SPECIFICATION

Data Model for Asset Location

Version 1-0

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Submodel Template of the Asset Adminstration Shell

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Die Teilmodell-Spezifikation enthält ECLASS. Es gelten die ECLASS Nutzungsbedingungen (https://eclass.eu/eclass-standard/nutzungsbedingungen).

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1 General

1.1 About this document

This document is a part of a specification series. Each part specifies the contents of a Submodel template for the Asset Administration Shell (AAS). The AAS is described in [1], [2], [3] and [6]. First exemplary Submodel contents were described in [4], while the actual format of this document was derived by the "Administration Shell in Practice" [5]. The format aims to be very concise, giving only minimal necessary information for applying a Submodel template, while leaving deeper descriptions and specification of concepts, structures and mapping to the respective documents [1] to [6].

The target group of the specification are developers and editors of technical documentation and manufacturer information, which are describing assets in smart manufacturing by means of the Asset Administration Shell (AAS) and therefore need to create a Submodel instance with a hierarchy of SubmodelElements. This document especially details on the question, which SubmodelElements with which semantic identification shall be used for this purpose.

1.2 Motivation and Scope of the Submodel

The location of static or mobile objects (assets / goods / trackables) and, if applicable, the origin and destination of transport processes are naturally the most important information in transport and internal logistics. In the past, the postal address or a simple location description (e.g., hall B, aisle 3) or a GNSS coordinate (Global Navigation Satellite System, like GPS) was sufficient as location information for controlling logistics processes.

With the increasing propagation of localization technologies such as Ultra-Wideband (UWB), BLE (Bluetooth Low Energy), RFID (Radio-Frequency Identification) and others, the continuous and precise tracking of objects becomes possible at reasonable costs. This opens up new possibilities for the automation, monitoring and analysis of goods flows and internal transportation tasks. It is also possible to measure masses of localization data for short distances within buildings, which is why the integration of a localization solution into warehouse systems or production lines is becoming increasingly popular. The systems for localization are usually referred to as real-time location systems (RTLS).

Automated guided vehicles (AGVs) and autonomous transport robots with free navigation (AGVs) are also increasingly being used for internal transportation tasks. These are another driver for the use of localization technologies in companies.

> Further applications that require localization information are augmented reality or robotics applications in which in addition to the position the orientation of an object, the pose (6DoF), is of interest. This Submodel is not supporting 6DoF orientation information.

Location data for assets are determined by different localization systems during the life cycle and even at the same point in time more than one system can deliver a location information. Today location data originate from a variety of non-interoperable systems, for which the data model for the localization information is not standardized.

Since asset location data are generated and used by different systems, for different use cases, in different life cycle phases and by different organizations it makes particular sense to manage the location data in the AAS of an asset in the form of a standardized Submodel.

1.3 Relevant standards

One important standard that aims the interoperability in the field of localization is the open locating standard omlox. Omlox is hosted under the umbrella of the PROFIBUS & PROFINET International (PI) organization. Omlox includes also a specification for omlox compliant locating systems and corresponding APIs. More information can be found here:

- https://omlox.com/
- https://www.profibus.com/technology/industrie-40/omlox-the-open-locating-standard

In the attachment of this Submodel specification a mapping between the Submodel template and the omlox specification has been included.

Further standards that have been considered regarding data for asset locations were:

- Open Geospatial Consortium (OGC) GeoPose 1.0 Data Exchange Standard
  Link: https://www.geopose.org/
- ISO 19116:2019(en): Geographic information – positioning services
- World Geodetic System - 1984 (WGS-84)

There is as well an initiative announced for an OPC UA Companion Specification “Global Positioning”.

2 Approach of the Submodel

2.1 Use cases and requirements

The use cases for localization of mobile objects can be, for example, divided into use cases for track & trace, location-based automation, production execution and maintenance as well as material flow.
With track & trace, for example, manual search efforts can be reduced or transportation resource utilization can be determined based on movement analyses. Track means the determination of the current location and trace means the traceability of the shipment's progress. This also includes applications for the traceability of the transport chain.
Location-based automation means that events such as transport orders are triggered depending on the position of an object.
When carrying out production or maintenance, location data helps to quickly reach the required components or machines to be serviced.
The control and optimization of the material flow along the entire logistics chain using various transport and control systems is another field of application for localization technologies.

In addition, also static objects have a permanent location that needs to be modeled. This can be used for example for use cases like navigation or as input for transportation orders where the origin and the destination can be linked to the Submodel instance.

> In many applications the origin and destination of an asset will play a role, e.g., for navigation or transport orders. Origin and destination can again be, in this case stationary, assets with this location data Submodel.

The requirement was to reflect the vast amount of imaginable use cases, the different needs on the quality of location data as well the different localization technologies with the Submodel template.

Three structure elements ensure that the multitude of use cases can be supported. First the semantic structure of a geographically referenced region which is site, area (or building) and fence (see Figure 1) where a site can have one or more areas and/or fences assigned, and an area can have fences assigned. The second structure element are coordinate reference systems (CRS) which have so called “ground control points” for a mapping between a global geographic CRS and the local CRS which enables the coordinate transformation between all local coordinate reference systems. Site, area and fence can share the same coordinate reference system or just have their own.

