Digitale Interoperabilität in kollaborativen Wertschöpfungsnetzwerken der Industrie 4.0

SPECIFICATION

Technical Data for AGV in Intralogistics

Version 1-0

2023-12-11

Submodel Template of the Asset Adminstration Shell

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10117 Berlin
Germany

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Authors

Haris Avgoustinos, EXPO21XX GmbH
Johannes Mäule, Fraunhofer-Institut für Fabrikbetrieb und -automatisierung IFF
Marcell Missura, T-Systems International GmbH
Thomas Pfaff, Sächsisches Textilforschungsinstitut e.V. (Use Case Provider)
Rico Schady, FoP Consult GmbH (Method Consultant)

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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 Scope of the Submodel

The material flow in the factory will increasingly be driverless and autonomously controlled. With the growing penetration of production with AGVs, these will also take on very specific transport, handling and, with the right setup, possibly also assembly or manufacturing tasks.

> In this specification AGV is used as generic term for all driverless vehicles and robots in intralogistics. This Submodel supports all kinds of driverless vehicles like AMR or guided FTF.

Suppliers of AGVs will continue to develop specific capabilities and features for their vehicles and possible attachments. This will inevitably lead to the situation where different types of vehicles and vehicles from different manufacturers have to be operated in one production environment. These mixed fleets have to be integrated in the overall driverless transportation system and controlled via a central or decentral control system. In most cases this control system will be linked to the ERP or MES system where it is receiving the transportation orders from. Control systems can be proprietary systems of the vehicle supplier or manufacturer-independent systems. With increasingly mixed fleets in operation manufacturer-independent control systems will be more widespread on the market.

Against this background, a digital twin in the form of an AAS for the vehicles is to form the data basis for the integration of the individual vehicles into an overall system. The Submodel "Technical Data for Automated Guided Vehicles in Intralogistics" aims to identify the necessary information for integration and standardize it with an AAS Submodel specification. In addition to the integration aspect in an overall system during the engineering phase, the Submodel should also take into account technical data needs for commissioning, operation and maintenance.

1.3 Relevant standards

One important standard that aims the interoperability of AGV in the field of communication is VDA 5050: „Schnittstelle zur Kommunikation zwischen Fahrerlosen Transportfahrzeugen (FTF) und einer Leitsteuerung.“, Version 2.0.0 of January 2022. This standard has been considered in the Submodel, especially to provide the necessary information for MQTT communication according VDA 5050.

Further standards that have been investigated regarding technical data for AGV were:

- VDI 2510: Automated Guided Vehicle Systems (AGVS)

- VDI 2710: Interdisciplinary design of automated guided vehicle systems (AGVS)
- VDI 4451: Compatibility of Automated Guided Vehicle Systems (AGVS)
- ISO 3691-4:2023: Industrial trucks: Safety requirements and verification, Part 4: Driverless industrial trucks and their systems
- MassRobotics Interoperability Standard for Industrial Mobile Robots, Version 1.0

2 Approach of the Submodel

2.1 Use cases and requirements

The use case of the Submodel is the provision of technical data of AGV for the engineering, commissioning, operation and maintenance of driverless transportation systems as shown in Figure 1.

For the engineering phase the Submodel provides relevant information that help to select the right type of vehicle and to engineer the overall system.

During the commissioning, operation and maintenance phase the Submodel provides technical data of interest but not content like contact information, capability descriptions, maintenance instructions or operational data. Therefore, other Submodel Templates are available from IDTA or should be developed in future.

