print;sortcol=2;table=1;up=0#sorted_table) |
| --- | --- | --- |
| arml | locationChanged | Fires when the implementation receives a new geospatial location representing the user's current position |
| VisualAsset | enterFieldOfVision | Fires when at least one pixel of the VisualAsset becomes visible on the screen |
|  | exitFieldOfVision | Fires when the last pixel of the VisualAsset moves out of the screen |
|  | click | Fires when the VisualAsset was clicked |
| ARAnchor | enterFieldOfVision | Fires when at least a part of the area the ARAnchor covers becomes visible on the screen |
|  | exitFieldOfVision | Fires when the ARAnchor becomes invisible on the screen |
| Trackable | tracked | Fires when the Trackable was detected in the scene |
|  | trackingLost | Fires when the Trackable cannot be tracked anymore |
| Animation | start | Fires just before the animation starts |
|  | finish | Fires just after the animation finished |

Event Listeners are registered in the event targets using

eventTarget.addEventListener(string type, EventListener listener);

Event Listeners are removed using

eventTarget.removeEventListener(string type, EventListener listener);

#### EventListener

interface EventListener {  
 void handleEvent(Event event);  
};

handleEvent is called whenever an event occurs of the type for which the EventListener interface was registered. The event parameter holds the Event object containing contextual information about the event.

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| **Requirement** |
| [http://www.opengis.net/spec/arml/2.0/req/scripting/EventHandling/firing](http://www.opengis.net/spec/arml2x0/req/scripting/EventHandling/firing) |
| An EventHandler is triggered when an event occurs of the type for which the EventListener interface was registered. |

#### Event

interface Event {  
 readonly attribute EventTarget target;  
};

target is used to indicate the Event Target to which the event was originally dispatched.

**Example:**

var clickFunction = function(event){  
 var t = event.eventTarget.src;  
 //do something  
};

var text = new arml.Text("This is my text");  
text.addEventListener("click", clickFunction);

# Annex A: Conformance Classes

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| A.1: Conformance Test Class Encoding | |
| [http://www.opengis.net/spec/arml/2.0/conf/model](http://www.opengis.net/spec/arml2x0/conf/model) | |
| **Target Type** | Encoding |
| Tests described in this section shall be used to test conformance of an XML encoding with the ARML 2.0 XML serialization. | |

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| **A.1.1 Encoding can be validated against XSD** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/general/xsd\_verification](http://www.opengis.net/spec/arml2x0/conf/model/general/xsd_verification) | |
| **Title** | Encoding can be validated against XSD |
| **Abbreviation** | xsd\_verification |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/general/xsd\_verification](http://www.opengis.net/spec/arml2x0/req/model/general/xsd_verification) |
| **Test Purpose** | To validate whether a given XML encoding complies with the ARML XSD definition. |
| **Test Method** | Validate the XML encoding against the XSD and verify that the validation is successful. |

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| **A.1.2 Encoding has correct root element** | |
| [http://www.opengis.net/spec/arml/2.0/conf/general/root\_element](http://www.opengis.net/spec/arml2x0/req/conf/general/root_element) | |
| **Title** | Encoding has correct root element |
| **Abbreviation** | root\_element |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/general/root\_element](http://www.opengis.net/spec/arml2x0/req/model/general/root_element) |
| **Test Purpose** | To validate that a given XML encoding has the correct root element set |
| **Test Method** | Inspect the encoding and check that the root element is arml. |

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| **A.1.3 Only Subclasses of ARElement allowed in ARElements** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/ARElement/container](http://www.opengis.net/spec/arml2x0/conf/model/ARElement/container) | |
| **Title** | Only Subclasses of ARElement allowed in ARElements |
| **Abbreviation** | ARElement/container |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/ARElement/container](http://www.opengis.net/spec/arml2x0/req/model/ARElement/container) |
| **Test Purpose** | To validate that a given XML encoding complies with the inheritance structure defined in the ARML 2.0 object model. |
| **Test Method** | Inspect the encoding and check that only subclasses of ARElement are immediate children in the <ARElements> tag. |

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| **A.1.4 ARElement not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/ARElement/interface](http://www.opengis.net/spec/arml2x0/conf/model/ARElement/interface) | |
| **Title** | ARElement not allowed in encoding |
| **Abbreviation** | ARElement/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/ARElement/interface](http://www.opengis.net/spec/arml2x0/req/model/ARElement/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract ARElement element. |
| **Test Method** | Inspect the encoding and check that ARElement is never used in the encoding. |

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| **A.1.5 IDs are unique** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/ARElement/id](http://www.opengis.net/spec/arml2x0/conf/model/ARElement/id) | |
| **Title** | IDs are unique |
| **Abbreviation** | ARElement/id |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/ARElement/id](http://www.opengis.net/spec/arml2x0/req/model/ARElement/id) |
| **Test Purpose** | To validate that each element with an ID can be uniquely referenced |
| **Test Method** | Inspect the encoding and check that ids of ARElements are unique. |

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| **A.1.6 Invalid Anchor references** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/Feature/anchors/relative](http://www.opengis.net/spec/arml2x0/conf/model/Feature/anchors/relative) | |
| **Title** | Invalid Anchor references |
| **Abbreviation** | Feature/anchors/relative |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/Feature/anchors/relative](http://www.opengis.net/spec/arml2x0/req/model/Feature/anchors/relative) |
| **Test Purpose** | To avoid having invalid Anchor references in the XML encoding |
| **Test Method** | Inspect the encoding and check that Anchors attached to Features by reference are referenced correctly using the xlink:href attribute. |

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| **A.1.7 Anchor not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/Anchor/interface](http://www.opengis.net/spec/arml2x0/conf/model/Anchor/interface) | |
| **Title** | Anchor not allowed in encoding |
| **Abbreviation** | Anchor/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/Anchor/interface](http://www.opengis.net/spec/arml2x0/req/model/Anchor/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract Anchor element. |
| **Test Method** | Inspect the encoding and check that Anchor is never used in the encoding. |

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| **A.1.8 ARAnchor not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/ARAnchor/interface](http://www.opengis.net/spec/arml2x0/conf/model/ARAnchor/interface) | |
| **Title** | ARAnchor not allowed in encoding |
| **Abbreviation** | ARAnchor/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/ARAnchor/interface](http://www.opengis.net/spec/arml2x0/req/model/ARAnchor/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract Anchor element. |
| **Test Method** | Inspect the encoding and check that ARAnchor is never used in the encoding. |

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| **A.1.9 Invalid VisualAsset references** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/ARAnchor/anchors/relative](http://www.opengis.net/spec/arml2x0/conf/model/ARAnchor/anchors/relative) | |
| **Title** | Invalid VisualAsset references |
| **Abbreviation** | ARAnchor/anchors/relative |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/ARAnchor/anchors/relative](http://www.opengis.net/spec/arml2x0/req/model/ARAnchor/anchors/relative) |
| **Test Purpose** | To avoid having invalid VisualAsset references in the XML encoding |
| **Test Method** | Inspect the encoding and check that VisualAssets attached to Anchors by reference are referenced correctly using the xlink:href attribute. |

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| **A.1.10 GMLGeometries not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/GMLGeometries/interface](http://www.opengis.net/spec/arml2x0/conf/model/GMLGeometries/interface) | |
| **Title** | GMLGeometries not allowed in encoding |
| **Abbreviation** | GMLGeometries/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/GMLGeometries/interface](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract GMLGeometries element. |
| **Test Method** | Inspect the encoding and check that GMLGeometries is never used in the encoding. |

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| **A.1.11 GML Point validation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/Point/xsd](http://www.opengis.net/spec/arml2x0/conf/model/Point/xsd) | |
| **Title** | GML Point validation |
| **Abbreviation** | Point/xsd |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/Point/xsd](http://www.opengis.net/spec/arml2x0/req/model/Point/xsd) |
| **Test Purpose** | To validate that a Point defined in an XML encoding also validates according to the GML Point specification. |
| **Test Method** | Inspect the encoding and check that all Point elements validate correctly against the Point Type defined in the XSD in the [GML Specification]. |

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| **A.1.12 GML LineString validation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/LineString/xsd](http://www.opengis.net/spec/arml2x0/conf/model/LineString/xsd) | |
| **Title** | GML LineString validation |
| **Abbreviation** | LineString/xsd |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/LineString/xsd](http://www.opengis.net/spec/arml2x0/req/model/LineString/xsd) |
| **Test Purpose** | To validate that a LineString defined in an XML encoding also validates according to the GML LineString specification. |
| **Test Method** | Inspect the encoding and check that all LineString elements validate correctly against the LineString Type defined in the XSD in the [GML Specification]. |

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| **A.1.13 GML Polygon validation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/Polygon/xsd](http://www.opengis.net/spec/arml2x0/conf/model/Polygon/xsd) | |
| **Title** | GML Polygon validation |
| **Abbreviation** | Polygon/xsd |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/Polygon/xsd](http://www.opengis.net/spec/arml2x0/req/model/Polygon/xsd) |
| **Test Purpose** | To validate that a Polygon defined in an XML encoding also validates according to the GML Polygon specification. |
| **Test Method** | Inspect the encoding and check that all Polygon elements validate correctly against the Polygon Type defined in the XSD in the [GML Specification]. |

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| **A.1.14 GML LinearRing order** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/GMLGeometries/LinearRing/order](http://www.opengis.net/spec/arml2x0/conf/model/GMLGeometries/LinearRing/order) | |
| **Title** | GML LinearRing order |
| **Abbreviation** | GMLGeometries/LinearRing/order |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/GMLGeometries/LinearRing/order](http://www.opengis.net/spec/arml2x0/req/model/GMLGeometries/LinearRing/order) |
| **Test Purpose** | To validate that a LinearRing is has a well-defined up- and down-side. |
| **Test Method** | Inspect the encoding and check that a LinearRing’s coordinates are specified in counter-clockwise order. |