There is no need to model a site, area or fence in the AAS. At the minimum a position with an assigned CRS is sufficient.

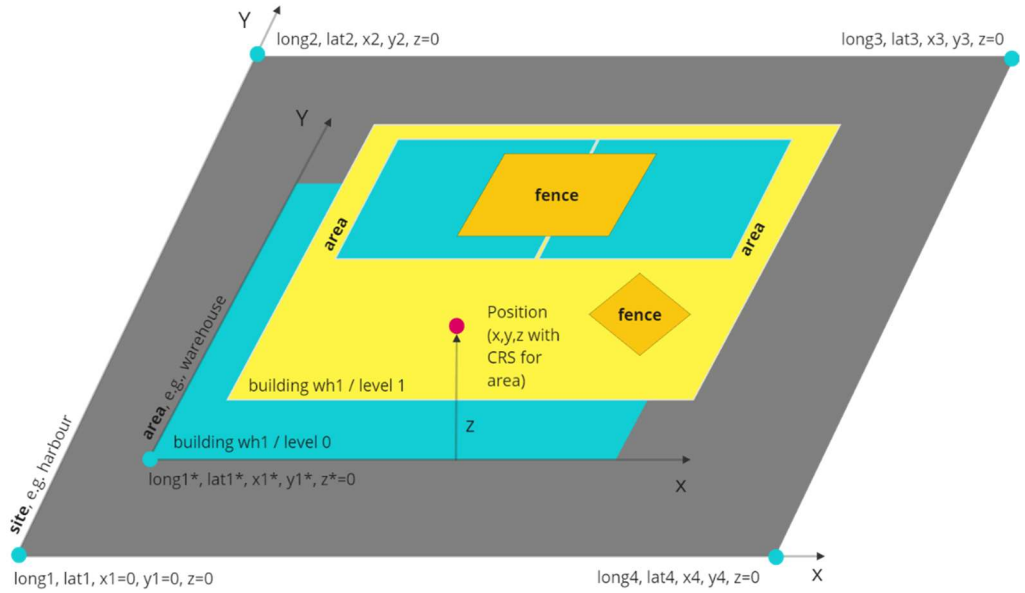

Figure 1: Structure elements of a geographically outlined region

A position (x,y,z-coordinate) is referenced to a CRS which will make it possible that an application based on the data of an AAS is able to determine the semantic relationship for a position, namely the assignment to a site, area or fence.

A fence is a virtual boundary, unlike an area or site which represent physical regions. It may or may not relate to an area or site. The main point of a fence is to enable capturing entry and exit events of assets entering or leaving a fence. A fence is therefore an essential concept for location-automation. For an example, whereas an area refers to a place (e.g. „Production Area C“), a fence could cover either multiple areas or a smaller region within an area (e.g., „Preparation for shipping“).

Figure 2: Modelling of the height

The modelling of the height is illustrated in Figure 2. For every CRS an ElevationReference has to be set which is defining the reference for the height (z-value of a position).

2.2 Structure and design decisions

The structure of the Submodel template is shown in Figure 3. The SubmodelElementLists “Adresses”, “VisitedSites” and “VisitedAreas” contain geographically referenced locations that an asset has visited during its lifecycle phases. Sites and areas can be referenced to their address(es).
VisitedFences are regions that are defined wherein events are generated when an asset enters or leaves that fence. The SubmodelCollection AssetTraces contains the records of events, namely the entry and exit of assets for VisitedSites, VisitedAreas and VisitedFences and with the SubmodelElementList LocationRecords the records of locations.

For the SubmodelElementLists of the SubmodelElementCollection AssetTraces the order is relevant. The last entry is the latest event or location that has been recorded.