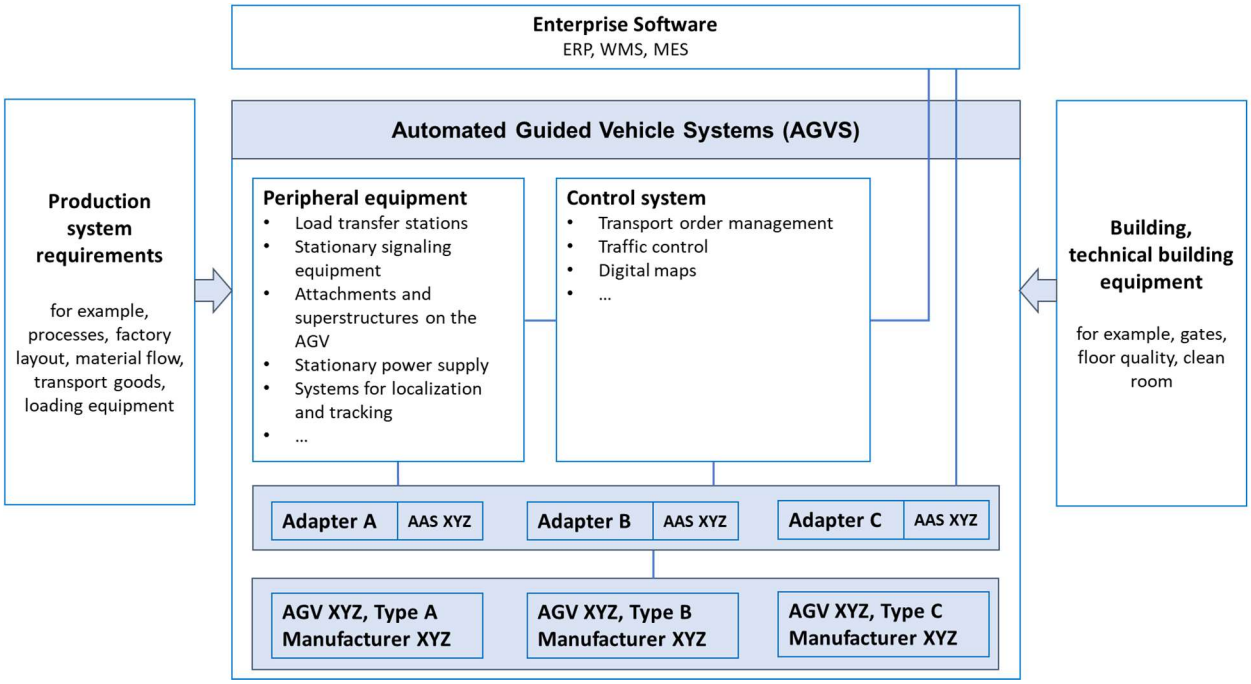

Figure 1: Driverless Transportation System

The Submodel contains the technical data of vehicles which is are an important element of automated guided vehicle system. As in Figure 1 shown, the different vehicle types from different manufacturers will be integrated with the peripheral equipment, control system and enterprise software through a kind of “adapter” that is implemented on a middleware layer. The Asset Administration Shell will provide vehicle specific data that can be accessed by the different system elements and is illustrated here as well on the middleware layer.

The Submodel “Technical Data for AGV in Intralogistics”, as one potential Submodel within the vehicle’s AAS, will provide technical data as well temporary technical data. Temporary technical data are depending on current configurations of the vehicle but differ from operational data, that are used to control the vehicle or are real-time values (see Table 1).

The concept of “Temporary Technical Data” has been introduced to model the actual implementation at the operator’s site as well as changing configurations in the operation phase. For the overall system the

Submodel of the AGV will deliver information not only about the vehicle “as build” but also “as operated” and embedded into the overall system.

Table 1: Differentiation between types of technical and operational data

	Permanent Technical Data	Temporary Technical Data	Operational Data
Explanation	Technical data of the vehicle as build	Technical data of the vehicle as currently configured (with complementary attachments)	Current state of the vehicle
Example	Hight of the vehicle	Current attachments	Battery level

2.2 Structure and design decisions

As standard for modeling of the Submodel the IDTA specification “Generic Frame for Technical Data for Industrial Equipment in Manufacturing“ with the document number IDTA 02003-1-2 has been followed (see Figure 2). The SubmodelCollection “Technical Properties” holds the specific technical data for AGV. The SubmodelCollection “FurtherInformation” holds potential additional information that have not been modeled so far as textual statements by the manufacturer.

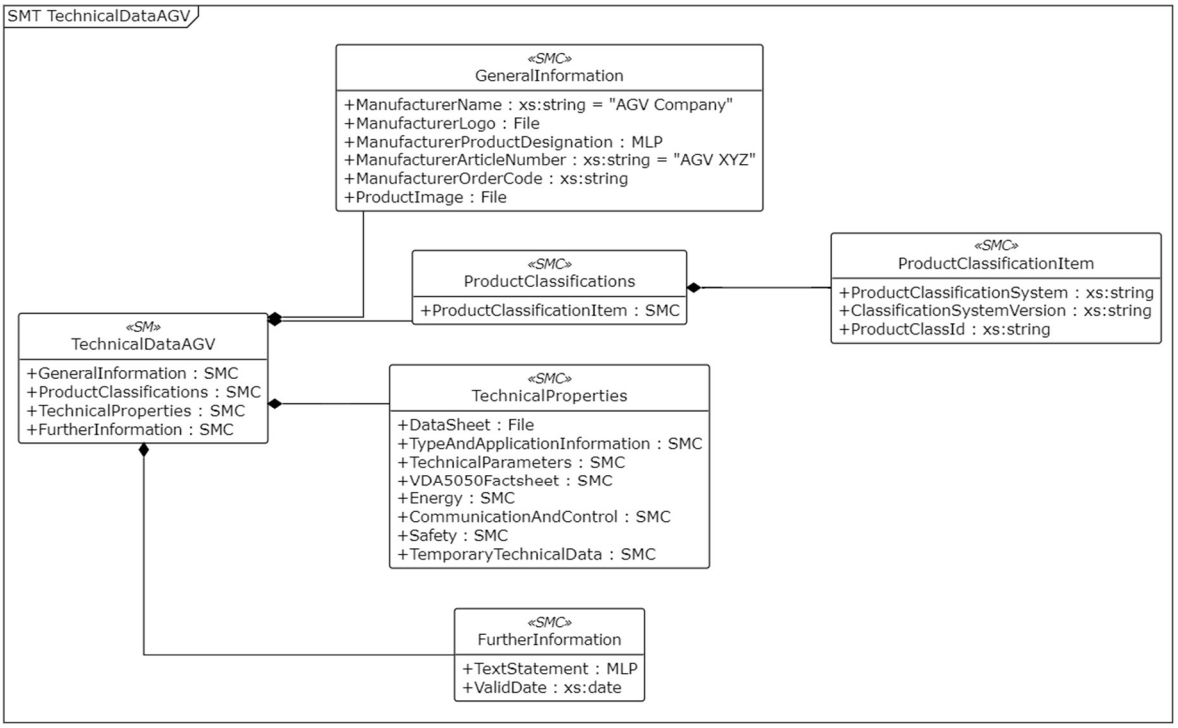

Figure 2: Information structuring of the Submodel template “TechnicalData”

The structure of the SubmodelCollection “Technical Properties” is shown in Figure 3. The manufacturers datasheet for an asset can be imported as File into the AAS directly in the “TechnicalProperties” section. All other information is structured under the SubmodelCollections “TypeAndApplicationInformation”,

“TechnicalParameters”, “VDA5050Factsheet”, “EnergyAndCommunication” with a subsection “Battery”, “Safety” and “TemporaryTechnicalData”.