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| **A.1.15 Valid RelativeTo references** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/RelativeTo/ref](http://www.opengis.net/spec/arml2x0/conf/model/RelativeTo/ref) | |
| **Title** | Valid RelativeTo references |
| **Abbreviation** | RelativeTo/ref |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/RelativeTo/ref](http://www.opengis.net/spec/arml2x0/req/model/RelativeTo/ref) |
| **Test Purpose** | To validate that a RelativeTo element uses only valid elements as reference. |
| **Test Method** | Inspect the encoding and check that any RelativeTo element has its ref property set to either   * reference an ARAnchor (except a LineString) by using a URI * reference a Model by using a URI * #user |

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| **A.1.16 VisualAsset not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/VisualAsset/interface](http://www.opengis.net/spec/arml2x0/conf/model/VisualAsset/interface) | |
| **Title** | VisualAsset not allowed in encoding |
| **Abbreviation** | VisualAsset/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/VisualAsset/interface](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract VisualAsset element. |
| **Test Method** | Inspect the encoding and check that VisualAsset is never used in the encoding. |

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| **A.1.17 VisualAsset2D not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/VisualAsset2D/interface](http://www.opengis.net/spec/arml2x0/conf/model/VisualAsset2D/interface) | |
| **Title** | VisualAsset2D not allowed in encoding |
| **Abbreviation** | VisualAsset2D/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/VisualAsset2D/interface](http://www.opengis.net/spec/arml2x0/req/model/VisualAsset2D/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract VisualAsset2D element. |
| **Test Method** | Inspect the encoding and check that VisualAsset2D is never used in the encoding. |

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| **A.1.18 Condition not allowed in encoding** | |
| [http://www.opengis.net/spec/arml/2.0/conf/model/Condition/interface](http://www.opengis.net/spec/arml2x0/conf/model/Condition/interface) | |
| **Title** | Condition not allowed in encoding |
| **Abbreviation** | Condition/interface |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/model/Condition/interface](http://www.opengis.net/spec/arml2x0/req/model/Condition/interface) |
| **Test Purpose** | To validate that a given XML encoding does not use the abstract Condition element. |
| **Test Method** | Inspect the encoding and check that Condition is never used in the encoding. |

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| A.2: Conformance Test Class Descriptive Implementation | |
| [http://www.opengis.net/spec/arml/2.0/conf/core](http://www.opengis.net/spec/arml2x0/conf/core) | |
| **Target Type** | Implementation |
| Tests described in this section shall be used to test conformance of an Implementation capable of handling ARML 2.0 files with only descriptive content. | |

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| **A.2.1 Parse ARML files** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/parse\_encoding](http://www.opengis.net/spec/arml2x0/conf/core/parse_encoding) | |
| **Title** | Parse ARML files |
| **Abbreviation** | parse\_encoding |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/parse\_encoding](http://www.opengis.net/spec/arml2x0/req/core/parse_encoding) |
| **Test Purpose** | To validate that an implementation can parse valid ARML 2.0 files |
| **Test Method** | Verify that the implementation can parse valid ARML 2.0 encodings that pass all tests in [http://www.opengis.net/spec/arml/2.0/conf/model](http://www.opengis.net/spec/arml2x0/conf/model). |

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| **A.2.2 Default Unit** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/units](http://www.opengis.net/spec/arml2x0/conf/core/units) | |
| **Title** | Default Unit |
| **Abbreviation** | units |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/units](http://www.opengis.net/spec/arml2x0/req/core/units) |
| **Test Purpose** | To validate that an implementation’s interpretation of sizes is in line with the specification’s definition of sizes. |
| **Test Method** | Verify that any VisualAsset2D object with width set to 1 appears the same size on the screen as a real world object of 1-meter width. |

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| **A.2.3 Invalid user ID** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ARElement/id\_user](http://www.opengis.net/spec/arml2x0/conf/core/ARElement/id_user) | |
| **Title** | Invalid user ID |
| **Abbreviation** | ARElement/id\_user |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ARElement/id\_user](http://www.opengis.net/spec/arml2x0/req/core/ARElement/id_user) |
| **Test Purpose** | To validate that an implementation does not allow ARElements with id *user*. |
| **Test Method** | Verify that the implementation ignores ARElement ids that are set to *user*. |

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| **A.2.4 Disabling Features** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Feature/enabled](http://www.opengis.net/spec/arml2x0/conf/core/Feature/enabled) | |
| **Title** | Disabling Features |
| **Abbreviation** | Feature/enabled |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Feature/enabled](http://www.opengis.net/spec/arml2x0/req/core/Feature/enabled) |
| **Test Purpose** | To validate that an implementation ignores a Feature and its associated objects when the Feature is disabled in the encoding. |
| **Test Method** | Verify that the implementation ignores any Feature and its associated Anchors and VisualAssets when its enabled property is set to false. |

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| **A.2.5 Disabling Anchors** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Anchor/enabled](http://www.opengis.net/spec/arml2x0/conf/core/Anchor/enabled) | |
| **Title** | Disabling Anchors |
| **Abbreviation** | Anchor/enabled |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Anchor/enabled](http://www.opengis.net/spec/arml2x0/req/core/Anchor/enabled) |
| **Test Purpose** | To validate that an implementation ignores an Anchor and its associated objects when the Anchor is disabled in the encoding. |
| **Test Method** | Verify that the implementation ignores any Anchor and its associated VisualAssets when its enabled property is set to false. |

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| **A.2.6 Anchors without Features** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Anchor/anchor\_without\_feature](http://www.opengis.net/spec/arml2x0/conf/core/Anchor/enabled) | |
| **Title** | Anchors without Features |
| **Abbreviation** | Anchor/anchor\_without\_feature |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Anchor/anchor\_without\_feature](http://www.opengis.net/spec/arml2x0/req/core/Anchor/enabled) |
| **Test Purpose** | To validate that an implementation will handle Anchors even when they are not attached to a Feature. |
| **Test Method** | Verify that the implementation adds Anchors to the composed scene even when they are direct descendants of the ARElements tag. |

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| **A.2.7 ARAnchors without Visual Assets** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ARAnchor/no\_visual\_asset](http://www.opengis.net/spec/arml2x0/conf/core/ARAnchor/no_visual_asset) | |
| **Title** | ARAnchors without Visual Assets |
| **Abbreviation** | ARAnchor/no\_visual\_asset |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ARAnchor/no\_visual\_asset](http://www.opengis.net/spec/arml2x0/req/core/ARAnchor/no_visual_asset%20) |
| **Test Purpose** | To validate that an implementation handles setting default VisualAssets to Anchors without a specific VisualAsset correctly. |
| **Test Method** | Verify that, when no valid VisualAsset is attached to an ARAnchor, the implementation   * adds an auto-generated VisualAsset of type Text to the ARAnchor, with its text set to the name of the Feature. * Adds no VisualAsset in case the Anchor is not linked to a Feature, or the Feature’s name property is empty. |

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| **A.2.8 No user position** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Geometry/no\_position](http://www.opengis.net/spec/arml2x0/conf/core/Geometry/no_position) | |
| **Title** | No user position |
| **Abbreviation** | Geometry/no\_position |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Geometry/no\_position](http://www.opengis.net/spec/arml2x0/req/core/Geometry/no_position) |
| **Test Purpose** | To validate that the implementation does not fail when the user’s current position cannot be determined. |
| **Test Method** | Verify that the implementation ignores any Geometry anchor in case the user’s current position cannot be determined. |

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| **A.2.9 Unknown CRS** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/crs](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/crs) | |
| **Title** | Unknown CRS |
| **Abbreviation** | GMLGeometries/crs |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/crs](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/crs) |
| **Test Purpose** | To validate that the implementation supports the default coordinate reference system (CRS), and does not fail when a CRS is unknown. |
| **Test Method** | Verify that the implementation supports at least the WGS84 coordinate reference system (CRS), and verify that the Implementation ignores any Geometry anchor with an unknown alternative CRS. |

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| **A.2.10 Default CRS** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/default\_crs](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/default_crs) | |
| **Title** | Default CRS |
| **Abbreviation** | GMLGeometries/default\_crs |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/default\_crs](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/default_crs) |
| **Test Purpose** | To validate that the implementation assumes the default CRS in case a CRS is not specifically set. |
| **Test Method** | Verify that the implementation uses WGS84 for any GMLGeometry that does not have the srsName attribute set. |

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| **A.2.11 Missing Altitude** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/no\_altitude](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/no_altitude) | |
| **Title** | Missing Altitude |
| **Abbreviation** | GMLGeometries/no\_altitude |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/no\_altitude](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/no_altitude) |
| **Test Purpose** | To validate that the implementation assumes a default altitude in case an altitude is not specifically set. |
| **Test Method** | Verify that the implementation sets the user’s current altitude for each GMLGeometry not specifying its own altitude value. |

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| **A.2.12 LineString definition** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/LineString/definition](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/LineString/definition) | |
| **Title** | LineString definition |
| **Abbreviation** | GMLGeometries/LineString/definition |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/ LineString/definition](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/%20LineString/definition) |
| **Test Purpose** | To validate that the implementation does not fail in case a LineString is not valid. |
| **Test Method** | Verify that the implementation ignores any LineString that does not consist of at least 2 coordinate tuples. |

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| **A.2.13 LinearRing definition** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/LinearRing/definition](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/LinearRing/definition) | |
| **Title** | LinearRing definition |
| **Abbreviation** | GMLGeometries/LinearRing/definition |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/ LinearRing/definition](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/%20LinearRing/definition) |
| **Test Purpose** | To validate that the implementation does not fail in case a LinearRing is not valid. |
| **Test Method** | Verify that the implementation ignores any LinearRing that does not consist of at least 4 coordinate tuples, or which starting point and end point do not match. |