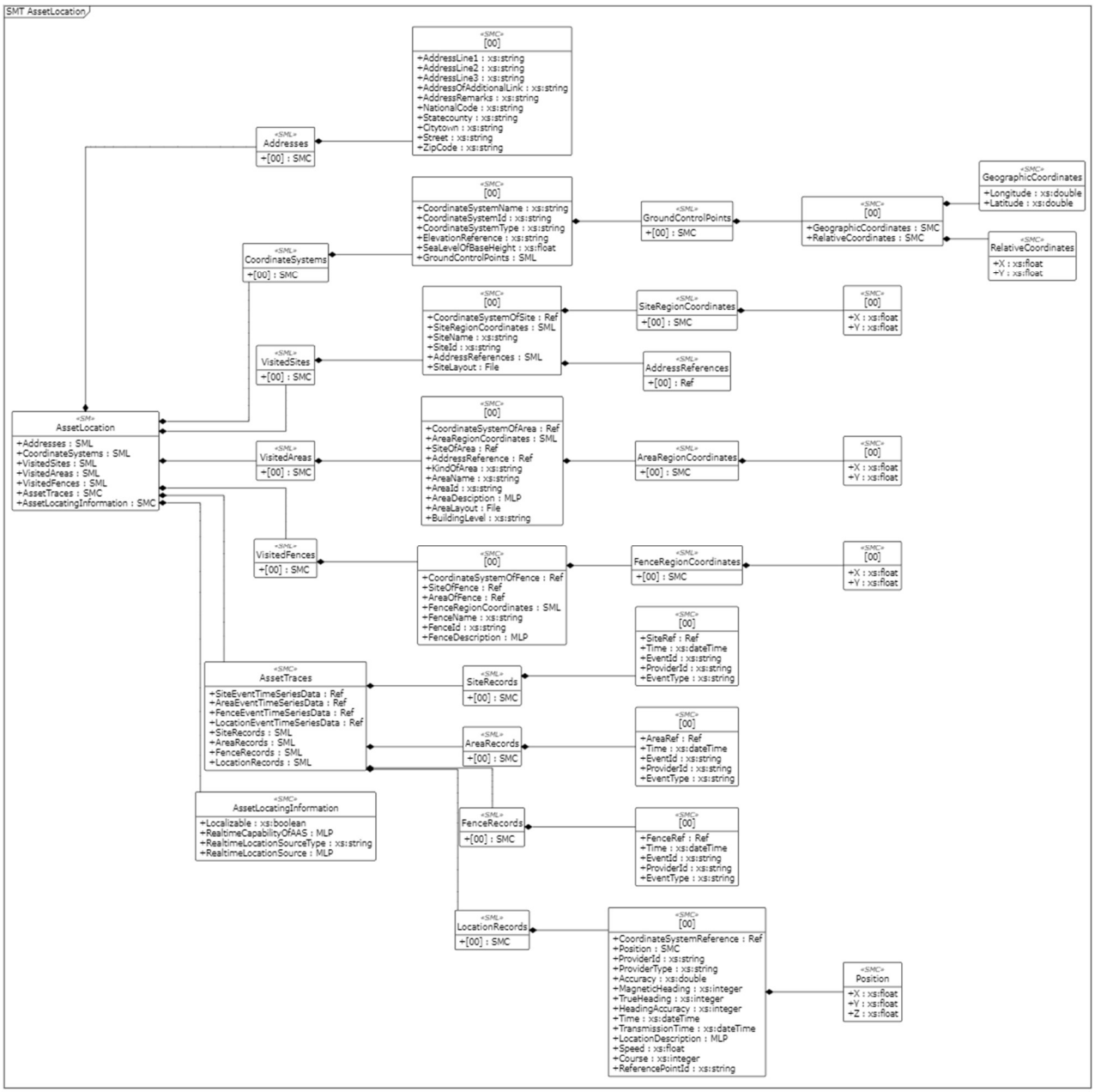

Figure 3: Information structuring of the Submodel template “Data Model for Asset Location”

3 Submodel and SubmodelElements

3.1 SubmodelElements of the Submodel template “Data Model for Asset Location”

Table 1: Submodel elements of “Data Model for Asset Location”

idShort:	AssetLocation		
Class:	Submodel		
semanticId:	https://admin-shell.io/idta/smt/assetlocation		
Parent:	Asset Administration Shell with asset which is a locatable physical object		
Explanation:	Submodel for tracking & tracing of the location of an asset		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SML] Addresses	[IRI] https://admin-shell.io/idta/sml/addresses List with postal addresses where an object has been located	n/a	[0..1]
[SML] CoordinateSystems	[IRI] https://admin-shell.io/idta/sml/coordinatesystems List with information about different coordinate systems that have been used to determine the location of an asset	n/a	[0..1]
[SML] VisitedSites	[IRI] https://admin-shell.io/idta/sml/visitedsites List with sites where an asset has been located or is located	n/a	[0..1]
[SML] VisitedAreas	[IRI] https://admin-shell.io/idta/sml/visitedareas List with areas (e.g., buildings, field warehouse) within a site where an asset has been located or is located	n/a	[0..1]
[SML] VisitedFences	[IRI] https://admin-shell.io/idta/sml/visitedfences List with fences (monitored localization zones) where an asset has entered/left	n/a	[0..1]

[SMC] AssetTraces	[IRI] https://admin-shell.io/idta/smc/assettraces Collection of localization event records for sites, areas, fences and locations	n/a	[0..1]
[SMC] AssetLocatingInformation	[IRI] https://admin-shell.io/idta/sml/assetlocatinginformation Collection with additional information concerning the localization of an asset	n/a	[0..1]

3.2 SubmodelElements of SML “Addresses”

Table 2: Submodel elements of “Addresses”

idShort:	Addresses		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/addresses		
Parent:	AssetLocation		
Explanation:	List with postal addresses where an object has been located		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRDI] 0173-1#01-ADR442#007 Address The SMC contains:		[0..*]
	[Prop] AddressLine1 IRDI: 0173-1#02-AAO124#004 description: address line 1	[String]	[0..1]
	[Prop] AddressLine2 IRDI: 0173-1#02-AAO125#004 description: address line 2	[String]	[0..1]
	[Prop] AddressLine3 IRDI: 0173-1#02-AAO126#004 description: address line 3	[String]	[0..1]
	[Prop] AddressOfAdditionalLink IRDI: 0173-1#02-AAQ326#003 description: address of additional link	[String]	[0..1]