In addition to typical properties that can be often found on AGV factsheets the Submodel is suitable to hold relevant detailed information for selection and system engineering as MultiLanguageProperties. Thus, also details of the functionality and characteristics of the vehicle can be transported by the AAS on expert level.

The JSON-Objects of the VDI 5050 Factsheet can be hold by the AAS as Blob with contentType: application/json.

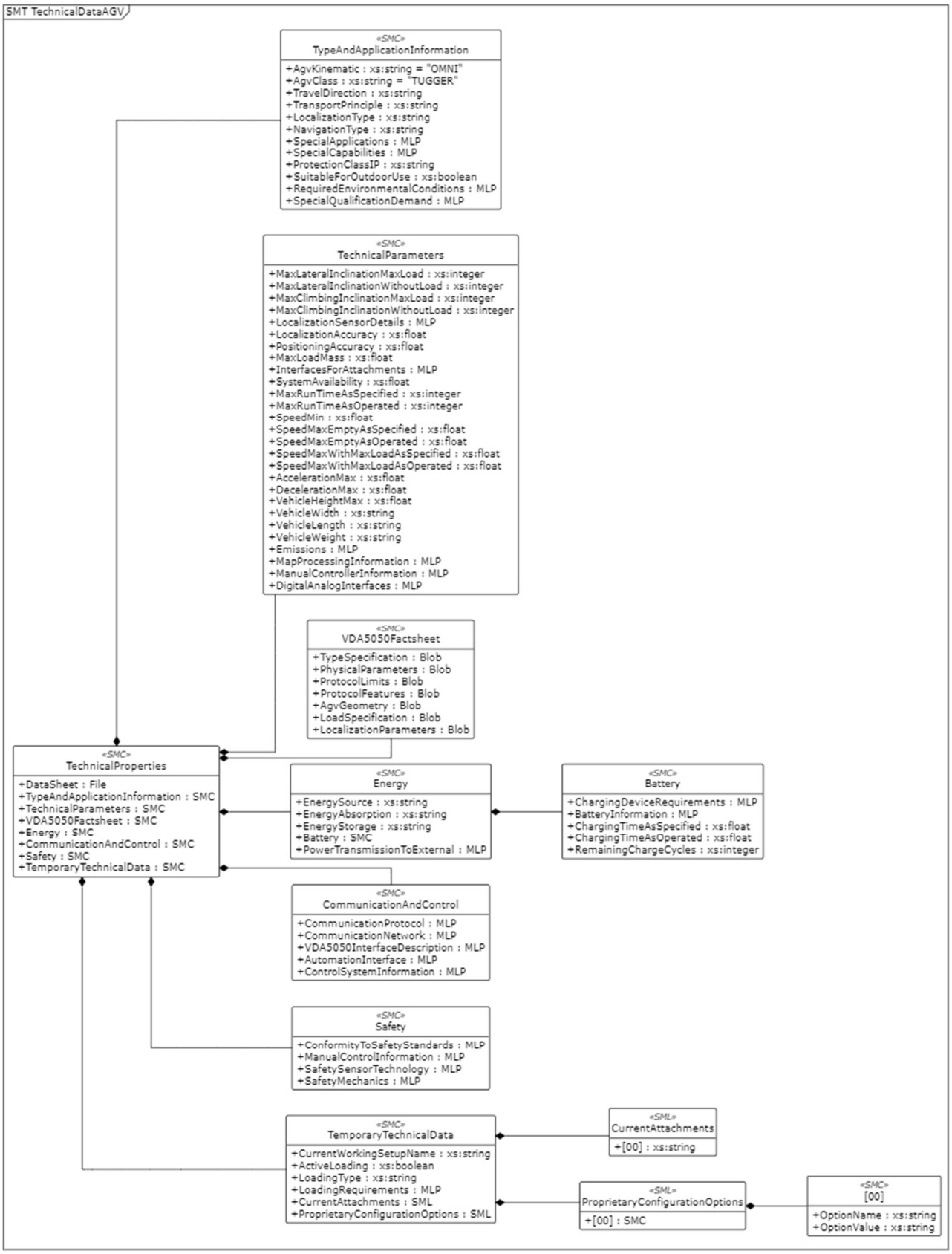

Figure 3: Information structuring of the SubmodelCollection “TechnicalProperties”