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| **A.2.14 Polygon definition** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/Polygon/definition](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/Polygon/definition) | |
| **Title** | Polygon definition |
| **Abbreviation** | GMLGeometries/Polygon/definition |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/Polygon/definition](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/Polygon/definition) |
| **Test Purpose** | To validate that the implementation does not fail in case a Polygon is not valid. |
| **Test Method** | Verify that the implementation ignores any Polygon with an invalid exterior LinearRing, and any inner “hole” defined by an invalid interior LinearRing. |

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| **A.2.15 Local CS for GMLGeometries** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/local\_cs/cs\_type](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/local_cs/cs_type) | |
| **Title** | Local CS for GMLGeometries |
| **Abbreviation** | GMLGeometries/local\_cs/cs\_type |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/local\_cs/cs\_type](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/local_cs/cs_type) |
| **Test Purpose** | To validate that the implementation defines a correct local coordinate reference system for GMLGeometries. |
| **Test Method** | Verify that the Implementation defines a local Cartesian coordinate system of each GMLGeometry, except for LineString, which does not define a coordinate system at all. |

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| **A.2.16 Local CS for Points** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/local\_cs/cs\_type/Point](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/local_cs/cs_type/Point) | |
| **Title** | Local CS for Points |
| **Abbreviation** | GMLGeometries/local\_cs/cs\_type/Point |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/local\_cs/ cs\_type/Point](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/local_cs/%20cs_type/Point) |
| **Test Purpose** | To validate that the implementation defines a correct local coordinate reference system for a Point. |
| **Test Method** | Verify that the Implementation defines the local coordinate system of a Point according to paragraph 6.4.1.2.5 section Point. |

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| **A.2.17 Local CS for Polygons** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/GMLGeometries/local\_cs/cs\_type/Polygon](http://www.opengis.net/spec/arml2x0/conf/core/GMLGeometries/local_cs/cs_type/Point) | |
| **Title** | Local CS for Polygons |
| **Abbreviation** | GMLGeometries/local\_cs/cs\_type/Polygon |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/GMLGeometries/local\_cs/ cs\_type/Polygon](http://www.opengis.net/spec/arml2x0/req/core/GMLGeometries/local_cs/%20cs_type/Point) |
| **Test Purpose** | To validate that the implementation defines a correct local coordinate reference system for a Polygon. |
| **Test Method** | Verify that the Implementation defines the local coordinate system of a Polygon according to paragraph 6.4.1.2.5 section Polygon. |

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| **A.2.18 Unknown Trackers** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/unknown\_tracker](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/unknown_tracker) | |
| **Title** | Unknown Trackers |
| **Abbreviation** | Trackable\_And\_Tracker/unknown\_tracker |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ unknown\_tracker](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20unknown_tracker) |
| **Test Purpose** | To validate that the implementation does not fail in case a Tracker is unknown. |
| **Test Method** | Verify that the Implementation ignores any unknown Tracker and its associated Trackables. |

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| **A.2.19 Contained Trackable** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/contained\_trackable](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/contained_trackable) | |
| **Title** | Contained Trackable |
| **Abbreviation** | Trackable\_And\_Tracker/contained\_trackable |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ contained\_trackable](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20contained_trackable) |
| **Test Purpose** | To validate that the implementation can handle Trackables stored in containers. |
| **Test Method** | Verify that, when the src property of a Tracker is set, the Implementation considers the value as a link to a container that holds multiple Trackables. |

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| **A.2.20 Trackable 2D Size** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/trackable\_2D\_size](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/trackable_2D_size) | |
| **Title** | Trackable 2D Size |
| **Abbreviation** | Trackable\_And\_Tracker/Trackable\_2D\_size |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ trackable\_2D\_size](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20trackable_2D_size) |
| **Test Purpose** | To validate that an implementation’s interpretation of a size of a 2D Trackable is in line with the specification’s definition of sizes of 2D Trackables. |
| **Test Method** | Verify that the Implementation considers the size of the Trackable set in the encoding as the width of the tracked object in meters when the Trackable is a 2D object. |

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| **A.2.21 Trackable 3D Size** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/trackable\_3D\_size](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/trackable_3D_size) | |
| **Title** | Trackable 3D Size |
| **Abbreviation** | Trackable\_And\_Tracker/Trackable\_3D\_size |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ trackable\_3D\_size](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20trackable_3D_size) |
| **Test Purpose** | To validate that an implementation’s interpretation of a size of a 3D Trackable is in line with the specification’s definition of sizes of 3D Trackables. |
| **Test Method** | Verify that the Implementation considers the size of the Trackable set in the encoding as the size of one unit in the engineering coordinate system of the model, in meters, when the Trackable is a 3D object. |

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| **A.2.22 Precedence of Trackable Size** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/trackable\_size\_preset](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/trackable_size_preset) | |
| **Title** | Precedence of Trackable Size |
| **Abbreviation** | Trackable\_And\_Tracker/Trackable\_size\_preset |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ trackable\_size\_preset](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20trackable_size_preset) |
| **Test Purpose** | To validate that an implementation always considers the encoding’s size setting to be of higher precedence than the size setting in the binary for Trackables. |
| **Test Method** | Verify that the Implementation gives precedence to the size property in the encoding over any size information in the binary representation of a Trackable, in case both are set. |

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| **A.2.23 Missing Trackable Size** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/trackable\_missing\_size](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/trackable_missing_size) | |
| **Title** | Missing Trackable Size |
| **Abbreviation** | Trackable\_And\_Tracker/trackable\_missing\_size |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ trackable\_missing\_size](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20trackable_missing_size) |
| **Test Purpose** | To validate that the implementation does not fail in case it cannot determine the correct size of a Trackable. |
| **Test Method** | Verify that the Implementation ignores a Trackable that has no size information set (neither in the binary, not in the encoding). |

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| **A.2.24 Default order for TrackingConfig** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Trackable\_And\_Tracker/config\_order\_max](http://www.opengis.net/spec/arml2x0/conf/core/Trackable_And_Tracker/config_order_max) | |
| **Title** | Default order for TrackingConfig |
| **Abbreviation** | Trackable\_And\_Tracker/config\_order\_max |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Trackable\_And\_Tracker/ config\_order\_max](http://www.opengis.net/spec/arml2x0/req/core/Trackable_And_Tracker/%20config_order_max) |
| **Test Purpose** | To validate that the implementation sets the correct default value for a TrackingConfig order, in case it is not set. |
| **Test Method** | Verify that the Implementation sets the order property to the maximum integer value when it is not set for a particular TrackingConfig. |

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| **A.2.25 RelativeTo src dimension** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/RelativeTo/GMLGeometry\_properties](http://www.opengis.net/spec/arml2x0/conf/core/RelativeTo/GMLGeometry_properties) | |
| **Title** | RelativeTo src dimension |
| **Abbreviation** | RelativeTo/GMLGeometry\_properties |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/RelativeTo/ GMLGeometry\_properties](http://www.opengis.net/spec/arml2x0/req/core/RelativeTo/%20GMLGeometry_properties) |
| **Test Purpose** | To validate that the implementation sets the correct srsDimension property in the element referenced by a RelativeTo anchor. |
| **Test Method** | Verify that the Implementation ignores the srsDimension and srsName properties of a GMLGeometry, and sets srsDimension to 3, when the GMLGeometry is used within a RelativeTo anchor. |

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| **A.2.26 ScreenAnchor property conflicts** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ScreenAnchor/property\_conflicts](http://www.opengis.net/spec/arml2x0/conf/core/ScreenAnchor/property_conflicts) | |
| **Title** | ScreenAnchor property conflicts |
| **Abbreviation** | ScreenAnchor/property\_conflicts |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/property\_conflicts](http://www.opengis.net/spec/arml2x0/req/core/ScreenAnchor/property_conflicts) |
| **Test Purpose** | To validate that the implementation fulfills the precedence rules for ScreenAnchors |
| **Test Method** | Verify that the implementation adheres to the following precedence-rules when conflicting top/bottom/height or left/right/width values are supplied in ScreenAnchors:   * Top takes precedence over height, which takes precedence over bottom * Left takes precedence over width, which takes precedence over right |

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| **A.2.27 ScreenAnchor missing properties** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ScreenAnchor/missing\_properties](http://www.opengis.net/spec/arml2x0/conf/core/ScreenAnchor/missing_properties) | |
| **Title** | ScreenAnchor missing properties |
| **Abbreviation** | ScreenAnchor/missing\_properties |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/missing\_properties](http://www.opengis.net/spec/arml2x0/req/core/ScreenAnchor/missing_properties) |
| **Test Purpose** | To validate that the implementation sets the correct default values for ScreenAnchors |
| **Test Method** | Verify that the Implementation sets the following default values:   * top is set to 0 when neither top, nor bottom is given * left is set to 0 when neither left, nor right is given * width and height are set to 100% when not given |

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| **A.2.28 ScreenAnchor ignored properties** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ScreenAnchor/ignored\_properties](http://www.opengis.net/spec/arml2x0/conf/core/ScreenAnchor/ignored_properties) | |
| **Title** | ScreenAnchor ignored properties |
| **Abbreviation** | ScreenAnchor/ignored\_properties |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/ignored\_properties](http://www.opengis.net/spec/arml2x0/req/core/ScreenAnchor/ignored_properties) |
| **Test Purpose** | To validate that the implementation ignores properties in ScreenAnchors as defined in the specification. |
| **Test Method** | Verify that the Implementation ignores the following properties for an Asset when it is attached to a ScreenAnchor:   * width and height * Orientation * orientationMode * ScalingMode * Any DistanceConditions |

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| **A.2.29 ScreenAnchor default properties** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ScreenAnchor/default\_properties](http://www.opengis.net/spec/arml2x0/conf/core/ScreenAnchor/default_properties) | |
| **Title** | ScreenAnchor default properties |
| **Abbreviation** | ScreenAnchor/default\_properties |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ScreenAnchor/default\_properties](http://www.opengis.net/spec/arml2x0/req/core/ScreenAnchor/default_properties) |
| **Test Purpose** | To validate that a ScreenAnchor’s distance to the user is always 0. |
| **Test Method** | Verify that the Implementation sets the distance from the user to any ScreenAnchor to 0. |