	[Prop] AddressRemarks IRDI: 0173-1#02-AAO202#004 description: address remarks	[String]	[0..1]
	[Prop] NationalCode IRDI: 0173-1#02-AAO134#003 description: national code	[String]	[0..1]
	[Prop] Statecounty IRDI: 0173-1#02-AAO133#003 description: state/county	[String]	[0..1]
	[Prop] Citytown IRDI: 0173-1#02-AAO132#003 description: city/town	[String]	[0..1]
	[Prop] Street IRDI: 0173-1#02-AAO128#003 description: street	[String]	[0..1]

3.3 SubmodelElements of SML “CoordinateSystems”

Table 3: Submodel elements of “CoordinateSystems”

idShort:	CoordinateSystems		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/coordinatesystems		
Parent:	AssetLocation		
Explanation:	List with information about different coordinate systems that have been used to determine the location of an asset		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/coordinatesystemsrecord Coordinate reference system (CRS) record The SMC contains:		[0..*]
	[Prop] CoordinateSystemName IRI: https://admin-shell.io/idta/prop/coordinatesystemname description: coordinate system name	[String]	[0..1]
		[String]	[1]

	[Prop] CoordinateSystemId IRI: https://admin-shell.io/idta/prop/coordinatesystemid description: Identification of a coordinate system	[String] EPSG:4326 LOCAL	[1]
	[Prop] CoordinateSystemType IRI: https://admin-shell.io/idta/prop/coordinatesystemtype description: Type of a coordinate system with the allowed enumeration values "EPSG:4326" or "LOCAL"	[String]	[1]
	[Prop] ElevationReference IRI: https://admin-shell.io/idta/prop/elevationreference description: Reference of the elevation information in a coordinate system; with the allowed enumeration values "SEALEVEL" or "LOCAL"	[Float] 105,50 m	[0..1]
	[Prop] SeaLevelOfBaseHeight IRI: https://admin-shell.io/idta/prop/sealevelofbaseheight description: Sea level of the base height of a coordinate system; normally the base height is at the origin of the coordinate system with Z=0,00 m	n/a	[1]
	[SML] GroundControlPoints IRI: https://admin-shell.io/idta/sml/groundcontrolpointsdescription: national code description: An array containing a mapping between geographic coordinates (longitude, latitude) in WGS84 (EPSG:4326) and relative coordinates (x,y)		

3.4 SubmodelElements of SML “GroundControlPoints”

Table 4: Submodel elements of “GroundControlPoints”

idShort:	GroundControlPoints
Class:	SubmodelElementList
semanticId:	https://admin-shell.io/idta/sml/groundcontrolpoints
Parent:	CoordinateSystems
Explanation:	An array containing a mapping between geographic coordinates (longitude, latitude) in WGS84 (EPSG:4326) and relative coordinates (x,y)

[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/groundcontrolpointsentry The SMC contains: [SMC] GeographicCoordinates IRDI: 0173-1#02-ABH934#002 description: Indication of the position of a point on the earth's surface [SMC] RelativeCoordinates IRDI: 0173-1#02-ABG741#001 description: defined value of the location related to the zero point of the coordinate system	 n/a n/a	 [1] [1]

3.5 SubmodelElements of SMC “GeographicCoordinates”

Table 5: Submodel elements of “GeographicCoordinates”

idShort:	GeographicCoordinates
Class:	SubmodelElementCollection
semanticId:	0173-1#02-ABH934#002
Parent:	GroundControlPoints
Explanation:	Indication of the position of a point on the earth's surface

[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Prop] Longitude	[IRDI] 0173-1#02-ABH961#002 Geographic longitude, also called longitude (Latin longitudo, English longitude, international abbreviation long or LON), describes one of the two coordinates of a location on the earth's surface, namely its position east or west of a defined (arbitrarily determined) north-south line, the prime meridian	[Double] 13.413215	[1]
[Prop] Latitude	[IRDI] 0173-1#02-ABH960#002 Latitude (B), also called geodetic latitude or latitude (Latin latitudo, English latitude, international abbreviation Lat. or LAT), is the northerly or	[Double] 52.521918	[1]

	southerly distance of a point on the earth's surface from the equator, given in angular measure in the unit of measurement degrees		

3.6 SubmodelElements of SMC “RelativeCoordinates”

Table 6: Submodel elements of “RelativeCoordinates”

idShort:	RelativeCoordinates		
Class:	SubmodelElementCollection		
semanticId:	0173-1#02-ABG741#001		
Parent:	GroundControlPoints		
Explanation:	defined value of the location related to the zero point of the coordinate system		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] X	[IRI] https://admin-shell.io/idta/prop/x X-coordinate value within a coordinate system	[Float] 115,10 m	[1]
[Prop] Y	[IRI] https://admin-shell.io/idta/prop/y Y-coordinate value within a coordinate system	[Float] 45,00 m	[1]

3.7 SubmodelElements of SML “VisitedSites”

Table 7: Submodel elements of “VisitedSites”

idShort:	VisitedSites
Class:	SubmodelElementList
semanticId:	https://admin-shell.io/idta/sml/visitedsites
Parent:	AssetLocation