3 Submodel and SubmodelElements

3.1 SubmodelElements of the Submodel template “TechnicalDataAGV”

Table 2: Submodel elements of “Technical Data for AGV in Intralogistics”

idShort:	TechnicalDataAGV		
Class:	Submodel		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/Submodel/1/2		
Parent:	Asset Administration Shell with asset, which is an AGV		
Explanation:	Submodel containing technical data for AGV in intralogistics		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] GeneralInformation	[IRI] https://admin-shell.io/ZVEI/TechnicalData/GeneralInformation/1/1 General information, for example ordering and manufacturer information.	n/a	[1]
[SMC] ProductClassifications	[IRI] https://admin-shell.io/ZVEI/TechnicalData/ProductClassifications/1/1 Product classifications by association of product classes with common classification systems.	n/a	[0..1]
[SMC] TechnicalProperties	[IRI] https://admin-shell.io/ZVEI/TechnicalData/TechnicalProperties/1/1 Individual characteristics that describe the product and its technical properties.	n/a	[0..1]
[SMC] FurtherInformation	[IRI] https://admin-shell.io/ZVEI/TechnicalData/FurtherInformation/1/1 Further information on the product, the validity of the information provided and this data record.	n/a	[0..1]

The SubmodelCollections GeneralInformation, ProductClassification and FurtherInformation are not further specified in this document as identical to the SMT “Generic “Generic Frame for Technical Data for Industrial Equipment in Manufacturing“ with the document number IDTA 02003-1-2.

3.2 SubmodelElements of SMC “TechnicalProperties”

Table 3: Submodel elements of “TechnicalProperties”

idShort:	TechnicalProperties		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/TechnicalProperties/1/1		
Parent:	TechnicalDataAGV		
Explanation:	Individual characteristics that describe the product and its technical properties		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[File] DataSheet	[IRI] https://admin-shell.io/idta/smt/file/datasheet Document with technical product data of the AGV provided by the manufacturer	n/a	[0..1]
[SMC] TypeAndApplicationInformation	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Information about the AGV type and the vehicle's applications	n/a	[0..1]
[SMC] TechnicalParameters	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Technical parameters/properties of the AGV	n/a	[0..1]
[SMC] VDA5050Factsheet	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Factsheet data according VDA 5050 MQTT communication protocol	n/a	[0..1]
[SMC] Energy	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Technical properties related to the energy supply of the AGV	n/a	[0..1]

[SMC] CommunicationAndControl	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Technical properties related to the communication and control of the AGV	n/a	[0..1]
[SMC] Safety	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Technical properties related to the safety of the AGV	n/a	[0..1]
[SMC] TemporaryTechnicalData	[IRI] https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1 Temporary technical data depending on the implementation at the operator and current configuration	n/a	[0..1]

3.3 SubmodelElements of SMC “TypeAndApplicationInformation”

Table 4: Submodel elements of “TypeAndApplicationInformation”

idShort:	TypeAndApplicationInformation		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/TechnicalProperties/1/1		
Parent:	TechnicalProperties		
Explanation:	Information about the AGV type and the vehicle's applications		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] AgvKinematic	[IRI] https://admin-shell.io/idta/smt/prop/agvkinematic Type of Kinematic of the AGV. The enumerations according VDA5050 "DIFF", "OMNI", "THREEWHEEL", "OTHER" can be used.	[String] OMNI	[0..1]
[Prop] AgvClass	[IRI] https://admin-shell.io/idta/smt/prop/agvclass Class of the AGV. The enumeration according VDA5050 with "FORKLIFT", "CONVEYER", "TUGGER", "CARRIER", "OTHER" can be used.	[String] TUGGER	[0..1]

[Prop] TravelDirection	[IRI] https://admin-shell.io/idta/smt/prop/traveldirection Direction of traveling of the AGV, the enumeration "FORWARD", "BACKWARD", "OMNI-DIRECTIONAL" can be used.	[String] OMNI-DIRECTIONAL	[0..1]
[Prop] TransportPrinciple	[IRI] https://admin-shell.io/idta/smt/prop/transportprinciple Transportation pinciple of the AGV. The enumeration "LOADPULLING", "LOADCARRYING", "MIXED" can be used.	[String] LOADPULLING	[0..1]
[Prop] LocalizationType	[IRI] https://admin-shell.io/idta/smt/prop/localizationtype Type of the localization the AGV is using. The enumeration according VDA5050 with "NATURAL", "REFLECTOR", "RFID", "DMC", "SPOT", "GRID", "OTHER" can be used.	[String] NATURAL	[0..1]
[Prop] NavigationType	[IRI] https://admin-shell.io/idta/smt/prop/navigationtype Type of navigation the AGV uses. The enumeration according VDA5050 with "PHYSICAL_LINE_GUIDED", "VIRTUAL_LINE_GUIDED", "AUTONOMOUS" can be used.	[String] AUTONOMOUS	[0..1]
[MLP] SpecialApplications	[IRI] https://admin-shell.io/idta/smt/mlp/specialapplications Special applications and usage sectors of the AGV, e.g. EMC environment, chemical industry, mining, clean rooms, refrigerated rooms, areas with explosion risk	[langString] Suitable for clean rooms@en	[0..1]
[MLP] SpecialCapabilities	[IRI] https://admin-shell.io/idta/smt/mlp/specialcapabilities Special capabilities and functions of the AGV	[langString] Suitable for uneven floors@en	[0..1]
[Prop] ProtectionClassIP	[IRDI] 0173-1#02-AAV695#003 Extent of protection provided by an enclosure against access to hazardous parts, against ingress of solid foreign objects and against ingress of water	[String] IP64	[0..1]
[Prop] SuitableForOutdoorUse	[IRDI] 0173-1#02-BAD676#009 Whether the product is suitable for use outdoors	[Boolean] no	[0..1]
[MLP] RequiredEnvironmentalConditions	[IRI] https://admin-shell.io/idta/smt/mlp/requiredenvironmentalconditions	[langString]	[0..1]