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| **A.2.30 Disabling Visual Assets** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/VisualAsset/enabled](http://www.opengis.net/spec/arml2x0/conf/core/VisualAsset/enabled) | |
| **Title** | Disabling Visual Assets |
| **Abbreviation** | VisualAsset/enabled |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset/enabled](http://www.opengis.net/spec/arml2x0/req/core/VisualAsset/enabled) |
| **Test Purpose** | To validate that an implementation ignores a VisualAsset it is disabled in the encoding. |
| **Test Method** | Verify that the implementation ignores any VisualAsset when its enabled property is set to false. |

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| **A.2.31 VisualAsset projection order** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/VisualAsset/projection\_order](http://www.opengis.net/spec/arml2x0/conf/core/VisualAsset/projection_order) | |
| **Title** | VisualAsset projection order |
| **Abbreviation** | VisualAsset/projection\_order |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset/projection\_order](http://www.opengis.net/spec/arml2x0/req/core/VisualAsset/projection_order) |
| **Test Purpose** | To validate that an implementation occludes objects according to their distance, in a natural way. |
| **Test Method** | Verify that the implementation projects the VisualAssets onto the screen according to their distance, with Assets closer to the user occluding Assets further away. |

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| **A.2.32 VisualAsset2D width and height** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/VisualAsset2D/width\_and\_height](http://www.opengis.net/spec/arml2x0/conf/core/VisualAsset2D/width_and_height) | |
| **Title** | VisualAsset2D width and height |
| **Abbreviation** | VisualAsset2D/width\_and\_height |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset2D/width\_and\_height](http://www.opengis.net/spec/arml2x0/req/core/VisualAsset2D/width_and_height) |
| **Test Purpose** | To validate that an implementation adheres to the calculation rules of width and height for VisualAsset2Ds, as defined in the specification. |
| **Test Method** | Verify that the implementation calculates width and height respectively according to the following rules:   * If only one of width and height is set, the other value is calculated on the aspect ratio of the VisualAsset2D. * If only one of width and height is set for Fill, the missing value is always set to 100% * If neither width, nor height is set, width is set to 100% and height is calculated according to the aspect ratio of the VisualAsset2D |

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| **A.2.33 VisualAsset2D orientation mode** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/VisualAsset2D/orientationMode](http://www.opengis.net/spec/arml2x0/conf/core/VisualAsset2D/orientationMode) | |
| **Title** | VisualAsset2D orientation mode |
| **Abbreviation** | VisualAsset2D/orientationMode |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset2D/ orientationMode](http://www.opengis.net/spec/arml2x0/req/core/VisualAsset2D/width_and_height) |
| **Test Purpose** | To validate that an implementation adheres to the calculation rules of orientations for VisualAsset2Ds, as defined in the specification. |
| **Test Method** | Verify that the implementation calculates the orientation of a VisualAsset according to the following rules:   * If orientationMode is set to user, the VisualAsset2D is oriented towards the user * If orientationMode is set to absolute, VisualAsset2D is positioned according to the coordinate system specification of the VisualAsset and the Anchor * If orientationMode is set to auto, the orientationMode is implicitely set to absolute when the VisualAsset2D is attached to a Trackable or a RelativeTo Anchor referencing a Trackable, and is set to user otherwise. |

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| **A.2.34 VisualAsset2D backside** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/VisualAsset2D/backSide](http://www.opengis.net/spec/arml2x0/conf/core/VisualAsset2D/backSide) | |
| **Title** | VisualAsset2D backside |
| **Abbreviation** | VisualAsset2D/backside |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/VisualAsset2D/backSide](http://www.opengis.net/spec/arml2x0/req/core/VisualAsset2D/backSide) |
| **Test Purpose** | To validate that an implementation adheres to the definitions for the backSide of a VisualAsset2D, as defined in the specification. |
| **Test Method** | Verify that the Implementation draws the back side of a VisualAsset2D according to the following rules:   * If backside is set to a hex value, the backside is painted in that color * If backside is set to *mirrored*, the front side is mirrored onto the back side. * If backside is set to *copied*, the font side is copied onto the back side. |

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| **A.2.35 Label content precedence** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/href\_and\_src\_precedence](http://www.opengis.net/spec/arml2x0/conf/core/Label/href_and_src_precedence) | |
| **Title** | Label content precedence |
| **Abbreviation** | Label/href\_and\_scr\_precedence |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/href\_and\_src\_precedence](http://www.opengis.net/spec/arml2x0/req/core/Label/href_and_src_precedence) |
| **Test Purpose** | To validate that an implementation adheres to the precedence rules for the content of a Label. |
| **Test Method** | Verify that the implementation gives src precedence over href in case both properties are set. |

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| **A.2.36 Label content required** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/href\_and\_src\_required](http://www.opengis.net/spec/arml2x0/conf/core/Label/href_and_src_required) | |
| **Title** | Label content required |
| **Abbreviation** | Label/href\_and\_scr\_required |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/href\_and\_src\_required](http://www.opengis.net/spec/arml2x0/req/core/Label/href_and_src_required) |
| **Test Purpose** | To validate that the implementation does not fail in case a Label is invalid. |
| **Test Method** | Verify that the implementation ignores Labels that have both src and href unset. |

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| **A.2.37 Label hyperlink behavior** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/hyperlinkBehavior](http://www.opengis.net/spec/arml2x0/conf/core/Label/hyperlinkBehavior) | |
| **Title** | Label hyperlink behavior |
| **Abbreviation** | Label/hyperlinkBehavior |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/hyperlinkBehavior](http://www.opengis.net/spec/arml2x0/req/core/Label/hyperlinkBehavior) |
| **Test Purpose** | To validate that an implementation adheres to the click behavior rules of a Label, as defined in the specification. |
| **Test Method** | Verify that the implementation handles clicks on hyperlinks in Labels according to the following rules:   * If the Label’s hyperlinkBehavior is set to block, links are not followed. * If the Label’s hyperlinkBehavior is set to blank, links are opened in full screen browser windows. * If the Label’s hyperlinkBehavior is set to self, links are opened inside the Label |

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| **A.2.38 Label default hyperlink behavior** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/hyperlinkBehavior\_default](http://www.opengis.net/spec/arml2x0/conf/core/Label/hyperlinkBehavior_default) | |
| **Title** | Label default hyperlink behavior |
| **Abbreviation** | Label/hyperlinkBehavior\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/hyperlinkBehavior\_default](http://www.opengis.net/spec/arml2x0/req/core/Label/hyperlinkBehavior_default) |
| **Test Purpose** | To validate that an implementation sets the correct default value for the hyperlink behavior of a Label. |
| **Test Method** | Verify that the Implementation sets hyperlinkBehavior to blank when not set. |

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| **A.2.39 Label default viewport** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/viewportWidth\_default](http://www.opengis.net/spec/arml2x0/conf/core/Label/viewportWidth_default) | |
| **Title** | Label default viewport |
| **Abbreviation** | Label/viewportWidth\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/viewportWidth\_default](http://www.opengis.net/spec/arml2x0/req/core/Label/viewportWidth_default) |
| **Test Purpose** | To validate that an implementation sets the correct default value for the viewport of a Label. |
| **Test Method** | Verify that the Implementation sets viewportWidth to 256 when not set or set to a negative value. |

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| **A.2.40 Label name and description replacement** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/metadata\_name\_description](http://www.opengis.net/spec/arml2x0/conf/core/Label/metadata_name_description) | |
| **Title** | Label name and description replacement |
| **Abbreviation** | Label/metadata\_name\_description |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/metadata\_name\_description](http://www.opengis.net/spec/arml2x0/req/core/Label/metadata_name_description) |
| **Test Purpose** | To validate that an implementation replaces the placeholders for references to the name and description in a Label correctly. |
| **Test Method** | Verify that the Implementation replaces any occurrences of $[name] and $[description] in the content of the Label with name and description of the Feature’s metadata the Label is linked to. Verify that, in case a property is not set, the implementation replaces the value with an empty string. |

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| **A.2.41 Label property replacement** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Label/metadata\_general](http://www.opengis.net/spec/arml2x0/conf/core/Label/metadata_general) | |
| **Title** | Label property replacement |
| **Abbreviation** | Label/metadata\_general |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Label/metadata\_general](http://www.opengis.net/spec/arml2x0/req/core/Label/metadata_general) |
| **Test Purpose** | To validate that an implementation replaces the placeholders for references to arbitrary properties in a Label correctly. |
| **Test Method** | Verify that the Implementation replaces any occurrences of $[(XPath-Expression)] in the content of the Label with the corresponding metadata content of the Feature’s metadata the Label is linked to. Verify that the replacement is only performed when the XPath evaluation returns a single text node, and is replaced with an empty string otherwise. |

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| **A.2.42 Fill default color** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Fill/color\_default](http://www.opengis.net/spec/arml2x0/conf/core/Fill/color_default) | |
| **Title** | Fill default color |
| **Abbreviation** | Fill/color\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Fill/color\_default](http://www.opengis.net/spec/arml2x0/req/core/Fill/color_default) |
| **Test Purpose** | To validate that an implementation sets the correct default color of a Fill element. |
| **Test Method** | Verify that the Implementation sets a Fill’s color property to #000000 (black) when not set. |

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| **A.2.43 Text name and description replacement** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Text/metadata\_name\_description](http://www.opengis.net/spec/arml2x0/conf/core/Text/metadata_name_description) | |
| **Title** | Text name and description replacement |
| **Abbreviation** | Text/metadata\_name\_description |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Text/metadata\_name\_description](http://www.opengis.net/spec/arml2x0/req/core/Text/metadata_name_description) |
| **Test Purpose** | To validate that an implementation replaces the placeholders for references to the name and description in a Text correctly. |
| **Test Method** | Verify that the Implementation replaces any occurrences of $[name] and $[description] in the content of the Text with name and description of the Feature’s metadata the Text is linked to. Verify that, in case a property is not set, the implementation replaces the value with an empty string. |