Explanation:	List with sites where an asset has been located or is located		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/sml/visitedsitesrecord The SMC contains: [Ref] CoordinateSystemOfSite IRI: https://admin-shell.io/idta/ref/coordinatesystemreference description: Reference to a local coordinate reference system for a site [SML] SiteRegionCoordinates IRI: https://admin-shell.io/idta/sml/regioncoordinates description: Coordinates forming a polygon that describes the region of the site/area/fence within the coordinate reference system of the site [Prop] SiteName IRI: https://admin-shell.io/idta/prop/sitename description: name of a site [Prop] SiteId IRI: https://admin-shell.io/idta/prop/siteid description: Identification of a site [SML] AddressReferences IRI: https://admin-shell.io/idta/sml/addressreferences description: List with references to addresses for site (site address) [File] SiteLayout IRI: https://admin-shell.io/idta/file/sitelayout description: File with a layout (map) of the site	n/a n/a [String] Kiefholzstraße 44 [String] K44 n/a n/a	[0..1] [0..1] [0..1] [1] [0..1] [0..1]

3.8 SubmodelElements of SML “SiteRegionCoordinates”,”AreaRegionCoordinates”, “FenceRegionCoordinates”

Table 8: Submodel elements of “SiteRegionCoordinates”, “AreaRegionCoordinates”, “FenceRegionCoordinates”

idShort(s):	SiteRegionCoordinates, AreaRegionCoordinates, FenceRegionCoordinates

Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/regioncoordinates		
Parent(s):	VisitedSites, VisitedAreas, VisitedFences		
Explanation:	Coordinates forming a polygon that describe the region of the site/area/fence within the coordinate reference system of the site/area/fence		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/regioncoordinateentry The SMC contains: [Prop] X IRI: https://admin-shell.io/idta/prop/x description: X-coordinate [Prop] Y IRI: https://admin-shell.io/idta/prop/y description: Y-coordinate	[Float] 115,10 m [Float] 45,00 m	[1] [1]

3.9 SubmodelElements of SML “VisitedAreas”

Table 9: Submodel elements of “VisitedAreas”

idShort:	VisitedAreas		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/visitedareas		
Parent:	AssetLocation		
Explanation:	List with areas (e.g., buildings, field warehouse) within a site where an asset has been located or is located		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/visitedareasrecord		

	The SMC contains:	n/a	[0..1]
	[Ref] CoordinateSystemOfArea IRI: https://admin-shell.io/idta/ref/coordinatesystemreference description: Reference to a local coordinate reference system for an area	n/a	[0..1]
	[SML] AreaRegionCoordinates IRI: https://admin-shell.io/idta/sml/regioncoordinates description: Coordinates forming a polygon that describes the area within the coordinate reference system of the area	n/a	[0..1]
	[Ref] SiteOfArea IRI: https://admin-shell.io/idta/ref/sitereference description: Reference to a site where the area is located in	n/a	[0..1]
	[Ref] AddressReference IRI: https://admin-shell.io/idta/ref/addressreference description: Reference to an address	[String] OPEN_SPACE	[0..1]
	[Prop] KindOfArea IRI: https://admin-shell.io/idta/prop/kindofarea description: Kind of the area, the enumeration "OPEN_SPACE", "SINGLE_LEVEL_BUILDING", "MULTI_LEVEL_BUILDING" can be used	[String] Außenlager Signale	[0..1]
	[Prop] AreaName IRI: https://admin-shell.io/idta/prop/areaname description: Name of the area or building	[String] ALSig	[1]
	[Prop] AreaId IRI: https://admin-shell.io/idta/prop/areaid description: Identification of an area	[langString] Einbruchgesicherter Bereich@de	[0..1]
	[MLP] AreaDesciption IRI: https://admin-shell.io/idta/mlp/areadescription description: Discription of an area	n/a	[0..1]
	[File] AreaLayout IRI: https://admin-shell.io/idta/file/arealayout description: File with a layout (map) of the area (e.g., hall plan)	[String] 1.5 EG	[0..1]
	[Prop] BuildingLevel IRDI: 0173-1#02-ABJ094#001 description: Number/designation of the floor		

3.10 SubmodelElements of SML “VisitedFences”

Table 10: Submodel elements of “VisitedFences”

idShort:	VisitedFences		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/visitedfences		
Parent:	AssetLocation		
Explanation:	List with fences (monitored localization zones) where an asset has entered/left		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/visitedfencesrecord The SMC contains:		
	[Ref] CoordinateSystemOfFence IRI: https://admin-shell.io/idta/ref/coordinatesystemreference description: Reference to a local coordinate reference system for a fence	n/a	[0..1]
	[Ref] SiteOfFence IRI: https://admin-shell.io/idta/ref/sitereference description: Reference to a site where the fence is located in	n/a	[0..1]
	[Ref] AreaOfFence IRI: https://admin-shell.io/idta/ref/areareference description: Reference to an area where the fence is located in	n/a	[0..1]
	[SML] FenceRegionCoordinates IRI: https://admin-shell.io/idta/sml/regioncoordinates description: Coordinates forming a polygon that describes the region of the fence within the coordinate reference system of the fence	n/a	[0..1]
	[Prop] FenceName IRI: https://admin-shell.io/idta/prop/fencename description: Name of the fence	[String] Anlieferung Schweißerei	[0..1]
	[Prop] FenceId IRI: https://admin-shell.io/idta/prop/fenceid description: Identification of a fence	[String] ANL01	[1]