	Description of required environmental conditions that have to be fulfilled to use the AGV, e.g., floor condition or ambient temperature (min./max.)	Temperaturbereich +5 … 40°C@de	
[MLP] SpecialQualificationDemand	[IRI] https://admin-shell.io/idta/smt/mlp/specialqualificationdemand	[langString] ROS2 mid level qualification recommended@en	[0..1]

3.4 SubmodelElements of SMC “TechnicalParameters”

Table 5: Submodel elements of “TechnicalParameters”

idShort:	TechnicalParameters		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1		
Parent:	TechnicalProperties		
Explanation:	Technical parameters/properties of the AGV		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] MaxLateralInclinationMaxLoad	[IRI] https://admin-shell.io/idta/smt/prop/maxlateralinclination Maximal lateral inclination of the AGV when loaded with the maximum weight	[Integer] 2°	[0..1]
[Prop] MaxLateralInclinationWithoutLoad	[IRI] https://admin-shell.io/idta/smt/prop/maxlateralinclination Maximal lateral inclination of the AGV when unloaded	[Integer] 3°	[0..1]
[Prop] MaxClimbingInclinationMaxLoad	[IRI] https://admin-shell.io/idta/smt/prop/maxclimbinginclination Maximal climbing inclination of the AGV when loaded with the maximum weight	[Integer] 3°	[0..1]
[Prop] MaxClimbingInclinationWithoutLoad	[IRI] https://admin-shell.io/idta/smt/prop/maxclimbinginclination	[Integer] 2°	[0..1]

	Maximal climbing inclination of the AGV when unloaded		
[MLP] LocalizationSensorDetails	[IRI] https://admin-shell.io/idta/smt/mlp/localizationsensordetails Information about used localization sensors by the AGV	[langString] LiDAR safety laser scanner used@en	[0..1]
[Prop] LocalizationAccuracy	[IRI] https://admin-shell.io/idta/smt/prop/localizationaccuracy Accuracy of the determination of the current location of the AGV	[Float] 30 mm	[0..1]
[Prop] PositioningAccuracy	[IRI] https://admin-shell.io/idta/smt/prop/positioningaccuracy Positioning accuracy of the AGV	[Float] 40 mm	[0..1]
[Prop] MaxLoadMass	[IRDI] 0173-1#02-ABJ258#001 Maximal load on the AGV including attachments and load Note: ECLASS definition: maximum external load allowed from above	[Float] 2000 kg	[0..1]
[MLP] InterfacesForAttachments	[IRI] https://admin-shell.io/idta/smt/prop/interfacesforattachments Description of the mechanical and electrical interfaces for load handling attachments and other attachments	[langString]	[0..1]
[Prop] SystemAvailability	[IRDI] 0173-1#02-ABA730#002 System availability of the AGV Note: ECLASS definition: probability that a machine will, when used under specified conditions, operate satisfactorily and effectively	[Float] 98 %	[0..1]
[Prop] MaxRunTime01	[IRDI] 0173-1#02-AAJ479#004 Max runtime as stated in the specification sheet of the AGV Note: ECLASS definition: specification of the duration of the operating time of the machine with an accumulator set/ battery set	[Integer] 120 min	[0..1]
[Prop] MaxRunTime02	[IRDI] 0173-1#02-AAJ479#004 Max runtime as the AGV is operated in the current environment Note: ECLASS definition: specification of the duration of the operating time of the machine with an accumulator set/ battery set	[Integer] 100 min	[0..1]

[Prop] SpeedMin	[IRI] https://admin-shell.io/idta/smt/prop/speedmin Minimum controlled continuous speed	[Float] 5 km/h	[0..1]
[Prop] SpeedMaxEmptyAsSpecified	[IRI] https://admin-shell.io/idta/smt/prop/speedmaxempty Maximum speed without load as specified by the manufacturer	[Float] 18 km/h	[0..1]
[Prop] SpeedMaxEmptyAsOperated	[IRI] https://admin-shell.io/idta/smt/prop/speedmaxempty Maximum speed without load as in the current system operated	[Float] 10 km/h	[0..1]
[Prop] SpeedMaxWithMaxLoadAsSpecified	[IRI] https://admin-shell.io/idta/smt/prop/speedmaxwithmaxload Maximum speed with maximal load as specified by the manufacturer	[Float] 18 km/h	[0..1]
[Prop] SpeedMaxWithMaxLoadAsOperated	[IRI] https://admin-shell.io/idta/smt/prop/speedmaxwithmaxload Maximum speed with maximal load as operated in the current system	[Float] 8 km/h	[0..1]
[Prop] AccelerationMax	[IRDI] 0173-1#02-ABG746#002 Maximum acceleration of the AGV with maximum load Note: ECLASS definition: largest temporal rate of change of the speed	[Float]	[0..1]
[Prop] DecelerationMax	[IRI] https://admin-shell.io/idta/smt/prop/decelerationmax Largest negative temporal rate of change of the speed	[Float]	[0..1]
[Prop] VehicleHeightMax	[IRDI] 0173-1#02-BAE355#006 Maximum height of the AGV without attachments Note: ECLASS definition: States the upper boundary for height	[Float] 511 mm	[0..1]
[Prop] VehicleWidth	[IRDI] 0173-1#02-AAG933#004 Maximum vehicle width Note: ECLASS definition: maximum length of the object in horizontal direction	[Float] 420 mm	[0..1]
[Prop] VehicleLength	[IRDI] 0173-1#02-ABE774#002 Maximum lengths of the AGV including outstanding components	[Float] 1200 mm	[0..1]