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| **A.2.44 Text property replacement** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Text/metadata\_general](http://www.opengis.net/spec/arml2x0/conf/core/Text/metadata_general) | |
| **Title** | Text property replacement |
| **Abbreviation** | Text/metadata\_general |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Text/metadata\_general](http://www.opengis.net/spec/arml2x0/req/core/Text/metadata_general) |
| **Test Purpose** | To validate that an implementation replaces the placeholders for references to arbitrary properties in a Text correctly. |
| **Test Method** | Verify that the Implementation replaces any occurrences of $[(XPath-Expression)] in the content of the Text with the corresponding metadata content of the Feature’s metadata the Text is linked to. Verify that the replacement is only performed when the XPath evaluation returns a single text node, and is replaced with an empty string otherwise. |

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| **A.2.45 Text default font color** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Text/font-color\_default](http://www.opengis.net/spec/arml2x0/conf/core/Text/font-color_default) | |
| **Title** | Text default font color |
| **Abbreviation** | Text/font-color\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Text/font-color\_default](http://www.opengis.net/spec/arml2x0/req/core/Text/font-color_default) |
| **Test Purpose** | To validate that an implementation sets the default font color value of a Text element correctly. |
| **Test Method** | Verify that the Implementation sets a Text’s font-color property to #000000 (black) when not set. |

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| **A.2.46 Text default background color** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Text/background-color\_default](http://www.opengis.net/spec/arml2x0/conf/core/Text/background-color_default) | |
| **Title** | Text default background color |
| **Abbreviation** | Text/background-color\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Text/background-color\_default](http://www.opengis.net/spec/arml2x0/req/core/Text/background-color_default) |
| **Test Purpose** | To validate that an implementation sets the default background color value of a Text element correctly. |
| **Test Method** | Verify that the Implementation sets a Text’s background-color property to #00000000 (transparent) when not set. |

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| **A.2.47 Invalid Image format** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Image/formats](http://www.opengis.net/spec/arml2x0/conf/core/Image/formats) | |
| **Title** | Invalid Image format |
| **Abbreviation** | Image/formats |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Image/formats](http://www.opengis.net/spec/arml2x0/req/core/Image/formats) |
| **Test Purpose** | To validate that the implementation does not fail in case an Image is invalid. |
| **Test Method** | Verify that the Implementation ignores an Image when it cannot support the format of the Image. |

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| **A.2.48 Invalid Model format** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Model/formats](http://www.opengis.net/spec/arml2x0/conf/core/Model/formats) | |
| **Title** | Invalid Model format |
| **Abbreviation** | Model/formats |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Model/formats](http://www.opengis.net/spec/arml2x0/req/core/Model/formats) |
| **Test Purpose** | To validate that the implementation does not fail in case a Model’s format is not supported. |
| **Test Method** | Verify that the Implementation ignores a Model when it cannot support the format of the Model. |

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| **A.2.49 Model Type Handling** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Model/type](http://www.opengis.net/spec/arml2x0/conf/core/Model/formats) | |
| **Title** | Model Type Handling |
| **Abbreviation** | Model/type |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Model/type](http://www.opengis.net/spec/arml2x0/req/core/Model/formats) |
| **Test Purpose** | To validate that the implementation does not display Models of type infrastructure. |
| **Test Method** | Verify that the Implementation displays Models of type normal, and uses Models of type infrastructure solely for occlusion handling. |

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| **A.2.50 Model Default Type** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Model/type\_default](http://www.opengis.net/spec/arml2x0/conf/core/Model/type_default) | |
| **Title** | Model Default Type |
| **Abbreviation** | Model/type\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Model/type\_default](http://www.opengis.net/spec/arml2x0/req/core/Model/type_default) |
| **Test Purpose** | To validate that the implementation sets the correct type value for a Model in case the property is not set specifically. |
| **Test Method** | Verify that the Implementation sets the type of a Model to normal if not set. |

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| **A.2.51 Default Scale properties** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scale/defaults](http://www.opengis.net/spec/arml2x0/conf/core/Scale/defaults) | |
| **Title** | Default Scale properties |
| **Abbreviation** | Scale/defaults |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Scale/defaults](http://www.opengis.net/spec/arml2x0/req/core/Scale/defaults) |
| **Test Purpose** | To validate that the implementation sets the correct default values for a Scale element in case the properties are not set specifically. |
| **Test Method** | Verify that the Implementation sets the x, y and z values respectively of Scale to 1 if not set. |

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| **A.2.52 Scale 3D Axis Transformation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scale/axis](http://www.opengis.net/spec/arml2x0/conf/core/Scale/defaults) | |
| **Title** | Scale 3D Axis Transformation |
| **Abbreviation** | Scale/axis |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Scale/axis](http://www.opengis.net/spec/arml2x0/req/core/Scale/defaults) |
| **Test Purpose** | To validate that the implementation uses the correct 3D transformation mode. |
| **Test Method** | Verify that the Implementation does not change the axis and their dimensions when Scale is applied, only the VisualAsset itself is scaled. |

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| **A.2.53 2D VisualAssets automatic orientation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/AutomaticOrientation\_VisualAssets/2D](http://www.opengis.net/spec/arml2x0/conf/core/AutomaticOrientation_VisualAssets/2D) | |
| **Title** | 2D VisualAssets automatic orientation |
| **Abbreviation** | AutomaticOrientation\_VisualAssets/2D |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ AutomaticOrientation\_VisualAssets/2D](http://www.opengis.net/spec/arml2x0/req/core/%20AutomaticOrientation_VisualAssets/2D) |
| **Test Purpose** | To validate that the implementation adheres to the definitions of automatic orientation for 2D VisualAssets. |
| **Test Method** | Verify that the Implementation implements the automatic orientation of a 2D VisualAsset according to the definitions in paragraph 6.5.2.1. |

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| **A.2.54 3D VisualAssets dimension 0 automatic orientation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/AutomaticOrientation\_VisualAssets/3D\_dim\_0](http://www.opengis.net/spec/arml2x0/conf/core/AutomaticOrientation_VisualAssets/3D_dim_0) | |
| **Title** | 3D VisualAssets dimension 0 automatic orientation |
| **Abbreviation** | AutomaticOrientation\_VisualAssets/3D\_dim\_0 |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ AutomaticOrientation\_VisualAssets/3D\_dim\_0](http://www.opengis.net/spec/arml2x0/req/core/%20AutomaticOrientation_VisualAssets/3D_dim_0) |
| **Test Purpose** | To validate that the implementation adheres to the definitions of automatic orientation for 3D VisualAssets. |
| **Test Method** | Verify that the Implementation implements the automatic orientation of a 3D VisualAsset according to the definitions in paragraph 6.5.2.2. |

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| **A.2.55 3D VisualAssets dimension 1 and 2 automatic orientation** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/AutomaticOrientation\_VisualAssets/3D\_dim\_1\_2](http://www.opengis.net/spec/arml2x0/conf/core/AutomaticOrientation_VisualAssets/3D_dim_0) | |
| **Title** | 3D VisualAssets dimension 1 and 2 automatic orientation |
| **Abbreviation** | AutomaticOrientation\_VisualAssets/3D\_dim\_1\_2 |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ AutomaticOrientation\_VisualAssets/3D\_dim\_1\_2](http://www.opengis.net/spec/arml2x0/req/core/%20AutomaticOrientation_VisualAssets/3D_dim_0) |
| **Test Purpose** | To validate that the implementation does not project 3D VisualAssets onto 1D and 2D Anchors. |
| **Test Method** | Verify that the Implementation ignores any 3D Visual Assets attached to a 1- or 2-dimensional Anchor. |

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| **A.2.56 Order of Execution of Manual Orientation for VisualAssets** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ManualOrientation\_VisualAssets/order](http://www.opengis.net/spec/arml2x0/conf/core/ManualOrientation_VisualAssets/order) | |
| **Title** | Order of Execution of Manual Orientation for VisualAssets |
| **Abbreviation** | ManualOrientation\_VisualAssets/order |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ ManualOrientation\_VisualAssets/order](http://www.opengis.net/spec/arml2x0/req/core/%20ManualOrientation_VisualAssets/order) |
| **Test Purpose** | To validate that the implementation executes 3D transformations in the correct order. |
| **Test Method** | Verify that the Implementation executes rotations in the following order: roll – tilt – heading |

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| **A.2.57 Axes Transformation when manually orientating VisualAssets** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ManualOrientation\_VisualAssets/axes](http://www.opengis.net/spec/arml2x0/conf/core/ManualOrientation_VisualAssets/axes) | |
| **Title** | Axes Transformation when manually orientating VisualAssets |
| **Abbreviation** | ManualOrientation\_VisualAssets/axes |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ ManualOrientation\_VisualAssets/axes](http://www.opengis.net/spec/arml2x0/req/core/%20ManualOrientation_VisualAssets/axes) |
| **Test Purpose** | To validate that the implementation uses the correct 3D transformation mode. |
| **Test Method** | Verify that the Implementation does not change the axis and their dimensions when orientation is applied, only the VisualAsset itself is oriented. |

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| **A.2.58 Definition of Manual Orientation of VisualAssets** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/ManualOrientation\_VisualAssets/application](http://www.opengis.net/spec/arml2x0/conf/core/ManualOrientation_VisualAssets/application) | |
| **Title** | Definition of Manual Orientation of VisualAssets |
| **Abbreviation** | ManualOrientation\_VisualAssets/application |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ ManualOrientation\_VisualAssets/application](http://www.opengis.net/spec/arml2x0/req/core/%20ManualOrientation_VisualAssets/application) |
| **Test Purpose** | To validate that the implementation adheres to the definitions of manual orientation for VisualAssets. |
| **Test Method** | Verify that the Implementation implements the manual orientation of VisualAssets as specified in section 6.5.2.3. |