	[MLP] FenceDescription IRI: https://admin-shell.io/idta/mlp/fencedescription description: Discription of a fence	[langString] Signal für Platzbelegung@de	[0..1]

3.11 SubmodelElements of SMC “AssetTraces”

Table 11: Submodel elements of “AssetTraces”

idShort:	AssetTraces
Class:	SubmodelElementCollection
semanticId:	https://admin-shell.io/idta/smc/assettraces
Parent:	AssetLocation
Explanation:	Collection of localization event records for sites, areas, fences and locations

[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Ref] SiteEventTimeSeriesData	[IRI] https://admin-shell.io/idta/ref/eventtimeseriesdata Reference to an AAS time series data Submodel instance of the same AAS with SiteRecords	n/a	[0..1]
[Ref] AreaEventTimeSeriesData	[IRI] https://admin-shell.io/idta/ref/eventtimeseriesdata Reference to an AAS time series data Submodel instance of the same AAS with AreaRecords	n/a	[0..1]
[Ref] FenceEventTimeSeriesData	[IRI] https://admin-shell.io/idta/ref/eventtimeseriesdata Reference to an AAS time series data Submodel instance of the same AAS with FenceRecords	n/a	[0..1]
[Ref] LocationEventTimeSeriesData	[IRI] https://admin-shell.io/idta/ref/eventtimeseriesdata Reference to an AAS time series data Submodel instance of the same AAS with LocationRecords	n/a	[0..1]
[SML] SiteRecords	[IRI] https://admin-shell.io/idta/sml/siterecords List with records for site localization events	n/a	[0..1]

[SML] AreaRecords	[IRI] https://admin-shell.io/idta/sml/arearecords List with records for area localization events	n/a	[0..1]
[SML] FenceRecords	[IRI] https://admin-shell.io/idta/sml/fencerecords List with records for fence localization events	n/a	[0..1]
[SML] LocationRecords	[IRI] https://admin-shell.io/idta/sml/locationrecords List with records for location (position) localization events	n/a	[0..1]

3.12 SubmodelElements of SML “SiteRecords”

Table 12: Submodel elements of “SiteRecords”

idShort:	SiteRecords		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/siterecords		
Parent:	AssetTraces		
Explanation:	List with records for site localization events		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/siterecordsrecord The SMC contains:		
	[Ref] SiteRef IRI: https://admin-shell.io/idta/ref/regionreference description: Reference to the site where the event has been recorded for	n/a	[1]
	[Prop] Time IRDI: 0173-1#02-ABF198#002 description: Time when the event occurred	[dateTime]	[1]
	[Prop] EventId IRI: https://admin-shell.io/idta/prop/eventid description: Identification of an event	[String]	[0..1]
	[Prop] ProviderId IRI: https://admin-shell.io/idta/prop/providerid description: Identification of the location provider which triggered the event	[String]	[0..1]

	[Prop] EventType IRI: https://admin-shell.io/idta/prop/eventtype description: Type of an event that is triggered when an asset is located at a localization fence	[String] REGION_ENTRY REGION_EXIT	[1]

3.13 SubmodelElements of SML “AreaRecords”

Table 13: Submodel elements of “AreaRecords”

idShort:	AreaRecords		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/arearecords		
Parent:	AssetTraces		
Explanation:	List with records for area localization events		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/arearecordsrecord The SMC contains:		
	[Ref] AreaRef IRI: https://admin-shell.io/idta/ref/regionreference description: Reference to the area where the event has been recorded for	n/a	[1]
	[Prop] Time IRDI: 0173-1#02-ABF198#002 description: Time when the event occurred	[dateTime]	[1]
	[Prop] EventId IRI: https://admin-shell.io/idta/prop/eventid description: Identification of an event	[String]	[0..1]
	[Prop] ProviderId IRI: https://admin-shell.io/idta/prop/providerid description: Identification of the location provider which triggered the event	[String]	[0..1]
	[Prop] EventType IRI: https://admin-shell.io/idta/prop/eventtype description: Type of an event that is triggered when an asset is located at a localization fence	[String] REGION_ENTRY REGION_EXIT	[1]

3.14 SubmodelElements of SML “FenceRecords”

Table 14: Submodel elements of “FenceRecords”

idShort:	FenceRecords		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/fencerecords		
Parent:	AssetTraces		
Explanation:	List with records for fence localization events		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/fencerecordsrecord The SMC contains:		
	[Ref] FenceRef IRI: https://admin-shell.io/idta/ref/regionreference description: Reference to the fence where the event has been recorded for	n/a	[1]
	[Prop] Time IRDI: 0173-1#02-ABF198#002 description: Time when the event occurred	[dateTime]	[1]
	[Prop] EventId IRI: https://admin-shell.io/idta/prop/eventid description: Identification of an event	[String]	[0..1]
	[Prop] ProviderId IRI: https://admin-shell.io/idta/prop/providerid description: Identification of the location provider which triggered the event	[String]	[0..1]
	[Prop] EventType IRI: https://admin-shell.io/idta/prop/eventtype description: Type of an event that is triggered when an asset is located at a localization fence	[String] REGION_ENTRY REGION_EXIT	[1]