	Note: ECLASS definition: maximum linear expansion of a product including outstanding components		
[Prop] VehicleWeight	[IRDI] 0173-1#02-ABD800#002 Maximum weight of the AGV without necessary weights Note: ECLASS definition: indication of the physical mass of the product, excluding any necessary weights	[Float] 610 kg	[0..1]
[MLP] Emissions	[IRI] https://admin-shell.io/idta/smt/mlp/emissions Description of emissions of the AGV during operation, e.g. noise or exhaust	[langString]	[0..1]
[MLP] MapProcessingInformation	[IRI] https://admin-shell.io/idta/smt/mlp/mapprocessinginformation Information about how the digital map is generated and processed by the AGV	[langString]	[0..1]
[MLP] ManualControllerInformation	[IRI] https://admin-shell.io/idta/smt/mlp/manualcontrollerinformation Information about the manual controllers of the AGV	[langString]	[0..1]
[MLP] DigitalAnalogInterfaces	[IRI] https://admin-shell.io/idta/smt/mlp/digitalanaloginterfaces Information about digital and analog interfaces of the AGV	[langString]	[0..1]

3.5 SubmodelElements of SMC “VDA5050Factsheet”

Table 6: Submodel elements of “VDA5050Factsheet”

idShort:	VDA5050Factsheet
Class:	SubmodelElementCollection
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1
Parent:	TechnicalProperties
Explanation:	Factsheet data according VDA 5050 MQTT communication protocol

[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Blob] TypeSpecification	JSON-object "typeSpecification" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]
[Blob] PhysicalParameters	JSON-object "physicalParameters" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]
[Blob] ProtocolLimits	JSON-object "protocolLimits" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]
[Blob] ProtocolFeatures	JSON-object "protocolFeatures" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]
[Blob] AgvGeometry	JSON-object "agvGeometry" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]
[Blob] LoadSpecification	JSON-object "loadSpecification" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]
[Blob] LocalizationParameters	JSON-object "localizationParameters" according VDA5050 Factsheet, Version 2.0.0, January 2022	n/a	[0..1]

3.6 SubmodelElements of SMC “Energy”

Table 7: Submodel elements of “Energy”

idShort:	Energy
Class:	SubmodelElementCollection
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1
Parent:	TechnicalProperties
Explanation:	Technical properties related to the energy supply of the AGV

[SME type]	semanticId = [idType]value	[valueType]	card.
idShort	**Description@en**	**example**	
[Prop] EnergySource	[IRI] https://admin-shell.io/idta/smt/prop/energysource	[String] POWER	[0..1]

	Type of auxiliary energy the AGV is consuming, the enumeration "POWER", "DIESEL", "GAS", "HYDROGEN", "HYBRID", "SOLAR", "OTHER" can be used		
[Prop] EnergyAbsorption	[IRI] https://admin-shell.io/idta/smt/prop/energyabsorption Way to absorb auxiliary energy. The enumeration "INDUCTION", "CONDUCTORRAIL", "FLEXIBLECABLE", "CHARGINGCABLE", "FILLER", "OTHER" can be used	[String] INDUCTION	[0..1]
[Prop] EnergyStorage	[IRI] https://admin-shell.io/idta/smt/prop/energystorage Type of storage the AGV is using. The enumeration "BATTERY", "TANK", "CARTRIDGE", "CAPACITOR", "OTHER" can be used.	[String] BATTERY	[0..1]
[SMC] Battery	[IRI] https://admin-shell.io/ZVEI/TechnicalData/SubSection/1/1 Information about the battery of the AGV	n/a	[0..1]
[MLP] PowerTransmissionToExternal	[IRI] https://admin-shell.io/idta/smt/mlp/powertransmissionexternal Information about mechanical or electrical power transmission capabilities from the AGV to external devices	[langString]	[0..1]

3.7 SubmodelElements of SMC “Battery”

Table 8: Submodel elements of “Battery”

idShort:	Battery		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/SubSection/1/1		
Parent:	Energy		
Explanation:	Information about the battery of the AGV		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	