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| **A.2.59 Definition of ScalingDistances** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scaling\_VisualAssets/minMaxScalingDistance](http://www.opengis.net/spec/arml2x0/conf/core/Scaling_VisualAssets/minMaxScalingDistance) | |
| **Title** | Definition of ScalingDistances |
| **Abbreviation** | Scaling\_VisualAssets/minMaxScalingDistance |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ Scaling\_VisualAssets/minMaxScalingDistance](http://www.opengis.net/spec/arml2x0/req/core/%20Scaling_VisualAssets/minMaxScalingDistance) |
| **Test Purpose** | To validate that the implementation sets correct default values for min and maxScalingDistance in case it is not set explicitly. |
| **Test Method** | Verify that the Implementation implements the min and maxScalingDistance of VisualAssets as specified in section 6.5.3. |

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| **A.2.60 Definition of scalingFactor** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scaling\_VisualAssets/scalingFactor](http://www.opengis.net/spec/arml2x0/conf/core/Scaling_VisualAssets/scalingFactor) | |
| **Title** | Definition of scalingFactor |
| **Abbreviation** | Scaling\_VisualAssets/scalingFactor |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ Scaling\_VisualAssets/ scalingFactor](http://www.opengis.net/spec/arml2x0/req/core/%20Scaling_VisualAssets/minMaxScalingDistance) |
| **Test Purpose** | To validate that the implementation implements the scalingFactor behavior correctly. |
| **Test Method** | Verify that the Implementation implements the scalingFactor of VisualAssets as specified in section 6.5.3. |

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| **A.2.61 Default minScalingDistance** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scaling\_VisualAssets/minScalingDistance\_default](http://www.opengis.net/spec/arml2x0/conf/core/Scaling_VisualAssets/minScalingDistance_default) | |
| **Title** | Default minScalingDistance |
| **Abbreviation** | Scaling\_VisualAssets/minScalingDistance\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ Scaling\_VisualAssets/minScalingDistance\_default](http://www.opengis.net/spec/arml2x0/req/core/%20Scaling_VisualAssets/minScalingDistance_default) |
| **Test Purpose** | To validate that the implementation sets correct default value for the scaling factor in case it is not set explicitly. |
| **Test Method** | Verify that the Implementation sets minScalingDistance to 0 when not set. |

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| **A.2.62 Ignoring maxScalingDistance with Natural Scaling** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scaling\_VisualAssets/maxScalingDistance\_ignored](http://www.opengis.net/spec/arml2x0/conf/core/Scaling_VisualAssets/maxScalingDistance_ignored) | |
| **Title** | Ignoring maxScalingDistance with Natural Scaling |
| **Abbreviation** | Scaling\_VisualAssets/maxScalingDistance\_ignored |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ Scaling\_VisualAssets/maxScalingDistance\_ignored](http://www.opengis.net/spec/arml2x0/req/core/%20Scaling_VisualAssets/maxScalingDistance_ignored) |
| **Test Purpose** | To validate that the implementation does not take maxScalingDistance into account for natural scaling. |
| **Test Method** | Verify that the Implementation ignores maxScalingDistance when natural scaling is used. |

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| **A.2.63 Ignoring scalingFactor with Natural Scaling** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Scaling\_VisualAssets/scalingFactor\_ignored](http://www.opengis.net/spec/arml2x0/conf/core/Scaling_VisualAssets/scalingFactor_ignored) | |
| **Title** | Ignoring scalingFactor with Natural Scaling |
| **Abbreviation** | Scaling\_VisualAssets/scalingFactor\_ignored |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/ Scaling\_VisualAssets/scalingFactor\_ignored](http://www.opengis.net/spec/arml2x0/req/core/%20Scaling_VisualAssets/scalingFactor_ignored) |
| **Test Purpose** | To validate that the implementation does not take scalingFactor into account for natural scaling. |
| **Test Method** | Verify that the Implementation ignores scalingFactor when natural scaling is used. |

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| **A.2.64 And-Concatenation of multiple Conditions** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Condition/multiple](http://www.opengis.net/spec/arml2x0/conf/core/Condition/multiple) | |
| **Title** | And-Concatenation of multiple Conditions |
| **Abbreviation** | Condition/multiple |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Condition/multiple](http://www.opengis.net/spec/arml2x0/req/core/Condition/multiple) |
| **Test Purpose** | To validate that the implementation complies with the AND concatenation rules of Conditions |
| **Test Method** | Verify that the Implementation only renders a VisualAsset when it either does not have a Condition attached, or all of the attached Conditions are met. |

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| **A.2.65 Maximum render distance** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Condition/Distance/max](http://www.opengis.net/spec/arml2x0/conf/core/Condition/Distance/max) | |
| **Title** | Maximum render distance |
| **Abbreviation** | Condition/Distance/max |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Distance/max](http://www.opengis.net/spec/arml2x0/req/core/Condition/Distance/max) |
| **Test Purpose** | To validate that the implementation does not render VisualAssets that are too far away. |
| **Test Method** | Verify that the Implementation ignores all VisualAssets that have a greater distance than the distance specified in max in their attached DistanceCondition. |

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| **A.2.66 Minimum render distance** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Condition/Distance/min](http://www.opengis.net/spec/arml2x0/conf/core/Condition/Distance/max) | |
| **Title** | Minimum render distance |
| **Abbreviation** | Condition/Distance/min |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Distance/min](http://www.opengis.net/spec/arml2x0/req/core/Condition/Distance/max) |
| **Test Purpose** | To validate that the implementation does not render VisualAssets that are too close. |
| **Test Method** | Verify that the Implementation ignores all VisualAssets that have a smaller distance than the distance specified in min in their attached DistanceCondition. |

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| **A.2.67 And-Concatenation of min and max distance** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Condition/Distance/min\_and\_max](http://www.opengis.net/spec/arml2x0/conf/core/Condition/Distance/min_and_max) | |
| **Title** | And-Concatenation of min and max distance |
| **Abbreviation** | Condition/Distance/min\_and\_max |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Distance/min\_and\_max](http://www.opengis.net/spec/arml2x0/req/core/Condition/Distance/min_and_max) |
| **Test Purpose** | To validate that the implementation complies with the AND concatenation rules of the values in a DistanceConditions |
| **Test Method** | Verify that, when both min and max are set in a DistanceCondition, the Implementation only shows a VisualAsset when both conditions yield true. |

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| **A.2.68 Default listener for SelectedCondition** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Condition/Selected/listener\_default](http://www.opengis.net/spec/arml2x0/conf/core/Condition/Selected/listener_default) | |
| **Title** | Default listener for SelectedCondition |
| **Abbreviation** | Condition/Selected/listener\_default |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Selected/listener\_default](http://www.opengis.net/spec/arml2x0/req/core/Condition/Selected/listener_default) |
| **Test Purpose** | To validate that the implementation sets the correct default anchor value for a SelectedCondition in case it is not set explicitely. |
| **Test Method** | Verify that the Implementation sets the listener to anchor in a SelectedCondition when not set. |

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| **A.2.69 SelectedCondition application** | |
| [http://www.opengis.net/spec/arml/2.0/conf/core/Condition/Selected/selected](http://www.opengis.net/spec/arml2x0/conf/core/Condition/Selected/selected) | |
| **Title** | SelectedCondition application |
| **Abbreviation** | Condition/Selected/selected |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/core/Condition/Selected/selected](http://www.opengis.net/spec/arml2x0/req/core/Condition/Selected/selected) |
| **Test Purpose** | To validate that the implementation only renders a VisualAsset when the conditions are met as defined in its SelectedCondition. |
| **Test Method** | Verify that the Implementation only renders a VisualAsset with a SelectedCondition when the listener is in selected state and selected is set to true, and the listener is in unselected state and selected is set to false respectively. |

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| A.3: Conformance Test Class: Descriptive and Scripting Implementation | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting](http://www.opengis.net/spec/arml2x0/conf/scripting) | |
| **Target Type** | Implementation |
| **Dependency** | [http://www.opengis.net/spec/arml/2.0/conf/core](http://www.opengis.net/spec/arml2x0/conf/core) |
| Tests described in this section shall be used to test conformance of an Implementation capable of handling ARML 2.0 files with descriptive and scripting content. All Conformance Tests in the Conformance Class [http://www.opengis.net/spec/arml/2.0/conf/core](http://www.opengis.net/spec/arml2x0/conf/core) must validate before the execution of the Conformance Tests in this Conformance Class. | |

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| **A.3.1 ARML Injection** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/general/arml\_injection](http://www.opengis.net/spec/arml2x0/conf/scripting/general/arml_injection) | |
| **Title** | ARML Injection |
| **Abbreviation** | general/arml\_injection |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/general/arml\_injection](http://www.opengis.net/spec/arml2x0/req/scripting/general/arml_injection) |
| **Test Purpose** | To validate that the implementation injects the arml object into the ECMAScript context. |
| **Test Method** | Verify that the implementation injects the arml object into the ECMAScript runtime at startup. |

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| **A.3.2 Object Access** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/general/object\_access](http://www.opengis.net/spec/arml2x0/conf/scripting/general/object_access) | |
| **Title** | Object Access |
| **Abbreviation** | general/object\_access |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/general/object\_access](http://www.opengis.net/spec/arml2x0/req/scripting/general/object_access) |
| **Test Purpose** | To validate that the implementation can access any ID-referenced object through the ECMAScript binding. |
| **Test Method** | Verify that, after an ARElement was added to the scene, its ECMAScript representation is accessible in the Implementation through *arml.getARElementById* with the id of the ARElement as parameter. |

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| **A.3.3 Declarative and Scripting Synchronization** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/general/synchronization](http://www.opengis.net/spec/arml2x0/conf/scripting/general/synchronization) | |
| **Title** | Declarative and Scripting Synchronization |
| **Abbreviation** | general/synchronization |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/general/synchronization](http://www.opengis.net/spec/arml2x0/req/scripting/general/synchronization) |
| **Test Purpose** | To validate that the implementation synchronizes the descriptive and the scripting representation of the scene. |
| **Test Method** | Verify that the Implementation makes the values of the properties declared in the declarative specification accessible through ECMAScript. |