3.15 SubmodelElements of SML “LocationRecords”

Table 15: Submodel elements of “LocationRecords”

idShort:	LocationRecords		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/sml/locationrecords		
Parent:	AssetTraces		
Explanation:	List with records for location (position) localization events		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/idta/smc/locationrecordsrecord The SMC contains: [Ref] CoordinateSystemReference IRI: https://admin-shell.io/idta/ref/coordinatesystemreference description: Reference to a coordinate reference system for the position [SMC] Position IRDI: 0173-1#02-ABI783#001 description: n/a [Prop] ProviderId IRI: https://admin-shell.io/idta/prop/providerid description: Identification of the location provider which triggered the event [Prop] ProviderType IRI: https://admin-shell.io/idta/prop/providertype description: Type of the location information provider, e.g. "UWB tag" [Prop] Accuracy IRI: https://admin-shell.io/idta/prop/accuracy description: The horizontal accuracy of the position data [Prop] MagneticHeading IRI: https://admin-shell.io/idta/prop/magneticheading description: The magnetic heading direction of the Asset	n/a n/a [String] [String] [Double] 0.1 m [Integer] 30° [Integer] 31°	[1] [1] [0..1] [0..1] [0..1] [0..1] [0..1]

	[Prop] TrueHeading IRI: https://admin-shell.io/idta/prop/trueheading description: The corrected magnetic heading direction of the Asset	[Integer] 2°	[0..1]
	[Prop] HeadingAccuracy IRI: https://admin-shell.io/idta/prop/headingaccuracy description: The maximum deviation between the reported magnetic heading and the true heading	[dateTime]	[1]
	[Prop] Time IRDI: 0173-1#02-ABF198#002 description: Time when the event occurred	[dateTime]	[0..1]
	[Prop] TransmissionTime IRI: https://admin-shell.io/idta/prop/transmissiontime description: Time (timestamp) when the location information has been updated	[String]	[0..1]
	[MLP] LocationDescription IRI: https://admin-shell.io/idta/mlp/locationdescription description: Location description (meta information for the position), it is recommended to refer to the origin of the CRS	[Float] 0,1 m/s	[0..1]
	[Prop] Speed IRDI: 0173-1#02-AAV544#004 description: Operating speed	[Integer] 45°	[0..1]
	[Prop] Course IRI: https://admin-shell.io/idta/prop/course description: The current course ("compass direction") where the asset is heading to	[String] X23	[0..1]
	[Prop] ReferencePointId IRI: https://admin-shell.io/idta/prop/referencepointid description: Identificator of a reference point at the Asset for which the position has been submitted		

3.16 SubmodelElements of SMC “Position”

Table 16: Submodel elements of “Position”

idShort:	Position
Class:	SubmodelElementCollection
semanticId:	0173-1#02-ABI783#001
Parent:	AssetTraces

Explanation:	Position of an asset		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] X	[IRI] https://admin-shell.io/idta/prop/x X-coordinate value within a coordinate system	[Float] 103,234 m	[1]
[Prop] Y	[IRI] https://admin-shell.io/idta/prop/y Y-coordinate value within a coordinate system	[Float] 103,234 m	[1]
[Prop] Z	[IRI] https://admin-shell.io/idta/prop/z Z-coordinate (height) value within a coordinate system	[Float] 103,234 m	[1]

3.17 SubmodelElements of SMC “AssetLocatingInformation”

Table 17: Submodel elements of “AssetLocatingInformation”

idShort:	AssetLocatingInformation		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/idta/sml/assetlocatinginformation		
Parent:	AssetLocation		
Explanation:	Collection with additional information concerning the localization of an asset		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] Localizable	[IRI] https://admin-shell.io/idta/prop/localizable Information whether the position can be currently updated with the correct position	[Boolean]	[0..1]
[MLP] RealtimeCapabilityOfAAS	[IRI] https://admin-shell.io/idta/mlp/realtimecapabilityofaas Information about to what extend the location provision via the AAS - as it is implemented in the system - has real time capability	[langString]	[0..1]

[Prop] RealtimeLocation SourceType	[IRI] https://admin-shell.io/idta/prop/realtimelocationsourcetype Type or name of the source that delivers real time information for the asset's location, e.g., OMLOX	[String]	[0..1]
[MLP] RealtimeLocation Source	[IRI] https://admin-shell.io/idta/mlp/realtimelocationsource Information regarding a source for real time location data, e.g., URL and API documentation for DeepHub	[langString]	[0..1]

Appendix A – Additional information

Using omlox Hub as a Provider for IDTA Asset Location Data

This appendix details the use of the omlox Hub standard as a centralized platform for integrating various location technologies with IDTA Asset Location. It focuses on how omlox Hub middleware functions as a primary source for IDTA Asset Location updates and real-time events.

The location data flow, in the context of an asset's lifecycle, involves two primary steps:

1. Receiving and Processing Asset Location Updates

The omlox Hub is designed to continuously receive location data from various locating systems. The data processing takes into account its origin, type, and the specific coordinate system from which it originates. Sending location data can be achieved through a REST PUT request to the omlox Hub’s batch update endpoint:

http://{HubURL}/deephub/v2/providers/locations

Following the initial pre-processing, the omlox Hub post-processes the location data, generating geofence and collision events. The transformed data is then distributed to subscribers via Websocket and MQTT.