[MLP] ChargingDeviceRequirements	[IRI] https://admin-shell.io/idta/smt/mlp/chargingdevicerequirements Requirements of the AGV for the charging station and infrastructure, e.g., voltage range or max. current	[langString]	[0..1]
[MLP] BatteryInformation	[IRI] https://admin-shell.io/idta/smt/mlp/batteryinformation Information about the used battery of the AGV, for example type of battery (e.g., NiCd), capacity and max. charge cycles	[langString]	[0..1]
[Prop] ChargingTimeAsSpecified	[IRDI] 0173-1#02-AAF391#006 Charging time of the AGV from empty to full capacity as specified by the manufacturer Note: ECLASS definition: time needed to fully recharge the rechargeable battery from empty to full capacity	[Float] 3.5 h	[0..1]
[Prop] ChargingTimeAsOperated	[IRDI] 0173-1#02-AAF391#006 Charging time of the AGV from empty to full capacity as implemented in the current system Note: ECLASS definition: time needed to fully recharge the rechargeable battery from empty to full capacity	[Float] 4.25 h	[0..1]
[Prop] RemainingChargeCycles	[IRI] https://admin-shell.io/idta/smt/prop/remainingchargecycles Assumed remaining charge cycles of the battery	[Integer] 950	[0..1]

3.8 SubmodelElements of SMC “CommunicationAndControl”

Table 9: Submodel elements of “CommunicationAndControl”

idShort:	CommunicationAndControl		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1		
Parent:	TechnicalProperties		
Explanation:	Technical properties related to the communication and control of the AGV		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**

idShort	Description@en	example	
[MLP] CommunicationProtocol	[IRI] https://admin-shell.io/idta/smt/mlp/communicationprotocol Information regarding the supported communication protocols, like MQTT, HTTP, OPC UA or ROS2	[langString]	[0..1]
[MLP] CommunicationNetwork	[IRI] https://admin-shell.io/idta/smt/mlp/communicationnetwork Information regarding the supported communication networks, like WLAN, 5G or IrDA	[langString]	[0..1]
[MLP] VDA5050InterfaceDescription	[IRI] https://admin-shell.io/idta/smt/mlp/vda5050InterfaceDescription Information about the MQTT communication according VDA 5050	[langString]	[0..1]
[MLP] AutomationInterface	[IRI] https://admin-shell.io/idta/smt/mlp/automationinterface Information about the supported automation interfaces and standards, like ROS1, ROS2, IO-Link or OPC UA	[langString]	[0..1]
[MLP] ControlSystemInformation	[IRI] https://admin-shell.io/idta/smt/mlp/controlsysteminformation Information regarding the used control system for the vehicle, e.g., SPS	[langString]	[0..1]

3.9 SubmodelElements of SMC “Safety”

Table 10: Submodel elements of “Safety”

idShort:	Safety		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1		
Parent:	TechnicalProperties		
Explanation:	Technical properties related to the safety of the AGV		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	

[MLP] ConformityToSafetyStandards	[IRI] https://admin-shell.io/idta/smt/mlp/conformitytosafetystandards Information regarding the safety standards that are met by the vehicle and certifications	[langString]	[0..1]
[MLP] ManualControlInformation	[IRI] https://admin-shell.io/idta/smt/mlp/manualcontrolinformation Safety information for manual control of the vehicle	[langString]	[0..1]
[MLP] SafetySensorTechnology	[IRI] https://admin-shell.io/idta/smt/mlp/safetysensortechnology Information about the sensor technology implemented to ensure vehicle safety	[langString]	[0..1]
[MLP] SafetyMechanics	[IRI] https://admin-shell.io/idta/smt/mlp/safetymechanics Information regarding implemented mechanical measures to ensure safety	[langString]	[0..1]

3.10 SubmodelElements of SMC “TemporaryTechnicalData”

Table 11: Submodel elements of “TemporaryTechnicalData”

idShort:	TemporaryTechnicalData		
Class:	SubmodelElementCollection		
semanticId:	https://admin-shell.io/ZVEI/TechnicalData/MainSection/1/1		
Parent:	TechnicalProperties		
Explanation:	Temporary technical data depending on the implementation at the operator and current configuration		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] CurrentWorkingSetupName	[IRI] https://admin-shell.io/idta/smt/prop/currentworkingsetup Name of the current working setup	[String] SetupMontage01	[0..1]

[Prop] ActiveLoading	[IRI] https://admin-shell.io/idta/smt/prop/activeloading Describes whether the AGV is currently able to load itself (true)	[Boolean] yes	[0..1]
[Prop] LoadingType	[IRI] https://admin-shell.io/idta/smt/prop/loadingtype Way of loading of the AGV, the enumeration acc. VDI 2510 can be used: "FORKS", "LIFTING TABLE", "ROLLER CONVEYOR", "CHAIN CONVEYOR", "BELT CONVEYOR", "TELESCOPIC TABLE", "CLAMPS", "ASSEMBLY INSTALLATION", "HANDLING DEVICE"	[String] FORKS	[0..1]
[MLP] LoadingRequirements	[IRI] https://admin-shell.io/idta/smt/mlp/loadingrequirements Requirements and instructions when loading with the current setup, e.g., load floor to floor vs. height difference	[langString]	[0..1]
[SML] CurrentAttachments	[IRI] https://admin-shell.io/idta/smt/sml/currentattachments List with the identification of current attachments on the AGV, e.g., for load handling	typeValueListElement: [Property] valueTypeListElement: [xs:String]	[0..1]
[SML] ProprietaryConfigurationOptions	[IRI] https://admin-shell.io/idta/smt/sml/proprietaryconfigurationoptions List with proprietary vehicle configuration settings	typeValueListElement: [SubmodelElementCollection]	[0..1]