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| **A.3.4 Misuse of ECMAScript specification** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/general/misuse](http://www.opengis.net/spec/arml2x0/conf/scripting/general/misuse) | |
| **Title** | Misuse of ECMAScript specification |
| **Abbreviation** | general/misuse |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/general/misuse](http://www.opengis.net/spec/arml2x0/req/scripting/general/misuse) |
| **Test Purpose** | To validate that the implementation raises an error in case the defined constructors, methods and properties are not used in the intended way. |
| **Test Method** | Verify that the Implementation raises an ECMAScript Error when constructors, methods and properties are misused. |

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| **A.3.5 ARML Injection into Label** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Label/injection](http://www.opengis.net/spec/arml2x0/conf/scripting/Label/injection) | |
| **Title** | ARML Injection into Label |
| **Abbreviation** | Label/injection |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Label/injection](http://www.opengis.net/spec/arml2x0/req/scripting/Label/injection) |
| **Test Purpose** | To validate that each Label can access to the arml object. |
| **Test Method** | Verify that the Implementation injects the arml root object into each Label before it is fully constructed. |

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| **A.3.6 Invalid animationId** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Model/animationId](http://www.opengis.net/spec/arml2x0/conf/scripting/Model/animationId) | |
| **Title** | Invalid animationId |
| **Abbreviation** | Model/animationId |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Model/animationId](http://www.opengis.net/spec/arml2x0/req/scripting/Model/animationId) |
| **Test Purpose** | To validate that the implementation raises an error in case a specified animationId is not accessible. |
| **Test Method** | Verify that the Implementation raises an ECMAScript Error when the animationId cannot be resolved. |

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| **A.3.7 Animation loop count definition for Model Animations** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Model/animationLoopCount](http://www.opengis.net/spec/arml2x0/conf/scripting/Model/animationLoopCount) | |
| **Title** | Animation loop count definition for Model Animations |
| **Abbreviation** | Model/animationLoopCount |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Model/animationLoopCount](http://www.opengis.net/spec/arml2x0/req/scripting/Model/animationLoopCount) |
| **Test Purpose** | To validate that the implementation sets the correct default value for a missing loopCount, and implements the correct looping behavior in Model animations. |
| **Test Method** | Verify that the Implementation sets the loopCount to 1 when not set, and verify that the animation will loop infinitely often when the value is set to -1. |

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| **A.3.8 Animation callback definition for Model Animations** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Model/animationCallback](http://www.opengis.net/spec/arml2x0/conf/scripting/Model/animationCallback) | |
| **Title** | Animation callback definition for Model Animations |
| **Abbreviation** | Model/animationCallback |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Model/animationCallback](http://www.opengis.net/spec/arml2x0/req/scripting/Model/animationCallback) |
| **Test Purpose** | To validate that the implementation implements the correct animation callback behavior. |
| **Test Method** | Verify that the Implementation triggers the callback when the animation finished playing, but will not trigger it when the animation was stopped explicitly by calling stop3DAnimation. |

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| **A.3.9 Animation loop count definition for regular Animations** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Animation/loopCount](http://www.opengis.net/spec/arml2x0/conf/scripting/Animation/loopCount) | |
| **Title** | Animation loop count definition for regular Animations |
| **Abbreviation** | Animation/animationLoopCount |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/loopCount](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/loopCount) |
| **Test Purpose** | To validate that the implementation sets the correct default value for a missing loopCount, and implements the correct looping behavior in Animations. |
| **Test Method** | Verify that the Implementation sets the loopCount to 1 when not set, and verify that the animation will loop infinitely often when the value is set to -1. |

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| **A.3.10 Default delay setting for Animations** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Animation/delay](http://www.opengis.net/spec/arml2x0/conf/scripting/Animation/loopCount) | |
| **Title** | Default delay setting for Animations |
| **Abbreviation** | Animation/delay |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/delay](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/loopCount) |
| **Test Purpose** | To validate that the implementation sets the correct default value for a missing delay property in Animations. |
| **Test Method** | Verify that the Implementation sets the delay to 0 when not set. |

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| **A.3.11 Default animation start value** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Animation/Number/start](http://www.opengis.net/spec/arml2x0/conf/scripting/Animation/Number/start) | |
| **Title** | Default animation start value |
| **Abbreviation** | Animation/Number/start |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/Number/start](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/Number/start) |
| **Test Purpose** | To validate that the implementation sets the correct default value for a missing start property in Animations. |
| **Test Method** | Verify that the Implementation sets the Animation’s start value to the current value of the property when no explicit start value is given. |

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| --- | --- |
| **A.3.12 Animation end value** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Animation/Number/end](http://www.opengis.net/spec/arml2x0/conf/scripting/Animation/Number/start) | |
| **Title** | Animation end value |
| **Abbreviation** | Animation/Number/end |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/Number/end](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/Number/start) |
| **Test Purpose** | To validate that the implementation sets the correct end value in Animations. |
| **Test Method** | Verify that, after the completion of the Animation, the Implementation sets the property’s value to the specified end value. |

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| **A.3.13 Animation end definition** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/Animation/Group/endDefinition](http://www.opengis.net/spec/arml2x0/conf/scripting/Animation/Group/endDefinition) | |
| **Title** | Animation end definition |
| **Abbreviation** | Animation/Group/endDefinition |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/Animation/Group/endDefinition](http://www.opengis.net/spec/arml2x0/req/scripting/Animation/Group/endDefinition) |
| **Test Purpose** | To validate that the implementation implements the correct behavior when an Animation is finished. |
| **Test Method** | Verify that the implementation considers an Animation group finished in the following cases:   * The longest Animation has finished in a parallel group. * The last Animation has finished in a sequential group. |

|  |  |
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| **A.3.14 Event Handling** | |
| [http://www.opengis.net/spec/arml/2.0/conf/scripting/EventHandling/firing](http://www.opengis.net/spec/arml2x0/conf/scripting/EventHandling/firing) | |
| **Title** | Event Handling |
| **Abbreviation** | EventHandling/firing |
| **Type** | Basic |
| **Requirement** | [http://www.opengis.net/spec/arml/2.0/req/scripting/EventHandling/firing](http://www.opengis.net/spec/arml2x0/req/scripting/EventHandling/firing) |
| **Test Purpose** | To validate that the implementation implements the correct event handling mechanisms. |
| **Test Method** | Verify that the Implementation triggers the EventHandler when an event occurred for which the EventListener interface was registered. |

# Annex B: Examples

The following section provides some examples of ARML snippets in common use cases. All use cases assume the following:

* A valid COLLADA 3D Model (including correctly referenced texture images) exists at the following location: <http://www.myserver.com/myModel.dae>; the Model's coordinate system is left-handed (x points left, y points up, z points to the front)
* A 512x512 (arbitrary) image exists at the following location: http://www.myserver.com/myImage.jpg
* A 512px wide and 1024px high artificial marker exists at the following location: http://www.myserver.com/myMarker.jpg. When printed, the marker is 20cm wide and 40cm high.

## B1: Typical geospatial AR Browser

A typical geospatial AR Browser shows placemarks, referenced by latitude and longitude values, as icons on the camera screen. When the user clicks on a placemark, a static info window is shown at the bottom of the screen, displaying some textual information.

**Remark:** Descriptions of the Placemarks are taken from the Wikipedia pages of the Golden Gate Bridge and Coit Tower.

<arml>  
 <ARElements>

<!-- define the placemark marker; we use custom scaling mode to allow markers to be visible from further away markers will appear 20 meters wide as a maximum in the composed scene. The Image will be used by each Placemark in the scene. -->

<Image id="placemarkMarker">  
 <ScalingMode type="custom">  
 <minScalingDistance>10</minScalingDistance>  
 <maxScalingDistance>1000</maxScalingDistance>  
 <scalingFactor>0.4</scalingFactor>  
 </ScalingMode>  
 <width>20</width>  
 <href xlink:href="http://www.myserver.com/myImage.jpg" />  
 </Image>

<!-- define the info window. The info window is located at the bottom of the screen and displays the name and description of the Feature it is attached to. It will only be visible when the particular Feature (placemark) was selected, and will disappear as soon as the Feature is unselected. The Anchor will be used by each Placemark in the scene. -->

<ScreenAnchor id="infoWindow">  
 <style>left: 0; width: 100%; bottom: 0; height: 25%</style>  
 <assets>  
 <Label>  
 <conditions>  
 <SelectedCondition>  
 <listener>feature</listener>  
 <selected>true</selected>  
 </SelectedCondition>  
 </conditions>  
 <src><b>$[name]</b><br />$[description]</src>  
 </Label>  
 </assets>  
 </ScreenAnchor>

<!-- Golden Gate Placemark -->

<Feature id="goldenGateBridge">  
 <name>Golden Gate Bridge</name>  
 <description>The Golden Gate Bridge is a suspension bridge spanning the Golden Gate, the opening of the San Francisco Bay into the Pacific Ocean.</description>  
 <anchors>  
 <anchorRef xlink:href="#infoWindow" />  
 <Geometry>  
 <assets><assetRef xlink:href="#placemarkMarker" /></assets>  
 <gml:Point gml:id="myPoint">  
 <gml:pos>37.818599 -122.478511</gml:pos>  
 </gml:Point>  
 </Geometry>  
 </anchors>  
 </Feature>

<!-- Coit Tower Placemark -->

<Feature id="coitTower">  
 <name>Coit Tower</name>  
 <description>Coit Tower, also known as the Lillian Coit Memorial Tower, is a 210-foot (64 m) tower in the Telegraph Hill neighborhood of San Francisco, California.</description>  
 <anchors>  
 <anchorRef xlink:href="#infoWindow" />  
 <Geometry>  
 <assets><assetRef xlink:href="#placemarkMarker" /></assets>  
 <gml:Point gml:id="myPoint">  
 <gml:pos>37.802494 -122.405727</gml:pos>  
 </gml:Point>  
 </Geometry>  
 </anchors>  
 </Feature>

</ARElements>  
</arml>

## B2: Different Representations based on Distance

The Golden Gate Bridge example from above will be reused, but this time, the Golden Gate Bridge should appear as a (scaled) icon when viewed from more than 5 kilometers away, as a red colored line when viewed from between 1 and 5 kilometers away, and as a 3D model showing the bridge just after its completion when viewed from less than 1 kilometer away.