To integrate asset location updates with omlox Hub:

- Establish a Websocket connection to the Hub’s endpoint at ***ws://{HubURL}/deephub/v2/ws/socket***
- Subscribe to the ***location_updates*** topic through the Websocket connection with the following message:
  {
  "event": "subscribe",
  "topic": "location_updates",
  }
- Update the IDTA Asset Location ***LocationRecords*** list using real-time omlox location updates from the Websocket connection, mapping the omlox location data to an IDTA Asset Location record as follows:
  - Rename the following objects (omlox property -> IDTA Asset Location property):
    - ***timestamp_generated*** -> ***Time***
    - ***provider_id*** -> ***ProviderId***
    - ***provider_type*** -> ***ProviderType***
    - ***true_heading*** -> ***Heading***
    - ***heading_accuracy*** -> ***HeadingAccuracy***
    - ***timestamp_sent*** -> ***TransmissionTime***
    - ***speed*** -> ***Speed***
    - ***course*** -> ***Course***
    - ***source*** -> ***CoordinateSystemReference***
  - Map the omlox position array to Position.x, Position.y and Position.z. The first item in an omlox position array is x, second is y, third is z.
  - Check if a reference to CoordinateSystemReference exists in the IDTA CoordinateSystems. If it does not exist: fetch the the omlox Zone with the respective id of

CoordinateSystemReference and create an entry in CoordinateSystems by mapping the omlox Zone to the IDTA Asset Location CoordinateSystem as follows:

- Map the omlox zone’s id to CoordinateSystemId
- Map the omlox zone’s ground_control_points to IDTA GroundControlPoints.

This process captures all necessary location updates, with the volume of data varying based on the locating systems’ type and configuration.

2. Real-time Event Generation and Asset Traces Processing

After capturing all raw location updates, the next step involves processing these to relate to specific geographic areas or named places. This can be done utilizing omlox Hub’s fence event processing. Fence events, triggered on entry and exit from a defined region, also help to manage the volume of location data stored within the asset shell by focusing on significant location changes.

Steps for integrating fence events include:

- Creating a Fence, assigning it a relevant region and name, using the omlox Hub’s REST API at ***http://{HubURL}/deephub/v2/fences***
- To map omlox fences to IDTA sites or areas, add a property named ***idta_type*** to the fence’s properties object, with possible values being site, area, or fence. This categorization helps to relate fence events with IDTA’s ***VisitedSites***, ***VisitedAreas***, or ***VisitedFences***.
- Establish a connection to the Hub’s Websocket endpoint at ***ws://{HubURL}/deephub/v2/ws/socket*** and subscribe to the ***fence_events*** topic.
- For each fence event received, update the IDTA Asset Location ***FenceRecords*** list and, based on the defined ***idta_type***, update the corresponding ***VisitedSites*** and ***VisitedAreas*** lists.
- Optionally, defer storing location updates received from the Hub to the IDTA ***LocationRecords*** as outlined in step 1 at the time a fence event is triggered. This effectively reduces the location records in the asset shell to maintain only the significant location changes when a region of interest is entered or left.

The omlox Hub's support for hierarchical fence layouts also allows for complex tracking and tracing scenarios. For example, a larger fence might represent an entire manufacturing site, with smaller fences representing halls or process steps. This hierarchical system can efficiently report the duration an asset spends in specific areas, like the time spent for an overall process at the site as well as times spent at specific processing steps during that site visit, optimizing the overall tracking and management process.

Appendix B – Explanations on used table formats

1. General

The used tables in this document try to outline information as concise as possible. They do not convey all information on Submodels and SubmodelElements. For this purpose, the definitive definitions are given by a separate file in form of an AASX file of the Submodel template and its elements.

2. Tables on Submodels and SubmodelElements

For clarity and brevity, a set of rules is used for the tables for describing Submodels and SubmodelElements.

- The tables follow in principle the same conventions as in [5].
- The table heads abbreviate 'cardinality' with 'card'.
- The tables often place two informations in different rows of the same table cell. In this case, the first information is marked out by sharp brackets [] form the second information. A special case are the semanticIds, which are marked out by the format: (type)(local)[idType]value.
- The types of SubmodelElements are abbreviated:

SME type	SubmodelElement type
Property	Property
MLP	MultiLanguageProperty
Range	Range
File	File
Blob	Blob
Ref	ReferenceElement
Rel	RelationshipElement
SMC	SubmodelElementCollection

- If an idShort ends with '{00}', this indicates a suffix of the respective length (here: 2) of decimal digits, in order to make the idShort unique. A different idShort might be choosen, as long as it is unique in the parent’s context.
- The Keys of semanticId in the main section feature only idType and value, such as: [IRI]https://admin-shell.io/vdi/2770/1/0/DocumentId/Id. The attributes "type" and "local" (typically "ConceptDescription" and "(local)" or "GlobalReference" and (no-local)") need to be set accordingly; see [6].
- If a table does not contain a column with "parent" heading, all represented attributes share the same parent. This parent is denoted in the head of the table.
- Multi-language strings are represented by the text value, followed by '@'-character and the ISO 639 language code: example@EN.
- The [valueType] is only given for Properties.

Appendix C – Bibliography

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