3.11 SubmodelElements of SML “CurrentAttachments”

Table 12: Submodel elements of “CurrentAttachements”

idShort:	CurrentAttachments
Class:	SubmodelElementList
semanticId:	shell.io/idta/smt/sml/currentattachments
Parent:	TemporaryTechnicalData

Explanation:	List with the name of current attachments on the AGV, e.g., for load handling		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[Prop] n/a	[IRI] https://admin-shell.io/idta/smt/prop/attachmentid Name of a current attachment on the AGV, e.g., for load handling	[String] Fork120	[0..1]

3.12 SubmodelElements of SML “ProprietaryConfigurationOptions”

Table 13: Submodel elements of “ProprietaryConfigurationOptions”

idShort:	ProprietaryConfigurationOptions		
Class:	SubmodelElementList		
semanticId:	https://admin-shell.io/idta/smt/sml/proprietaryconfigurationoptions		
Parent:	TemporaryTechnicalData		
Explanation:	List with proprietary vehicle configuration settings		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] n/a	[IRI] https://admin-shell.io/ZVEI/TechnicalData/SubSection/1/1 The SMC contains: [Prop] OptionName with IRI: https://admin-shell.io/idta/smt/prop/optionname and definition: Name of the proprietary configuration option [Prop] OptionValue with IRI: https://admin-shell.io/idta/smt/prop/optionvalue and definition: Value of the proprietary option	n/a [String] additional battery [String] available	[0..1] [1] [1]

Appendix A – Additional information

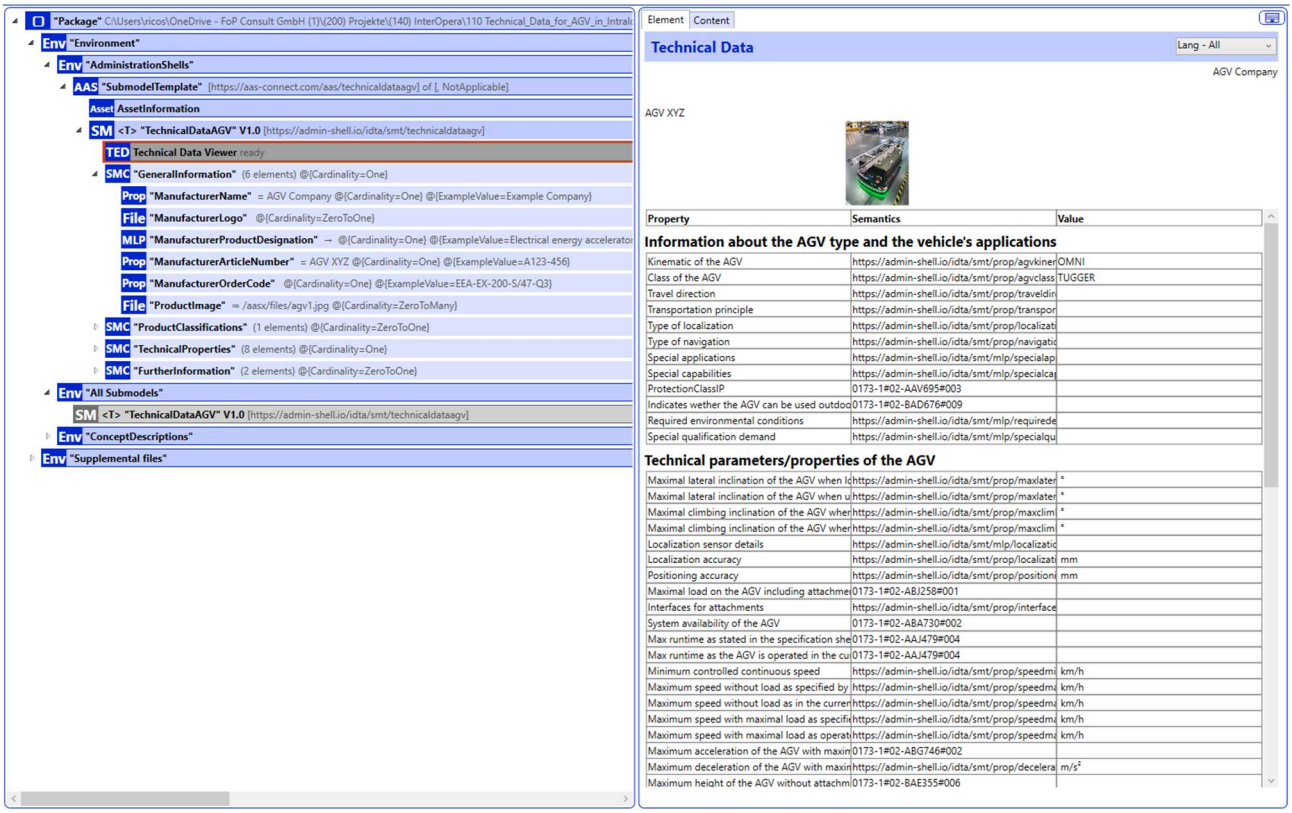

Figure 4: Screenshot of the Technical Data Viewer (specific plug-in of the Package Explorer)

The Technical Data Viewer is going to be activated within the Package Explorer when the semanticId of the SMT “Generic Frame for Technical Data for Industrial Equipment in Manufacturung” is used. The semanticId is: „https://admin-shell.io/ZVEI/TechnicalData/Submodel/1/2“.

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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