<arml>  
 <ARElements>  
 <Image id="placemarkMarker">  
 <conditions>  
 <DistanceCondition>  
 <min>5000</min>  
 </DistanceCondition>  
 </conditions>  
 <ScalingMode type="custom">  
 <minScalingDistance>10</minScalingDistance>  
 <maxScalingDistance>1000</maxScalingDistance>  
 <scalingFactor>0.4</scalingFactor>  
 </ScalingMode>  
 <width>20</width>  
 <href xlink:href="http://www.myserver.com/myImage.jpg" />  
 </Image>

<Fill id="myRedFill">  
 <!-- only visible when 1km <= distance <= 5km -->  
 <conditions>  
 <DistanceCondition>  
 <max>5000</max>  
 <min>1000</min>  
 </DistanceCondition>  
 </conditions>

<!-- the Golden Gate Bridge is 27.4 meters wide, thus the height of the Fill (which represents the width of the Bridge) is set to 27.4 meters -->  
 <height>27.4</height>  
 <!-- red color -->  
 <style>color:#FF0000;</style>  
 </Fill>

<Model id="3dModel">  
 <!-- only visible when distance <= 1km -->  
 <conditions>  
 <DistanceCondition>  
 <max>1000</max>  
 </DistanceCondition>  
 </conditions>  
 <href xlink:href="http://www.myserver.com/myModel.dae" />  
 </Model>

<!-- Golden Gate Placemark -->

<Feature id="goldenGateBridge">  
 <name>Golden Gate Bridge</name>  
 <anchors>  
 <Geometry>  
 <assets>  
 <!-- the model and the icon are mapped onto the same point, but shown at different distances (see the VisualAssets declaration on top for details) -->  
 <assetRef xlink:href="#placemarkMarker" />  
 <assetRef xlink:href="#3dModel" />  
 </assets>  
 <gml:Point gml:id="myPoint">  
 <gml:pos>37.818599 -122.478511</gml:pos>  
 </gml:Point>  
 </Geometry>

<Geometry>  
 <!-- the line-representation must be mapped as a LineString Geometry -->  
 <assets><assetRef xlink:href="#filledLine" /></assets>  
 <gml:LineString gml:id="myLineString">  
 <gml:posList>  
 37.827752 -122.479541 37.811005 -122.477739  
 </gml:posList>  
 </gml:LineString>  
 </Geometry>  
 </anchors>  
 </Feature>

</ARElements>  
<arml>

## B3: 3D Model on a Trackable

The 3D Model should appear on top of the referenced marker to play a game etc.

<arml>  
 <ARElements>  
 <!-- register the Tracker to track a generic image -->  
 <Tracker id="defaultImageTracker">  
 <uri xlink:href="http://www.opengis.net/arml/tracker/genericImageTracker" />  
 </Tracker>

<!-- define the artificial marker the Model will be placed on top of -->  
 <Trackable>  
 <assets>  
 <!-- define the 3D Model that should be visible on top of the marker -->  
 <Model>  
 <href xlink:href="http://www.myserver.com/myModel.dae" />  
 </Model>  
 </assets>  
 <config>  
 <tracker xlink:href="#defaultImageTracker" />  
 <src>http://www.myserver.com/myMarker.jpg</src>  
 </config>  
 <size>0.20</size>  
 </Trackable>

</ARElements>  
</arml>

## B4: Color the Outline of the artificial marker

Use case: When the marker is detected in the camera screen, a red line, 1 centimeter wide, should be drawn around the marker (the marker outline).

<arml>

<ARElements>

<!-- define the VisualAsset for the outline - the LineString will be filled with red color -->  
 <Fill id="myRedFill">  
 <!-- height set to 0.01 causes the LineString to be drawn 1cm thick -->  
 <height>0.01</height>  
 <!-- define red color for the fill -->  
 <style>color:#FF0000;</style>  
 </Fill>

<!-- define the Tracker and the Marker (see previous example) -->  
 <Tracker id="defaultImageTracker">  
 <uri xlink:href="http://www.opengis.net/arml/tracker/genericImageTracker" />  
 </Tracker>  
 <Trackable id="myTrackable">  
 <config>  
 <tracker xlink:href="#defaultImageTracker" />  
 <src>http://www.myserver.com/myMarker.jpg</src>  
 </config>  
 <size>0.20</size>  
 </Trackable>

<!-- defines the location of the outline of the marker as a LineString which has to be defined relative to the Trackable's center point -->  
 <RelativeTo id="markerOutline">  
 <assets>  
 <!-- use the Fill-VisualAsset defined above to draw the LineString -->  
 <assetRef xlink:href="#myRedFill" />  
 </assets>  
 <!-- reference the Trackable the RelativeTo-geometry will be using -->  
 <ref xlink:href="#myTrackable" />  
 <!-- define the Outline as LineString, from the top right corner of the marker, moving clockwise. The top right point is 10 centimeters to the right, 20 centimeters to the top and 0 centimeters above the Trackable's center (0.01, 0.02 and 0 meters). -->  
 <gml:LineString gml:id="myLineString">  
 <gml:posList>0.01 0.02 0 0.01 -0.02 0 -0.01 -0.02 0 -0.01 0.02 0 0.01 0.02 0</gml:posList>  
 </gml:LineString>  
 </RelativeTo>

</ARElements>  
</arml>

## B5: Color the entire area of a marker

The use case above can be slightly altered to color the entire marker area instead of just the outline, only the LineString-element must be significantly changed, while the Fill-element is implicitly set back to 100% width and height, causing the entire marker area to be filled.

<arml>

<ARElements>

<!-- define the VisualAsset for the colored area -->  
 <Fill id="myRedFill">  
 <!-- define red color for the fill -->  
 <style>color:#FF0000;</style>  
 </Fill>

<!-- define the Tracker and the Marker (see previous example) -->  
 <Tracker id="defaultImageTracker">  
 <uri xlink:href="http://www.opengis.net/arml/tracker/genericImageTracker" />  
 </Tracker>  
 <Trackable id="myTrackable">  
 <config>  
 <tracker xlink:href="#defaultImageTracker" />  
 <src>http://www.myserver.com/myMarker.jpg</src>  
 </config>  
 <size>0.20</size>  
 </Trackable>

<!-- defines the location of the area of the marker as a Polygon which has to be defined relative to the Trackable's center point -->  
 <RelativeTo id="markerOutline">  
 <assets>  
 <!-- use the Fill-VisualAsset defined above to draw the LineString -->  
 <assetRef xlink:href="#myRedFill" />  
 </assets>  
 <!-- reference the Trackable the RelativeTo-geometry will be using -->  
 <ref xlink:href="#myTrackable" />  
 <!-- define the Outline as LineString, from the top right corner of the marker, moving clockwise. The top right point is 10 centimeters to the right, 20 centimeters to the top and 0 centimeters above the Trackable's center (0.01, 0.02 and 0 meters). -->  
 <gml:Polygon gml:id="myPolygon">  
 <gml:exterior>  
 <gml:LinearRing>  
 <gml:posList>0.01 0.02 0 0.01 -0.02 0 -0.01 -0.02 0 -0.01 0.02 0 0.01 0.02 0</gml:posList>  
 </gml:LinearRing>  
 </gml:exterior>  
 </gml:Polygon>  
 </RelativeTo>

</ARElements>  
</arml>

# Annex C: Revision history

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Date | Release | Author | Paragraph modified | Description |
| 2012-10-31 | 1.0.0 | Martin Lechner | All | Copy from TWiki to this document for RFC |
| 2012-11-02 | 1.0.0 | Martin Lechner | Sections 1,2,4,5,7 | Fixed some broken Links, added historical information on ARML 1.0 |
| 2012-12-07 | 1.0.0 | Martin Lechner | Sections 6,7,8,9 | Incorporated comments received during the public commenting phase |
| 2014-11-26 | 1.0.0 | Martin Lechner | All | Added requirements and conformance classes into the document, along with some minor editorial updates.  Final editorial changes before Adoption Vote. |
| 2015-02-09 | 1.0.0 | Martin Lechner | Section 6 | Fixed typo error as reported in the adoption vote |
| 2015-02-12 | 1.0.0 | Carl Reed, Scott Simmons | multiple | OGC staff edits prior to publication |
| 2015-02-20 | 1.0.0 | Martin Lechner | Annex | Moved Section 9 to Annex A, moved Annex A, B and C to B, C and D; Added Test Purpose, Type, Name and Abbreviation to Conformance Tests |

# Annex D: Bibliography

[AR Glossary] - [http://www.perey.com/ARStandards/AR\_Glossary\_2.2\_May\_3.pdf](http://www.perey.com/ARStandards/AR_Glossary_2.2_May_3.pdf" \t "_top)  
[Wikipedia AR Definition] - [http://en.wikipedia.org/wiki/Augmented\_reality](http://en.wikipedia.org/wiki/Augmented_reality" \t "_top)  
[Ronald Azuma AR Definition] - [http://www.cs.unc.edu/~azuma/ARpresence.pdf](http://www.cs.unc.edu/%7Eazuma/ARpresence.pdf" \t "_top)  
[EPSG Codes] - [http://spatialreference.org/ref/epsg/](http://spatialreference.org/ref/epsg/" \t "_top)  
[ARML 1.0 Specification] - [http://openarml.org](http://openarml.org/" \t "_top)